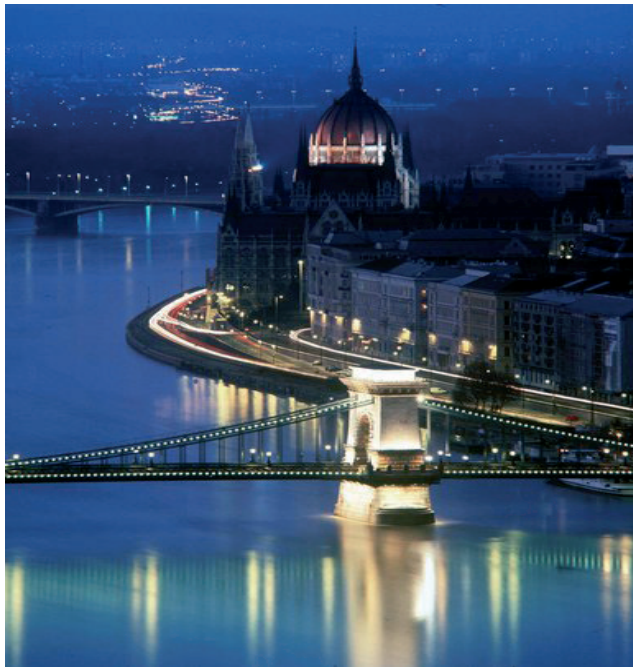


**Proceedings of the  
12th International Symposium on Logistics  
(ISL 2007)**

***Developing Sustainable Collaborative  
Supply Chains***



**Kulwant S Pawar, Chandra S Lalwani and Moreno Muffatto**

**Editors**

# ***Developing Sustainable Collaborative Supply Chains***

**Proceedings of the  
12th International Symposium on Logistics  
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Nottingham University  
**Business School**



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**Kulwant S Pawar, Chandra S Lalwani, Moreno Muffatto  
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## **INTRODUCTION**

*We would like to welcome our friends and colleagues to the annual International Symposium on Logistics (12th ISL). It is 14 years since the first symposium on Logistics was held in Nottingham in 1993 and has now become a regular, well-established and premier international event in the field of Logistics and Supply Chain Management. As always many members of the ISL community look forward to meeting, sharing and exchanging their research ideas and results in both a formal and informal setting which the symposium provides. The ISL series continues to grow in strength and stature in terms of contributions made by the participants to the field of Logistics and Supply Chain Management. Similarly, the concept of alternating the symposium every year between Europe and the rest of the World is now well established. To date this event has successfully been held seven times in Europe (Nottingham, UK 1993 and 1995, Padua, Italy 1997, Florence, Italy 1999, Salzburg, Austria 2001, Seville, Spain 2003, Lisbon, Portugal 2005) and four times outside Europe (Iwate, Japan 2000, Melbourne, Australia 2002 and Bangalore, India 2004, Beijing, China 2006). This year's event in Budapest, Hungary continues with the tradition following the very successful and productive event held in Beijing, China last year. As usual ISL 2007 brings together leading academics, researchers and practitioners to exchange ideas, views and the latest research in the field of Logistics and Supply Chain Management.*

*The theme of this year's 12th International Symposium in Logistics is "Sustainable Collaborative Global Supply Chains". To a certain extent this theme capitalises and builds upon the papers presented during the previous two ISL events. It also represents an emerging and highly challenging area of research and practice for both academics and practitioners alike. The current industrial context is characterised by increasing global competition, decreasing product life cycles, flexible structure of manufacturing, increased levels of global outsourcing, collaborative networked organisations, higher levels of uncertainties and, above all, customers, who are demanding higher levels of service. This means that the challenges to supply chain management have never been greater. In our view holding this event in Hungary represents a timely opportunity for academics and researchers to explore pertinent issues surrounding logistics and supply chains with Hungary now emerging as a 'global manufacturing factory'. This year's symposium attempts to address some of these issues.*

*Potential authors were invited to submit an abstract to the Symposium Chairmen. All abstracts were reviewed by two experts from the International Advisory Committee and final papers were further reviewed by an International Panel of Reviewers. As a result papers are included in this volume with 220 contributing authors coming from 23 countries. This book of proceedings has been organised according to the following categories:*

- **Supply Chain Management**
- **Design and Organization of Supply Chains**
- **Supply Chain Uncertainty**
- **Supply Chain Diagnostics**
- **Supplier Involvement in Product Development**
- **Logistics Planning and Control Models**
- **Outsourcing and Global Logistics**
- **Environmental Logistics**
- **Decision Support Systems and Communication Technologies including RFID**
- **Inventory Management**
- **Transport and Distribution**

*We would like to take this opportunity to express our sincere thanks to all the presenters, delegates, reviewers, Advisory Committee members, local organization committee members, and guest speakers for their interesting and valued contributions.*

*Finally, our very special thanks go to Alison Parrett for her wonderful all round administrative support throughout the entire organisation often under stressful, demanding and unpredictable circumstances.*

*Professor Kulwant S Pawar and Professor Chandra S Lalwani*

**July 2007**

# **SUPPLY CHAIN MANAGEMENT**



## **INTEGRATION STRATEGIES: AN EMPIRICAL INVESTIGATION**

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### **ABSTRACT**

An increase in the level of supply chain integration is often seen as one of the main factors to increase performance in a buyer-supplier relationship. This paper assumes that more integration is not always beneficial. Based upon survey data five clusters that differ in the type and level of integration are distinguished, that hardly differ in performance. An important managerial implication is to be cautious in pursuing integration.

### **INTRODUCTION**

Frohlich and Westbrook (2001, p. 185) introduced their study by noticing that "Our knowledge is relatively weak concerning which forms of integration manufacturers use to linkup with suppliers and customers". Nowadays, it seems that the strategic importance of integration and its effect on performance are not subject to debate anymore. There is an almost an overwhelming empirical evidence showing the positive relationship between integration and performance. Despite the amount of supply chain integration research following and extending the approach of Frohlich and Westbrook (2001), we still know little concerning the forms of integration. One of the reasons can be as Ho et al (2002) suggest that there is little consistency in the basic definitions and contents of the constructs used in supply chain integration studies.

Much of the integration research seems to be based on Stevens (1989). Stevens (1989) proposes a straightforward path of four stages of integration: from baseline to functional integration and onwards to internal integration, to reach external integration in the fourth stage. Based upon cross sectional data several authors have found evidence for these stages of integration (Childerhouse and Towill, 2002, 2003; and Gimenez & Ventura, 2003, 2005). Within this type of research different forms of integration are interpreted as the level of integration. The same type of reasoning is implicitly present in much of the more recent survey based research in supply chain integration (Van der Vaart and Van Donk, 2007). Although we realize that it simplifies much of this research, the conclusion from this research is mainly - as stated above - that an increase in integration increases performance. Within this body of knowledge, forms of integration have been measured in different ways: Frohlich and Westbrook (2001) differentiate between upstream and downstream integration (integration with customer and supplier respectively) and they measure the "degree of integration" as being the level of the integrative practices. Others (e.g. Droge et al, 2004) distinguish between internal and external integration as forms of integration or look at a certain aspect (e.g. information integration (Culp et al, 2004)). Although an impressive number of diverse aspects have been measured by different authors (see Van der Vaart and Van Donk (2007) and Das et al (2006) for a list of constructs and variables), we do hardly know if and how organisations differ in supply chain integration.



In this paper we assume, building on recent work by Das et al. (2006), that more supply chain integration – irrespective how it is measured – is not always required or beneficial. Das et al (2006) focus on the multivariate nature of integration, they argue that “unique configurations of integration practices will yield superior performance” and that sometime a reduction in initiatives, “contrary to the ‘more is better’ belief” is needed (p. 564). Our investigation is in line with this last point.

The aim of this paper is to find empirical evidence for the proposition that different forms of integration can lead to comparable levels of supply chain performance. As such, this paper is in line with Bask and Juga (2001) who state that some organisations might need a high level of overall integration whereas others require only intense integration in selected areas. Different forms of supply chain integration are measured based upon recent work by Van der Vaart and Van Donk (2007). They distinguish three different supply chain integration dimensions, derived from an in-depth analysis of items used in integration research. These dimensions are labelled as supply chain practices, patterns and attitudes. Supply chain practices are tangible activities or technologies that play an important role in the collaboration of a focal firm with its suppliers and/or customers. Supply chain patterns are the modes of interaction used for the exchange of information and for planning. And, finally, supply chain attitudes can be seen as the attitudes of buyers and/or suppliers towards each other or towards supply chain management in general.

We expect that organizations show different configurations in these three dimensions without having an effect on their performance. For example it might well be that some have higher levels of integration in supply chain patterns while others might have higher levels in practices. Following the type of research design from which the three dimensions are derived, it was found appropriate to answer the main questions by performing a survey.

The paper is structured as follows. First, we will sketch the theoretical background of our work and define the concepts of supply chain practices, patterns and attitudes. Next, we will describe the methodology of the paper. Subsequently, we will present and discuss the results. And finally, we will draw the conclusions from the research.

## **THEORETICAL BACKGROUND**

This section will elaborate the three dimensions of integration: supply chain practices, patterns and attitudes and develop our central proposition on the relationship between supply chain integration and performance.

Based on a literature review of survey-based research in supply chain integration Van der Vaart and Van Donk (2007) distinguish three different types of items to measure supply chain integration: supply chain practices, patterns and attitudes. Supply chain practices can be defined according to Van der Vaart and Van Donk (2007) as tangible activities or technologies that play an important role in the collaboration of a focal firm with its suppliers and/or customers. Examples of these items are: the use of integrated production planning, packaging congruence, Vendor Managed Inventories (VMI) and deliveries synchronisation (e.g., De Toni and Nassimbeni, 1999; Frohlich and Westbrook, 2001; Kulp et al., 2004).

Supply chain patterns are the patterns used for the exchange of information and for planning. In other words, patterns are the modes of interaction between the focal firm and its suppliers and/or customers. Example activities are regular visits

to the supplier's facility, frequent face-to-face communication, high corporate level communication on important issues with key suppliers and formal, periodic written evaluation of suppliers (e.g., Bagchi and Skjoett-Larsen, 2005; Carr and Pearson, 1999; Chen et al., 2004; Duffy and Fearne, 2004; Stanley and Wisner, 2001).

Finally, supply chain attitudes can be seen as the attitude of buyers and/or suppliers towards each other or towards supply chain management in general. Examples of items used in the questionnaires are "we expect our relationship with key suppliers to last a long time", "we view our suppliers as an extension of our company", "problems that arise in the course of this relationship are treated as joint rather than individual responsibilities" and "the responsibility for making sure that the relationship is works for both the other party and us is shared jointly" (e.g. Chen et al., 2004; Johnston et al., 2004).

As stated in the introduction many researchers have investigated the – positive – effect of supply chain integration on performance. Typical examples of the hypotheses tested which are mostly confirmed are: better performing plants exhibit higher use of advanced buyer-supplier operational practices (De Toni & Nassimbeni, 1999); there is a positive impact of supply chain interactions on an organization's time-related performances (Salvador et al., 2001); and companies with the greatest arcs of supplier and customer integration will have the largest rates of performance improvement (Frohlich & Westbrook , 2001). Bask and Juga (2001) argue that the holistic view on integration needs revision, as tight integration is only the answer for some organizations. For others integration might only be needed on selected areas. Others have doubted the general wisdom of the need to increase integration, as well. Bagchi et al. (2005) conclude "supply chain integration is more a rhetoric than reality in most industries in Europe" (p. 288), and that "the nature and extend of integration has been rather selective" (p 288). They also state that it seems to show wisdom not to integrate too much. More recently, Das et al. (2006) establish further doubt about the level of integration needed and suggest that there is an optimal level of investing in supply chain integration practices. Their empirical study supports the idea of an optimal set of supplier integration practices. Vickery et al (2003) pointed at the same effect for investments in IT. They show that ERP investments might negatively influence financial firm performance. Overall, we might conclude that the relationship integration-performance is less straightforward than the majority of the empirical research suggests.

There are some additional arguments from a methodological point of view. The above distinction into three dimensions shows that conceptually the constructs used are not always sound. Therefore, using these as new dimensions to further investigate the nature of the integration adds to our knowledge. Van der Vaart and Van Donk (2007) also doubt the relationship found in part of the research based on the measurement of performance as being too aggregate, financially skewed and not related to the performance of the buyer-supplier relationship. Based on the above concerns, we expect that organisations might differ in their supply chain practices, patterns and attitudes. The two related central propositions of this paper are:

*Different configurations of supply chain attitudes, patterns, and practices exist, but are not directly related to performance differences.*

More specifically:

*A higher level of supply chain integration does NOT necessarily imply a superior performance.*

In other words, we expect that organisations will show a high score on one or several of our three dimensions (practices, patterns or attitudes), without having the often expected high scores on all of them and without directly effecting performance of the relationship.

## **METHODOLOGY**

A web-survey questionnaire was developed after an extensive review of the literature. The survey included items to measure different dimensions of integration: practices, patterns and attitudes.

The starting population in this study was made up by companies in NACE Rev 1.1 business codes 21, 22, 24, 25 and 27-35 in Spain and The Netherlands. Our main focus was to investigate the relationship between a supplier and its main customer/buyer (in a business to business relation), so our target population was not known beforehand. Data collection took place from January to June 2006. In the Netherlands, 308 questionnaires were sent and 79 complete questionnaires were returned, giving a response rate of 25.6%. In Spain, the questionnaire was sent to 463 companies and 65 responses were obtained, giving a response rate of 14.04%. In total, it results in a sample of 144 companies from Spain and The Netherlands.

In the first step of the data analysis factor analysis was conducted in order to explore the underlying supply chain integration dimensions. The second step was the classification of the sample companies into groups through cluster analysis, in order to highlight the existence of differences in supply chain integration. As a final step the differences in performance improvement between the derived clusters were analysed.

## **RESULTS: INTEGRATION DIMENSIONS**

The factor analysis carried out, used principal components analysis with varimax rotation. In the interest of convergent and discriminant validity, we only considered items that had a factor loading higher than 0.6 and did not have important cross-loads (items with a loading on a second factor with a difference lower than 0.2 were omitted for further analysis). The solution explains 73.361% of the variance.

The first four factors embody practices. *Packaging integration* refers to adapting the packaging materials (pallets, containers, etc.) to the needs of the key buyer, while *delivery integration* refers to the synchronisation of delivery activities. A third factor includes items regarding *planning information* ("we receive information about production plans, changes in the production plans, and sales forecasts"). The fourth factor comprises items addressing *joint improvement*, such as "working together to improve operations and logistics processes", and "working together to synchronize operations and logistics processes".

The fifth and sixth factor represent patterns, that is, the way both companies exchange information. While the fifth factor is related to *non-structured communication* (face-to-face communication, high corporate level of communication and the use of phones and videoconferences to communicate), the sixth factor in contrast is related to *structured communication* (direct computer-to-computer link, online access to the planning systems of the key buyer, and the use of formal communication channels).

The last two factors represent supply chain attitudes. *Long-term relationship* (the seventh factor) includes the following items: “we value a long-term relationship with our key buyer”, and “we see our relationship as a long-term alliance”. Finally, *cooperative behaviour* includes items such as “the parties would rather work out a new deal than to hold each other to the original terms when some unexpected situation arises”, and “it is expected that the parties will be open to modifying their agreement if unexpected events occur”.

To summarize, the eight factors found in the analysis are all homogeneous in the sense that all underlying items are only practices, only patterns or only attitudes. A first result of this paper is that supply chain integration can be distinguished as consisting of supply chain practices, patterns and attitudes.

### CLUSTER ANALYSIS: INTEGRATION CONFIGURATIONS

A five cluster solution was specified and a K-means cluster analysis was used to generate the results. Table 1 shows for each variable the mean values of the clusters (the centroids), which characterise each cluster. We compared the clustering variables by group means using a one-way ANOVA and Post Hoc tests. The ANOVA test showed that there were statistically significant differences between group means for all integration constructs except for the construct Long term relationships. The test of homogeneity of variances (Levene test) was performed to determine which post hoc analysis was most appropriate. Scheffé and Tamhane pairwise comparison tests were used to identify significant differences between individual pairs of groups on each integration construct. Table 1 also shows the results of the ANOVA and Post Hoc tests.

		Clusters					ANOVA Sig.
		1	2	3	4	5	
Practices	Packaging integration	3.38	6.17	6.03	5.71	3.29	.000
	Pairwise difference	(2, 3, 4)	(1, 5)	(1, 5)	(1, 5)	(2, 3, 4)	
	Delivery integration	5.84	5.81	6.36	6.42	4.68	.000
	Pairwise difference	(5)	-	(5)	(5)	(1, 3, 4)	
	Planning information	3.71	3.69	5.66	4.69	1.68	.000
	Pairwise difference	(3, 5)	(3, 4, 5)	(1, 2, 4, 5)	(2, 3, 5)	(1, 2, 3, 4)	
Patterns	Joint improvement	4.42	3.92	5.52	2.58	2.39	.000
	Pairwise difference	(3, 4, 5)	(3, 4, 5)	(1, 2, 4, 5)	(1, 2, 3)	(1, 2, 3)	
	Non-structured communication	5.59	5.48	6.03	5.78	4.88	.001
	Pairwise difference	-	-	(5)	-	(3)	
	Structured communication	2.48	2.46	5.29	5.03	1.89	.000
	Pairwise difference	(3, 4)	(3, 4)	(1, 2, 5)	(1, 2, 5)	(3, 4)	
Attitudes	Long term relationship	6.40	6.29	6.57	6.29	6.08	.176
	Pairwise difference	-	-	-	-	-	
	Cooperative behaviour	4.97	4.96	5.29	3.60	3.89	.000
	Pairwise difference	(4, 5)	(4, 5)	(4, 5)	(1, 2, 3)	(1, 2, 3)	
	NUMBER OF CASES	29	45	29	12	19	

Pairwise differences shown are significant at the .05 level

Table 1. Cluster solution

The above results suggest that there are different forms or configurations of integration. The discriminant analysis showed that the clustering algorithm classified 97.8 percent of the companies correctly, indicating very good differentiation among the clusters. The final centroids of the clusters are plotted in Figure 1.

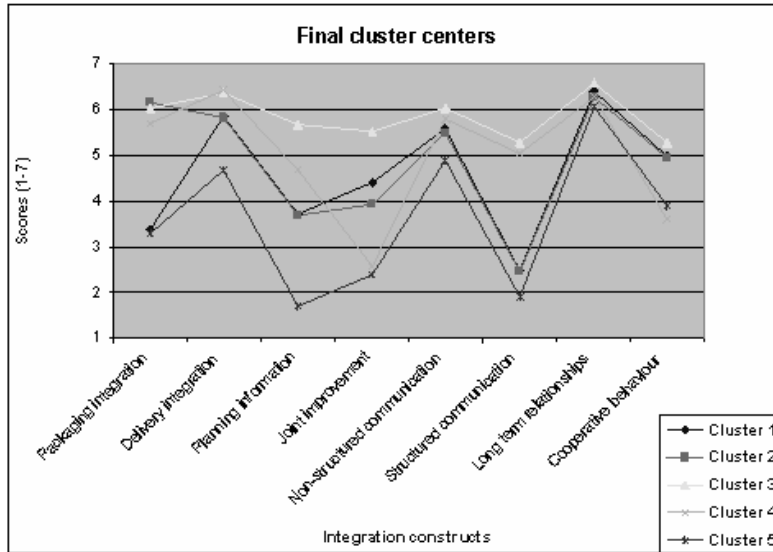


Figure 1. Graphical representation of the centroids of the five cluster

### **Comparison of the performance improvement between the five clusters.**

Finally, to test the main proposition of this paper, we consider the performance improvement in each of the configurations of integration. To compare the performance of the five clusters we compared the group means using a one-way ANOVA and Post Hoc tests.

The results show that there are only a few significant differences in performance between the clusters. That suggests that the configuration of integration does hardly influence supply chain performance. Significant differences in performance between clusters are only found with respect to the delivery lead times and reliability (delivers on the agreed date). Cluster 3 and 4 perform significantly better than cluster 5 with respect to improvements in delivery lead times. Cluster 4 also outperforms cluster 2 with respect to both improvements in delivery lead times and improvements in reliability (agreed date).

### **INTERPRETATION AND DISCUSSION**

The results of the above analysis suggest that five clusters can be distinguished. In this section the implication of these five clusters are explored. Cluster 3 represents suppliers with high scores ( $> 5$ ) on all integration factors. Cluster 5 on the other hand embodies suppliers with low scores ( $< 5$ ) on all but one integration factor. Moreover the comparison of means shows the difference between these two clusters is statistically significant on all integration factors except for long-term relationship. Therefore, it seems obvious to label cluster 3 and cluster 5 as High Integrators and Low Integrators, respectively. This seems an obvious result and in line with earlier findings. However, in contrast to earlier

studies, there are only limited performance differences between the two clusters, in line with our expectations.

The other three clusters have a mixed profile. These clusters score high on some integration factors and low on others. The comparison of means show that there are no significant difference between these three clusters with respect to the factors long-term relationship and non-structured communication. The same holds for the comparison with the clusters labelled as High Integrators and Low Integrators. That means that the two mentioned factors are not relevant for the interpretation of the clusters 1, 2 and 4.

Cluster 1 is a cluster that is characterized by the fact that the means of all integration factors lie somewhere between the means of the scores of the High Integrators and the Low Integrators. The comparison of means shows that there are many significant differences with High Integrators, with Low Integrators or both. This cluster is labelled as Medium Integrators. Remarkably, cluster 1 scores relatively low on factors that involve buyer-specific (or transaction-specific) investments like packaging integration and structured communication and scores relatively high on delivery integration and cooperative behaviour.

Table 4 shows that there is only one significant difference between cluster 1 and 2. That is that cluster 2 scores much higher on packaging integration. This difference seems to provide evidence that there is not only a difference in the level of integration but that in different relationships specific integration factors are important. Cluster 2 is labelled as Medium Integrators (with Packaging Integration).

Cluster 4 also indicates that differences in supply chain integration are more subtle than only differences in the level of integration. Suppliers in this cluster score on average high on the integration factors that involve specific investments (packaging integration and structured communication), but remarkably low on joint improvement and cooperative behaviour. Apparently these supplier are well integrated with their buyers in certain areas and did some specific investments for their key buyer, but the relationship is not very cooperative and parties do not work together to achieve improvements. An explanation might be that the buyer has the power in the relationship to force the supplier to invest in for instance certain packaging materials and EDI. Cluster 4 is labelled as High Integrators (Non-Cooperative).

A preliminary conclusion is that different clusters can be distinguished and that these clusters not only differ in the level of integration, but also in the form or configuration of integration. The presumption is that companies choose different levels and types of integration and that higher levels not necessarily lead to comparable improvement in performance. Although the results presented in table 5 show a few significant differences between the clusters, overall it provides support for this presumption. Illustrative is that the High Integrators only outperform the Low Integrators and only do so with respect to one of the 16 performance items (improvements with respect to delivery lead times).

The results above are partly in line with the results by Das et al (2006): more investments in integration do not pay off from above a certain level. However, our results are beyond those presented in the earlier literature in two ways. Firstly, our results suggest that what can be considered as an 'optimal' level of integration might be different for different groups/clusters of organisations. Secondly, our results indicate that different configurations of integration exist along the lines of the three basic dimensions: attitudes, patterns, and practices. A possible explanation is that supply chain integration research has insufficiently

paid attention to other factors that might influence the configuration of integration. We already mentioned transaction-specific investments, power and trust. Other relevant factors might be the level and type of uncertainty in demand, or the distinction made by Fisher (1997) in innovative and functional supply chains, or the type of production system (Van Donk and Van der Vaart, 2003).

Another issue to discuss relates to approaches that present stages of integration (like Stevens, 1989). Our results suggest that an appropriate level of integration might be different for different suppliers, and consequently that standardised stages from low to high integration might be far from adequate for practical use. Longitudinal research, rather than cross-sectional can clarify such issues better.

### **CONCLUSION AND FURTHER RESEARCH**

The main aim of this paper was to better understand the relationship between supply chain integration and performance. We specifically challenge the assumption that more integration improves performance. Building upon three dimensions of integration: practices, patterns, and attitudes, a survey is performed that distinguishes five clusters of organisations that hardly differ in their performance but significantly differ in their type or configuration of supply chain integration. These differences not only apply to the level of integration, but also in a clear distinction in which integration constructs are employed. For example, differences are detected in the use of Packaging Integration, and in the use of Joint Improvement or the willingness to cooperate. Another contribution of this paper is that it empirically assesses these three supply chain dimensions.

The current research has a number of limitations. We have only gathered data from suppliers and not from more partners in a chain. Our sample might be small and not totally representative. Although the last point will not influence the general conclusion, it might influence the integration constructs found as well as the clusters detected. A larger sample across more industries, including buyers might detect that other factors emerge, but without doubt the general pattern of practices, patterns and attitudes will surely be visible.

We submit that the paper has an important managerial implication. Rather than following the rhetoric of striving for 'integration', managers should carefully select those practices and patterns that suit their situation. Unfortunately, this paper does not indicate which factors are most influential and how this should influence these choices. Further research, along the lines sketched in the discussion is needed, that should include such factors as power, uncertainty in demand, and other business characteristics. A last concern for future research is, as mentioned, research that follows companies with respect to their supply chain integration efforts and the effect of those efforts over a number of years.

*A list of references along with additional tables is available from the authors upon request.*

## **CPG INDUSTRY – FORMULATING ROBUST IT STRATEGIES TO TACKLE SUPPLY CHAIN DYNAMICS**

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### **ABSTRACT**

The combined effect of higher customer expectations and the need to enhance shareholder value is driving a sustained focus on various Information Technology adoption strategies such as Product Life Cycle Management (PLM) and Master Data Management (MDM) in the Consumer Packaged Goods (CPG) industry. In order to have a sustainable competitive advantage, organizations need to formulate robust IT strategies to tackle the unique supply chain dynamics of the CPG industry.

A highly competitive market characterized by a number of global players, the CPG industry is going through frequent mergers and acquisitions resulting in the integration of diverse business processes, systems as well as product portfolios. Additionally, tighter industry regulations, and the constant requirement for new product innovation to be “in touch” with the consumer are some of the inevitable extrinsic factors that drive supply chain dynamics.

In this article, we highlight the top 3 challenges that a number of CPG companies grapple with and suggest a framework to adopt ‘best-fit’ IT strategy that effectively supports business imperatives.

### **INTRODUCTION**

Consumer Packaged Goods manufacturers, specifically the food and beverage producers and retailers understand that new products are the lifeblood of driving profitability. Launching a new product successfully is one thing, but scaling quickly into steady state and sustaining long term brand value is a proven way to beat the competition. There is nothing more frustrating for CPG sales and marketing leaders than to drive the formulation of an attractive product or packaging, and then not being able to launch or build volume on time. Even a small misstep in a product launch execution can significantly impact the growth potential of sound strategy and great innovation.

Traditionally, the new CPG product success rate has been low and this has been an area of focus for quite some time now. A study by Information Resources Inc. as quoted by IBM in their 2004 report, states that only 4% of the products introduced really succeed in the market place<sup>1</sup>. Typical challenges associated with new product introduction include:

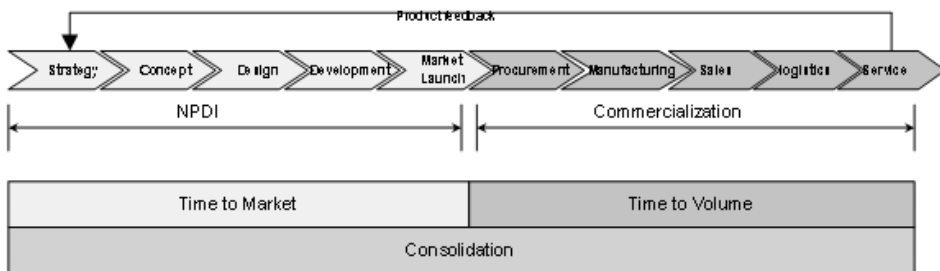
- Lack of historical data and uncertainty associated with consumer demand
- Incorrect & unclear data on important checkpoints on the launch continuum
- Operation silos and a lack of single version of truth impeding agile execution



Planned activities constantly change in any supply chain, variability is inherent, and is more pronounced as the complexity increases. But by gaining quick access, as well as communicating dynamic information across functions, the effect of variability is minimized. It is in this context, that the right information technology strategy can be a competitive advantage.

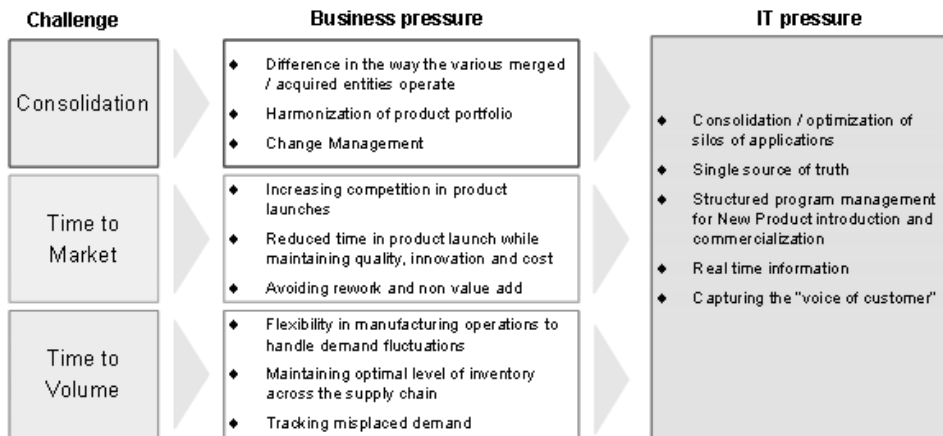
**TOP 3 CPG BUSINESS CHALLENGES:**

The influence of big box retailers on CPG manufacturers has been enormous. By establishing closer relations with end consumers, and with the expensive and limited shelf space, they have been able to dictate terms, and manufacturers have no options but to respond. The biggest challenges lie in this process of enhancing the response mechanism. To achieve seamless integration of the new product design/introduction and commercialization functions, rapid time to market as well as time to volume supported by effective consolidation of diverse processes and systems is critical (Fig.1)



**Fig.1: Top 3 CPG Industry Business Challenges**

The implications of these challenges on business and IT are depicted in the figure below (Fig. 2)



**Fig.2: Key Challenges and their implications on Business and IT**

**TIME TO MARKET**

According to a 2006 IBM institute for business value study, apart from consumer need identification, reducing the time to market is one of the most significant challenges in the new product development and introduction.<sup>2</sup> The key requirement and success of any new product launch program primarily depends on reducing the time to market. By reducing the time to market, CPG firms can claim the leadership position for the specific product being launched. Time to market assumes much more significance considering the very short product life cycles that characterizes the industry.

Quantitatively, Information Technology's 1Q 2004 report, states that manufacturers can realize around 25% price premium for being able to bring out new products faster than competitors. There is an additional motivation too – around 2.5% increase in revenue for around 10% increase in product innovation instances.<sup>3</sup>

Increasing number of CPG companies are turning to PLM applications to provide timely information visibility and shrink new product trial and launch cycles. Manufacturers have been able to leverage information availability and accessibility across functions and regions to smartly position and move the products thro the pipeline quickly, and avoid the typical pitfalls during trial and launch cycles. Additionally, dynamic review of initial market feedback happens, and this instantaneously drives the required customizations in product formulations or other design features. P & G, Coke and Heinz are a few examples of PLM implementations.

**TIME TO VOLUME**

By definition, PLM drives "de-segmentation" of information across functions and develop independent information representations of all products that will be made available to all functions like product formulation/labeling design, manufacturing, sales, customer support and retirement. All changes associated with the product during its lifecycle will be collated and will be easily accessible not only across the organization's supply chain, but also across relevant functions in the partner's supply chain.

In the context of time to volume, or time to ramp-up, it is the above practice that helps detect and correct quality issues quickly. During a new CPG product batch trial, it is important to not only capture quality specification performance in the production cycle, but also to know how the product performs in its usage out in the field. Based on both of these quality data, design and specifications could be tweaked in time, and may be even loosened to cut back un-necessary time and resources aimed at meeting rigid requirements that may not be required to begin with.

Another facet of PLM which enables time to volume is its integration capability with various business systems in the CPG value chain. Being 'in-touch' with diverse Design, Demand and Supply Chain Planning, ERP and CRM systems, PLM taps information quickly and communicates any changing product / labeling requirements, regional regulations as well as leveraging any unknown ideas and best practices to reduce ramp up time.

Additionally, in a market that demands product customization and differentiation, PLM enables quick formulation design changes that can largely require common raw materials and production processes at the initial stages, but which can be tailored at later steps to meet customer specific requirements, and still reduce time to volume. Also, by soliciting customer inputs during early stages of product design and avoiding "complex and over design", the product cycle times can be accelerated.

### **INDUSTRY CONSOLIDATION**

Companies across industry verticals have tried to capitalize on the globalization wave, but the activity seen in the CPG industry has been unprecedented. As a means to increase their market share and kill competition, global CPG companies have resorted to inorganic growth in a big way through mergers and acquisitions of either their direct competitors for specific product lines, or companies with unrelated product lines to expand product portfolio. Examples include P&G - Gillette, Kraft Foods - General Foods, Kellogg - Worthington, and Estee lauder - Darphin.

Consolidation has been good for many reasons, but it has also brought with it, critical challenges around harmonizing product lines, synergizing the diverse operating cultures and supply chain strategies, and above all, formulating appropriate Information Technology strategy to support seamless consolidation.

In the consolidated scenario, the IT application landscape is all the more complex with diverse applications, which can be a mix of best of breed and enterprise applications from different vendors. Critical data such as customer, product, pricing, promotions are maintained in multiple applications. Enterprise application integration to achieve a single source of truth is both costly and time consuming.

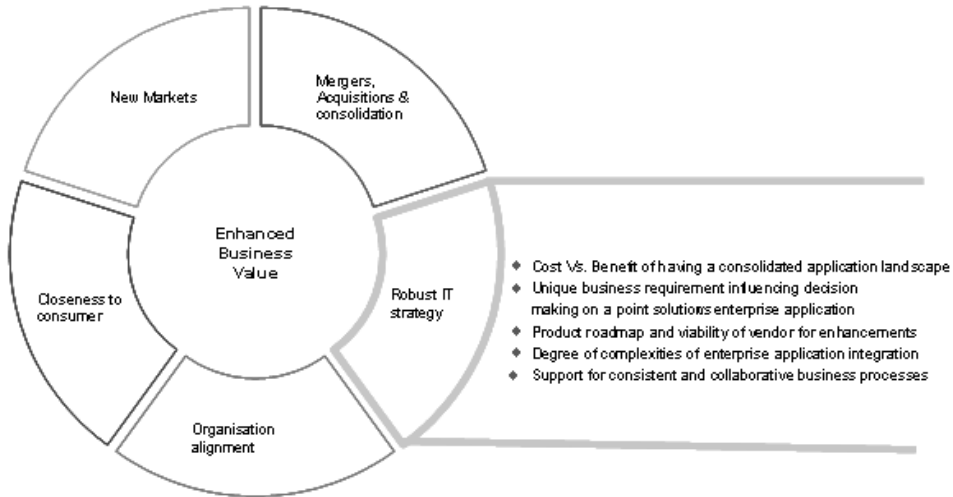
Having an appropriate PLM and MDM application that works well off the other back-end applications is very critical, more so in the consolidated scenario. While PLM package ensures the required information availability from a product introduction perspective, a complimentary MDM ensures that data is available at a central location about products that would help the commercialization aspect of the product.

### **FORMULATION OF A ROBUST IT STRATEGY**

CPG companies need to put in place a robust IT strategy that can help mitigate the above critical challenges and stay ahead in the competitive marketplace. A good analysis of the following questions can facilitate formulating such a strategy:

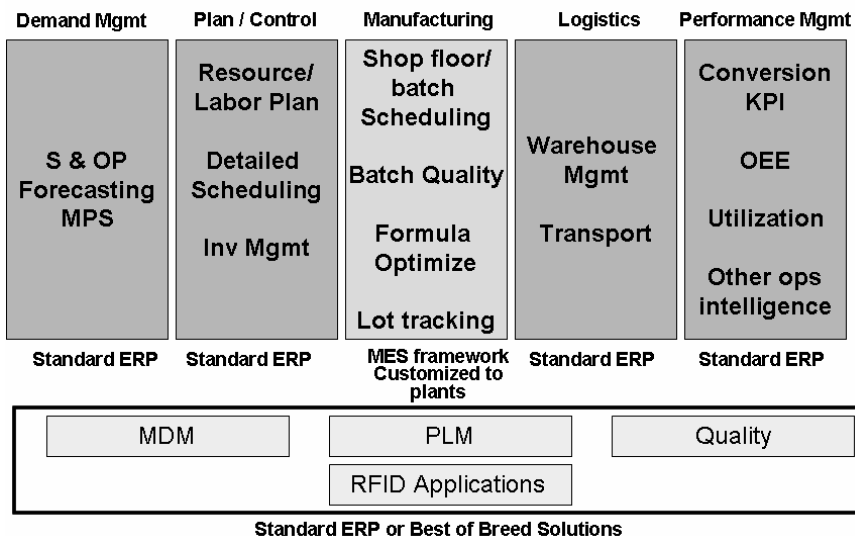
- ❖ What are the business drivers and metrics?
- ❖ What is the Current and desired state for each of those metrics?
- ❖ What are the different ways to reach the desired state?
- ❖ How can IT effectively play the role of an enabler in achieving the desired state?
- ❖ What is the current application landscape?
- ❖ How to decide and align IT applications that best fits the requirement?

Effective IT strategy contributes significantly to enhancing business value and sufficient consideration needs to be given to various key issues as shown in the figure below (Fig. 3)



**Fig.3: Robust IT Strategy as contributor to enhancing business value**

IT strategy determines the mix of applications that best serve the needs of the organization and there is no one single solution that would fit all organizations. This may have to be considered considering the industry and organization context. For a typical CPG company undergoing the above mentioned challenges, a possible IT application landscape is illustrated in the figure below (Fig. 4):



**Fig.4: Typical IT application Landscape in a CPG company**

PLM and MDM are the two critical applications that can help in overcoming the challenges of Time to market, Time to volume and consolidation. It is important to note that while both have an important role to play in meeting the above three challenges, an appropriate PLM solution would differentiate organization success in overcoming the challenges of Time to Market and Time to Volume and a robust MDM solution would clearly be the need of the hour in a consolidation scenario.

Now coming to the strategy for PLM, it is to be noted that under the guise of application harmonization, organizations should not generally move towards consolidation of applications by having, for example, an ERP product providing PLM functionality. They should assess the actual business need and if it turns out that a point solution for PLM would be best suiting the needs, then, the PLM well integrated with other applications such as the ERP would be the key.

In scenarios where multiple small PLM solutions dotting the application landscape like formulation management, recipe management, it would be ideal to have one PLM solution that caters to more than a few business areas.

In a consolidated scenario, a MDM solution would bring significant benefits by acting as a central repository of all master data information, taking feeds from multiple applications, maintaining this data and sending the updates back to those applications, thus providing for a single version of truth. The debate of whether to have a best-of-breed solution or to ride on the functionality provided by an ERP vendor holds good here as well.

## **SUMMARY**

Compared to other industry verticals like Hi-tech and automotive, the CPG industry has lagged behind in adopting technology strategies to tackle complexities during new product innovation, as well as in harmonizing heavily segmented processes. In many ways, the power of major retailers are driving efficient response mechanisms, and an increasing number of companies are now turning to information technology to integrate stand alone processes, build agile response mechanisms and compete with the Best in Class. However, formulating custom fit technology strategies that caters to local as well as global requirements is critical to deliver that balance between cutting edge functionality and cost of ownership.

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## **ALIGNING RELATIONSHIP GOALS AND MEASURES WITHIN A LOGISTICS TRIAD**

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### **ABSTRACT**

The paper explores the three way relationship that exists between the logistics provider, the Shipper and the Consignee. It has been argued previously that this logistics triad should be seen as a fundamental building block of logistics provision and supply chain practice. This contrasts with the current emphasis in the literature on the two-way or dyadic relationship, which characterises much of the Buyer and Seller relationship literature for both tangible products and intangible services. After reviewing the literature on dyadic partnering including the importance of aligning goals and measures and proposing questions on how this may be applied in the triadic form, a logistics triad is rigorously researched, a new aligned performance goal and supporting measures are introduced and the results after nine months assessed. The paper concludes by proposing that although logistics relations need to be contingent to their environment, in some cases an extended aligned partnership across the logistics triad may overcome inherent weak links and support sustained performance improvement.

### **INTRODUCTION**

In modern supply chains environmental uncertainty, globalisation, time and quality based competition are all pressures encouraging a partnering or collaborative orientation. The argument put forward is that by partnering a competitive advantage can be achieved both in economic performance and customer satisfaction and loyalty (Mentzer et al, 2000). Much of the business relationship management literature has focused on this, exploring the two-way or dyadic interactions between two parties in the supply chain as a fundamental building block of supply chain management. This can be between the Buyer and Seller of the tangible product, or in logistics service provision between the Shipper and the Carrier (LaLonde and Cooper, 1989, Whipple et al, 1996). However, in logistics, a third party logistics provider (the Carrier) has an inherent relationship with not one but two connected parties; the party it is contracted to, the Shipper, and a further party it provides the physical link of goods movement with, the Consignee. This leads to the conclusion that business relationships in logistics should be assessed and managed on a tripartite rather than a dyadic basis between all three inter-connected parties (Beier, 1989).

This paper focuses on the logistics triad with the purpose of gaining a deeper understanding of how the misalignment of goals and measures between the three players may impact on their inter-relationships and performance. A literature review covering traditional logistics dyadic relationships and the importance of aligned goals and measures is initially covered, before the issues raised are reflected upon within the logistics triad concept. Research questions are formulated and the method explained. An indicative logistics triad in the steel industry is examined and the impact of realigned changes in goals and measures across the logistics triad after nine months is demonstrated.

### **THE SHIPPER – CARRIER RELATIONSHIP**

The fundamental “make or buy” question has not just been an issue for manufacturing or production of tangible goods. It has also become more generalised on customer service elements such as logistics provision. Increasingly over the last two to three decades logistics provision has been outsourced (Lieb et al, 1993) and consequently emphasis has been placed, both in academic literature and practical terms, on what type of relationship should ideally be sought between the Shipper and Carrier.

Logistics providers, as Carriers, play a vital role in supply chains and their development. As the link provider between the Shipper and Consignee they are integral cogs in the chain and act as crucial facilitators of modern supply chain management (Mason and Lalwani, 2006). Taking a systems perspective, as supply chain systems increasingly compete with supply chain systems (Christopher 1992) the inter-dependence of entities within the chain of supply has developed. Thus the importance of goods arriving consistently and reliably on time to the right place is invariably paramount. The literature suggests that in sectors where time and quality based provision are at the fore, trust, communication, successful collaboration, good decision making, and business performance are positively correlated. So partnering formation (rather than a transaction based relationship) is motivated primarily to gain a competitive advantage in the marketplace (Bleeke and Ernst, 1991).

Consequently the dyadic partnership in logistics provision, between the Shipper and the Carrier has been seen as a key building block when taking a supply chain management perspective. Ellram and Hendrick, (1995) defined a partnership as “an ongoing relationship between *two* firms that involves a commitment over an extended time period”. Specifically in logistics provision, LaLonde and Cooper (1989) defined a partnership as, “a relationship between *two* entities in the logistics channel that entails a sharing of benefits and burden over some agreed time horizon”. They found that there was a trend towards longer term relationships, especially so in industries where Shippers and Consignees were pursuing more responsive strategies such as Just in Time. But in logistics, the provider is the link between the two parties by necessity has a relationship with both of them; thus the notion of the logistics triad can be conceived (Beier, 1989).

### **RESEARCHING THE LOGISTICS TRIAD**

The logistics triad is inherently more complicated than the basic dyadic partnership. Instead of one dyadic relationship it proposes that as a core building block, outsourced logistics provision is in fact made up of three dyadic relationships as well as a triadic relationship shared by all three members of the triad (Beier, 1989). This is clearly illustrated in Figure 1 based on Bask’s (2001) research. A further complication is that although two relationships are underpinned by a contract - Relationship (1) between the third party logistics provider (A) and the Shipper (B), and Relationship (2) between the Shipper and the Consignee (C) - the third dyadic Relationship (3) between the third party logistics provider and the Consignee is much more informal. The challenge that Beier (1989) foresaw was for all the triad members to be able to, “monitor improvements and distribute the costs and benefits”.

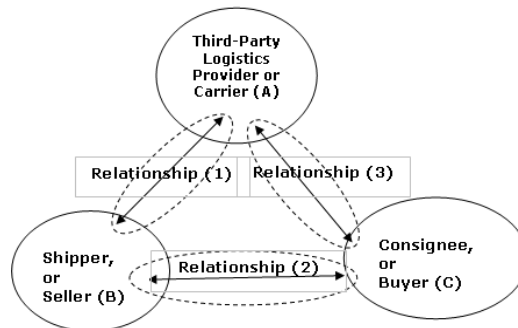


Figure 1: Three Dyadic Relationships among Seller, Buyer and Third-Party Logistics Provider (based on Bask, 2001)

Gentry (1996) proposed that, "increasing the Carriers' involvement within existing Buyer-Seller partnerships may allow additional opportunities for cost savings, service improvements, and increased equipment use for both partners over time". Through a questionnaire survey she found that joint management of Carriers did lead to an increase in joint problem solving efforts and the use of long-term contracts with Carriers. However since then, there has been a paucity of research in this area. Larson and Gammelgaard (2002) referred to Gentry (1996) who both observed that "virtually no research addresses the three way linkage of the transportation provider between supplier and purchasing firms", and we, along with other authors, have identified only a few other related studies (Bask, 2001 and Stefansson, 2006).

We therefore sought to further explore the notion argued by Bask (2001) that the relationships between all three members of the triad and across the triad itself are important. In particular our research asked if the better alignment of goals and measures across the logistics triad could enhance overall supply chain performance. The principal research question that emerged was:

*Given the additional complexities inherent in the logistics triad, is it possible to develop an alignment of jointly held goals and measures?*

### **ALIGNMENT OF GOALS AND MEASURES IN COLLABORATION**

Key to begin addressing this is to understand previous research on the alignment of goals and measures. Whilst there has been little research on this in the context of the logistics triad there has been research in this field focussing on dyadic partnerships. Fundamentally, the relationship between the Shipper and a Carrier is built around the performance of the Shipper which as a service provider is relatively intangible (Lu, 2003). Gentry (1996) supports this, suggesting that, "critical elements of successful collaborative arrangements are sustained service performance on behalf of the Carrier". But beyond this, to change from a short-term opportunistic stance to a longer term partnering position, both parties "must have a vision of a partnering relationship and the objective of developing such a relationship for it to work" (LaLonde and Cooper, 1989). In logistics relationships, to move from a day to day operational view to a longer term perspective requires an extension of the partnering base so that it is founded on multiple contacts across the organisation.



Barratt (2004) supports this noting that this range of relationships between two parties can be categorised into strategic, collaborative and cultural elements. Based on this framework the alignment of partnering goals at a strategic level and supply chain metrics at a collaborative level can be seen as key elements of this approach. The principal goal of partnership is for both companies that have engaged in a collaborative activity to improve their operations individually but also as the holistic supply chain (Fawcett and Clinton, 1996). Therefore, the adopted performance measures need to combine to support this endeavour. A second research question can therefore be proposed:

*If it is possible to develop an alignment of jointly held goals and measures between all three parties does the better alignment of them positively impact on supply chain performance?*

## **METHOD**

An action research based approach proposed by Coughlan and Coughlan (2002) was chosen to enable interaction between the researchers and the companies in the logistics triad. Action research is case-study based but differs from case studies in that it helps to change the subject of inquiry - through implementing the research findings - after the research is completed. Case studies provide a medium where both the researchers and the case companies realise benefits in that theories are developed to contribute to academic endeavours and concurrently offer practitioner relevance to industry. According to Voss et al. (2002), case studies are suitable for research involving exploratory, theory building, theory testing, and theory extension/refinement.

During May 2005, a team of researchers including the authors carried out a study on a steel supply chain using a methodology called the Quick Scan developed by Naim et al (2002). The underlying principal of the Quick Scan is that it allows a greater degree of depth to be obtained than via, say, a survey, particularly with regards to cause and effect analysis. However, it does not require an extensive amount of resource or period of time with a case company, hence minimising the disturbance to the organisations being observed (Towill et al., 2002). The supply chain consists of a primary steel producer (the Shipper), a steel tube manufacturer (the Consignee) and the logistics provider (the Carrier) which connects the two. The focus is on both the physical and information flows between the three companies.

The Quick Scan diagnostic is based upon four sources of data; attitudinal and quantitative questionnaires, process maps, structured interviews and archival information. The Quick Scan covers a 2-week period during which each member of the triad is visited and data obtained through process mapping, interviews and questionnaires. These form the qualitative stage of the data collection process. In addition, quantitative data by way of archival sources is also collected to be analysed. The questionnaire is broken down into sub sections of supply chain strategy, quality, level of partnering or collaboration with each triad member, IT development, and finally delivery issues and metrics. The interviews ask specialist questions to functional managers, such as managers for Raw Materials, Transport Operations, Customer Account and Production Control as well as Senior Managers for Sales and Operations on issues such as production planning, stock replenishment, delivery scheduling, etc.

Initially, each source of data is analysed individually by members of the research team. A brainstorming session is then held to develop a cause and effect analysis of the issues in the supply chain and to propose improvements to address these. Further analysis as required is carried out. A feedback presentation is given to all partners, from which a course of action was developed and implemented. The research team then carry out a follow up study, comprising interviews, nine months after implementation to identify the changes that have occurred within the triad.

### ASSESSING THE STATE OF RELATIONSHIPS ACROSS THE TRIAD

The level of partnering among the companies was quantified using the questionnaire findings. The findings are shown in Table 1. These are the statistical means of the views obtained from the respondents across the triad (1 = low, 5 = high). Reciprocal views on partnering by one partner on the other were compared and found to be similar, increasing the validity of the findings. The internal level of partnering between functions was higher for all partners, when compared to external relationships with the other partners. These results are along the diagonal of the table (3.2, 3.9, and 3.3).

1 = low; 5 = high		Subject of opinion		
		Shipper	Logistics Service Provider (Carrier)	Consignee
Source of opinion	Shipper	3.2	2.8 (1)	2.5 (2)
	Logistics Service Provider (Carrier)	2.8 (1)	3.9	1.9 (3)
	Consignee	2.7 (2)	1.0 (3)	3.3

**Table 1: The Levels of Partnering between the Triad Members.**

(The relationship number from Figure 1 is highlighted in brackets)

Looking at the relationships between the partners, there was a medium level of partnering in Relationship 1 between the Shipper and the Logistics Service Provider (equal reciprocal views of 2.8) and on Relationship 2 between the Shipper and Consignee (reciprocal views of 2.5 and 2.7). These were perhaps not surprising, as they reflected the traditional or contractual approach to conducting business. There was however, a low level of partnering (reciprocal views of 1.0 and 1.9) on Relationship 3 between the Logistics Service Provider and the Consignee.

While no dyadic relationship could be categorised as strong, the link between the Carrier, and the Consignee (Relationship 3), was especially weak. Interestingly, this was the only dyadic link where there was no under-pinning support of a contract. Working on the basis that a chain is, only as good as its weakest link the research team explored the causes of this weakness and what could be put in place to improve it. The Consignee, as the end customer in this triad, placed great importance in reduction of uncertainty of the order to delivery performance. However, due to a range of factors, promised production schedules were not always maintained and this led to behaviour such as over-ordering and the build up of buffer stocks to protect in-bound supply, but at additional cost. Our focus was particularly on the logistics triad and consequently it was felt critical that production and distribution performance measures were disaggregated so that greater transparency was available of the performance of each element of supply.

### MISALIGNMENT OF PERFORMANCE MEASURES

A major explanatory driver of these findings on the state of relationships was confusion surrounding goals and measures. It was found that there was only a superficial common alignment of goals and no sharing of performance measures across the triad.

Although the main goal for each company was ostensibly delivery on time and in full, the performance measures that did exist exposed that there were a range of interpretations held across the triad members of what this actually meant. In addition, each party had developed its own measurement system. The steel producer measured whether the steel coil was manufactured and ready for delivery, the steel tubes manufacturer whether the steel coil ordered was delivered at their site on the date promised by the Shipper while the logistics provider measured whether the steel coil requested to be shipped had been delivered to the transport plan. This confusion of goals and consequent misalignment in measures is summarised in Table 2.

	<b>Manufacturing Focused KPI</b>	<b>Transport Focused KPI</b>	<b>KPI Measure</b>
<b>Steel Producer</b> (Shipper)	<b>Yes</b>	<b>No</b>	<b>ROTT</b> Ready on Time Tonnes
<b>Logistics Provider</b> (Carrier)	<b>No</b>	<b>Yes</b>	<b>DOTT</b> Delivered on Time Tonnes
<b>Steel Tubes Manufacturer</b> (Consignee)	<b>Yes</b>	<b>Yes</b>	<b>R &amp; DOTT</b> Ready & Delivered on Time Tonnes

Table 2: Conflicting Measures across the Logistics Triad

The different criteria for what constituted a delivery on time-in full led to a 20% divergence in recorded performance between the Carrier and the Consignee over the sampled period. This created frustration and did not support the building of trusting inter-dependent relationships.

A new co-owned measurement system was developed by the companies and facilitated by the research team. This focused solely on the distribution goal of delivering the call off order on time-in full and clearly attributed ownership to the correct party when a mis-delivery occurred through a system of failure codes. In developing the new measures the logistics provider asked the Consignee, "what were the main failure areas for call off to the Consignee and failure to deliver on time-in full". Seven failure codes were then identified and these are summarised in Table 3. The failure codes were a vital element as they helped to sort out the "blame culture" when things did go wrong. The logistics provider was responsible for compiling the KPI sheet but before the results were published each week all parties had a chance to challenge any attributed failure codes that they felt were unmerited.

<b>Delivery Failure Codes</b>	
<b>Disbanded</b>	Loads planned by the steel producer but not found by steel producer dispatch team or logistics provider – so disbanded
<b>Delivery Failure</b>	Logistics provider failure to deliver by the time deadline
<b>Traffic Delays, Breakdowns</b>	Delivery failure outside logistics provider's control
<b>Late Call Off</b>	Delivery unable to take place due to late call off of order by tube manufacturer
<b>Late Planned</b>	Delivery unable to take place due to late planning of transport by logistics provider
<b>Steel Producer Issue</b>	Loading delay (inc. too hot to load steel which can take 2-3 days to cool).
<b>Steel Tubes Manufacturer Issue</b>	Failure to receive a load – e.g. no one to empty at receiving bays

Table 3: Summary of Failure Codes Adopted in the Logistics Triad

At the nine months review carried out by the research team it was clear that a renewed focus on the distribution operation had emerged. This centred on getting the load to the site, delivering it and following everything through to ensure the distribution job was done to a satisfactory level from all perspectives. This had had a dramatic impact resulting in a clear improvement in the actual and perceived performance of the distribution operation. Results for a typical six week delivery period showed that on time performance had improved substantially to 96% from a much lower figure earlier of around 75% at the time of the initial Quick Scan.

The improved performance and clarity in appropriating blame if deliveries went off plan, led to a substantial removal of frustration, back-biting and time-consuming problem solving that had generally fallen below the radar but were awkward to manage. Subsequently, this also resulted in softer improvements such as a more flexible, trusting and accommodating approach between the Carrier and the Consignee which was producing a solid foundation for strategic investments to be put in place to ensure continued performance improvement for all parties.

## **CONCLUSIONS**

Much of the logistics relationship literature focuses on the dyadic interactions between two parties in the supply chain. These relationships are normally underpinned by contracts. In the case of logistics, this can lead to a weaker relationship between the Carrier and Consignee, which reduces overall supply chain effectiveness. Our research has indicated that a renewed focus on all three relationships in the logistics triad, and especially the non-contracted element between the Carrier and the Consignee can help in the re-building of relationships in both competence and character based forms. We have demonstrated that it is possible to develop aligned goals and performance measures, therefore addressing the first research question. It should be added that the support at a strategic level from senior directors of all three companies as well as at the operational level was important. Reviewing the impact of the new performance measurement system reveals a significant improvement in delivery performance, along with stronger relationships throughout the triad.

As to the scalability, the potential would seem to exist to apply this further across each of the parties operations and other similar logistics structures. However, a triad is more complex than a dyad and scaling up such an idea will add even more complexity. The importance of the Carrier in developing their role as supply chain leaders has also been demonstrated linking Shippers and Consignees together more effectively and facilitating improved performance which can be achieved to the benefit of all parties across the triad.

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## **TUNING SUPPLY CHAIN INTEGRATION AND UNCERTAINTY TO ACHIEVE PERFORMANCE**

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### **ABSTRACT**

One of the main themes in the Supply Chain Management literature has been the impact of integration on performance. Many authors agree that integrative practices have a positive impact on corporate and supply chain performance. This paper questions if supply chain integration is always beneficial by investigating the influence of uncertainty. The paper contributes in several ways. Firstly, it analyzes supply chain integration differently by distinguishing three basic dimensions of integration: practices, patterns and attitudes. Secondly, the paper seeks to find the influence of demand and technology uncertainty on the required level of supply chain integration. The paper presents the results of a survey conducted among Dutch and Spanish companies. The results show that if uncertainty in demand and technology are high, higher levels of integration lead to improvements in performance, while under low uncertainty integration does not improve performance. These results help to better understand the appropriate fit between supply chain integration and uncertainty as well as help to develop managerial guidelines to improve supply chain integration.

### **INTRODUCTION**

One of the main themes in the supply chain management literature has been integration as a key factor in achieving improvements (e.g. Tan et al., 1999; Romano, 2003). Many authors agree that integrative practices and a high level of integration have a positive impact on corporate and supply chain performance. Recent empirical work (Frohlich & Westbrook, 2001; Vickery et al., 2003; Childerhouse & Towill, 2003; Gimenez & Ventura, 2005) shows convincing empirical evidence for the relationship between integration and performance. Whereas the empirical evidence seems to be overwhelming, a part of the literature doubts the results and approach taken in supply chain integration research. Firstly, starting from the well-known and often cited article of Fisher (1997) an increasing number of researchers have realized that supply chain integration might need a more tailored approach in order to be successful. One possible way to further explore that is to include context (Ho et al., 2002) or business conditions (Van Donk & Van der Vaart, 2004, 2005; Van der Vaart & Van Donk, 2006). A first example is the research of Ramdas & Spekman (2000). Secondly, others emphasize the need for sound constructs and methodologies to better understand supply chain integration and the relationship between supply chain integration and performance. Tan (2001), Croom et al. (2001), and Giannakis et al (2004) review the literature and state that the variety of supply chain management and integration definitions is large. The same can be concluded with respect to the constructs and measurement scales that are used in survey research in supply chain management (Chen & Paulraj, 2004). All in all, the consistency of measures and constructs is still limited, according to Ho et al.

(2002). One point of concern is that different aspects of integration are measured, without explicitly addressing such choices. E.g. the papers of Johnston et al. (2004) and Frohlich & Westbrook (2001) both address integration, but the first one measures patterns of behaviour, while the second one focuses on operational practices. In addition, the number of items used to measure a specific aspect of integration seems to be small, in some research.

A third point of concern relates to the level of analysis of integration, performance and their relationship. Some studies implicitly measure integration as a construct or attribute at the organisational level and only a few papers (e.g. Johnston et al, 2004; Gimenez and Ventura, 2005) consider single supplier-buyer links and relationships. What is however really confusing is the measurement of performance. What does it actually mean conceptually or theoretically if e.g. the relationship between the level of integration with one single supplier and the buying firm's financial performance is correlated? Or, what does the correlation between the improvement of the return on investment and issues like commitment to suppliers or customers imply? How can managers interpret and use such findings?

A final point of concern is how uncertainty is perceived in the supply chain literature. Uncertainty has been identified as one of the main elements in supply chain. Uncertainty has been identified in Bullwhip studies (Lee, etc) as one of the causes for uncontrolled behaviour in supply chains. Controlling sources of uncertainty such as customer demand, manufacturing and supply (Davis, 1993) has been one of the central elements in supply chain integration. Integration in a supply chain will thus naturally focus on information sharing and exchange to remedy the level of uncertainty. Childerhouse and Towill (2002, p. 3503) state: "An integrated supply chain has minimal uncertainties in all four areas" [customer demand, manufacturing, supply and control]. Here we will perceive uncertainty as an exogenous factor that influences the need for integration (see Van Donk & Van der Vaart, 2005).

Based upon the above considerations and remarks this paper aims to better understand what the appropriate level of integration is under different levels of uncertainty and to what extent a fit between uncertainty and integration influences improvements in performance. In developing our measurements and constructs we built on a recent paper by Van der Vaart & Van Donk (2007) reviewing survey-based research in this area and we use data from a survey among suppliers to empirically investigate the above relationship.

The paper is structured as follows. The next section will present the theoretical background of the paper, developing the theoretical framework and the propositions to be tested. We omitted the methodology. The third section will present the results and findings. The subsequent section will further interpret and discuss the findings.

## **THEORETICAL BACKGROUND**

This section discusses three dimensions of integration: practices, patterns and attitudes, along with our research framework. We end with developing three propositions.

### *Supply chain integration*

A recent review in (Van der Vaart & Van Donk, 2006) of survey based supply chain research concludes that items as used in contemporary research can be subsumed into three categories or dimensions: supply chain practices, patterns,

and attitudes. As one of their other conclusions is that no useful categories could be found using the factors and constructs reported in the articles reviewed, we use these three dimensions as our basic understanding of supply chain integration.

Supply chain practices are concrete activities or technologies that play an important role in the collaboration of a focal firm with its suppliers and/or customers. Examples are the use of EDI, integrated production planning, packaging congruence, Vendor Managed Inventories (VMI), and deliveries synchronization (e.g. De Toni & Nassimbeni, 1999; Frohlich & Westbrook, 2001; Kulp et al, 2004).

Related to these practices are supply chain patterns are the modes of interaction between the focal firm and its suppliers and/or customers Examples are regularly visits to the supplier's facility, frequent face-to-face communication, high corporate level communication on important issues with key suppliers, and formal, periodic written evaluation of suppliers (e.g., Bagchi & Skjoett-Larsen, 2005; Carr & Pearson, 1999; Chen et al, 2004; Duffy & Fearn, 2004; Stanley & Wisner, 2001).

The last category includes items that measure supply chain attitudes of buyers and/or suppliers towards each other or towards supply chain management in general. Examples used in the questionnaires are "we expect our relationship with key suppliers to last a long time", "we view our suppliers as an extension of our company", and "the responsibility for making sure that the relationship works for both the other party and us is shared jointly" (e.g., Chen et al, 2004; Johnston et al, 2004).

#### *Research framework and propositions*

Based on the concerns and findings discussed above we propose the research model as depicted in Figure 1. A first central idea is that supply chain integration needs to be measured explicitly under three headings: supply chain attitudes, patterns and practices. Previous research has mixed a collection of these three types of supply chain items into one factor. Of course, it might be that different attitudes, practices and patterns are involved in supply chain integration. We assume that attitudes, patterns and practices will interact in some way. It seems likely (as an example) that (positive) attitudes are a first step in developing a relationship and improving integration. However, intensive daily contact (being equivalent to a high level of interaction/patterns) might have a positive impact on attitudes. We assume that attitudes do not directly influence the performance of the relationship as it is hard to imagine that lead times can be reduced by having a more positive or cooperative attitude with respect to a supplier or buyer. Patterns and practices are assumed to have a direct impact on performance. Uncertainty has a moderating effect on the effectiveness and appropriateness of supply chain practices and patterns. A moderating effect means that a high level of integration is not automatically needed but depends or should be fitted to the type and level of uncertainty as experienced in the supply chain. Based upon the framework of Fisher (1997) and earlier empirical work by Van Donk & Van der Vaart (2005) we can formulate the following propositions.

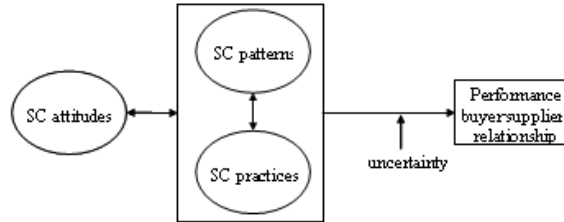
#### **Proposition 1**

*If uncertainty in demand is high, a high level of supply chain integration will result in higher performance of the buyer-supplier relationship.*

(And the reverse)



*If the uncertainty in demand is low a high level of supply chain integration will NOT result in better performance of the buyer-supplier relationship.*



### **Proposition 2**

*If uncertainty in technology is high, a high level of supply chain integration will result in higher performance of the buyer-supplier relationship.*

(And the reverse)

*If the uncertainty in technology is low a high level of supply chain integration will NOT result in better performance of the buyer-supplier relationship.*

The above two propositions are not looking at integration in a more detailed way. Looking at the idea of Fisher (1997) and at the findings of Van Donk & Van der Vaart (2004) and Van der Vaart & van Donk (2006) it seems that certain types of integration will be required and effective if uncertainty is low. Specifically all integrative practices and patterns that aim at standardization of the relationship might prove to be within easy reach and will probably attribute to reduction of costs: e.g. standardization of packages or delivery times. That implies

### **Proposition 3**

*If uncertainty in demand/technology is low, standardized and formalized supply chain practices and patterns will improve buyer-supplier relationship's performance.*

(And the reverse)

*If uncertainty in demand/technology is high, non-standardised and formalized supply chain practices and patterns are needed to improve performance of the buyer supplier relationship.*

## **METHODOLOGY**

Given limitation on pages, we have skipped this section.

## **RESULTS**

### *Factor analysis*

Factor analysis was carried out to reduce integration practices, patterns and attitudes to a smaller number of underlying factors. The solution explains 73.361% of the variance. The results suggest an eight factor structure.

Factor 1 is mainly comprised of items addressing *joint improvement*, such as "working together to improve operations and logistics processes", and "working together to synchronize operations and logistics processes". Factor 2 includes items addressing *cooperative behaviour*, such as "the parties would rather work out a new deal than to hold each other to the original terms when some unexpected situation arises", and "it is expected that the parties will be open to

modifying their agreement if unexpected events occur". Factor 3 includes items regarding *planning information* ("we receive information about production plans, changes in the production plans, and sales forecasts"). Factors 4 and 5 are related to the way both companies exchange information. Factor 4 is related with *structured communication* (direct computer-to-computer link, online access to the planning systems of the key buyer, and the use of formal communication channels) while factor 5 with *non-structured communication* (face-to-face communication, high corporate level of communication and the use of phones and videoconferences to communicate). Factor 6 is related with the concept of *long-term relationship* and includes the following items: "we value a long-term relationship with our key buyer", and "we see our relationship as a long-term alliance". Finally, the last two factors are related with physical integration: packaging and delivery integration. *Packaging integration* refers to the idea of adapting the packaging materials (pallets, containers, etc.) to the needs of the key buyer, while *delivery integration* refers to the synchronisation of the delivery activities.

Factor analysis was also carried out to reduce the number of uncertainty variables into a number of underlying dimensions. Principal components analysis with varimax rotation was used. The results suggest a two factor structure. Factor 1 can be labelled *technology uncertainty*, as it comprises items related with changes in technology, while factor 2 can be labelled *demand uncertainty*, as it includes items related with demand uncertainty (volume and mix).

#### *Correlation analysis*

Bivariate correlation analysis was carried out to identify which integration factors correlate with measures of cost and service performance. In order to take the business conditions into consideration, correlations between integration factors and performance measures were measured within four different groups of companies: low demand uncertainty, low technology uncertainty, high demand uncertainty and high technology uncertainty.

For both demand uncertainty and technology uncertainty two sub-samples were obtained: one with high uncertainty and another with low uncertainty. The cut off points used to classify the companies were calculated with the aim of obtaining two equivalent sub-samples in terms of size and both tried to be one third of the sample. The cut off points for demand uncertainty were 3 and 4.5. This means that companies with a level of demand uncertainty lower than or equal to 3 were classified under the low demand uncertainty group and companies with a level of demand uncertainty equal to or higher than 4.5 were classified into the group of high demand uncertainty. The cut off points for technology uncertainty were 2 and 4 (companies with a level of technology uncertainty lower than or equal to 2 were classified under the low technology uncertainty group and companies with a level of technology uncertainty equal to or higher than 4 were classified into the group of high technology uncertainty).

Table 1 presents the results of the correlation analysis, that is, the significant correlations between the SCM factors and the performance items for each of the four constructed groups. Most significant correlations indicate positive impact of integration on performance improvements. Positive means lower costs or improved service delivery. There are five exceptions, that is, that integration has a negative impact on performance improvements for instance an increase in the administrative costs.

Table 1. Correlation analysis: Integration and performance improvements

	Low uncertainty		High uncertainty	
	Demand	Technology	Demand	Technology
<b>Packaging integration</b>		Agreed date (-.409*)		Production costs (.297*) Special requirements (.319*) Early notifications (.485**)
<b>Delivery integration</b>	Special requirements (.415***) Early notifications (.315*) Short delivery LT (.610**)	Short delivery LT (.574**)	Product mix (.310*) Quantities ordered (.312*)	Transportation costs (.314*) Product mix (.298*) Quantities ordered (.354*) Early notifications (.425***) Short delivery LT (.482**)
<b>Long term relationship</b>	Administrative costs (-.344*)	Administrative costs (-.309*)	Transportation costs (.332*) Administrative costs (.334*) Stock outs (.292*) Early notifications (.351*)	Early notifications (.480**)
<b>Non-structured communication</b>	Product mix (.334*) Quantities ordered (.404**)		Product mix (.382***) Early notifications (.391**)	Product mix (.311*) Early notifications (.506**)
<b>Structured communication</b>	Short delivery LT (.313*)		Cost-to-serve (-.295*) Short delivery LT (.313*)	
<b>Planning information</b>			Special requirements (.361***) Agreed date (.293*)	Special requirements (.403***) Early notifications (.329*)
<b>Cooperative behaviour</b>	Stock outs (.398**)		Administrative costs (.297*)	Early notifications (.407**)
<b>Joint improvement</b>				Cost-to-serve (-.356*) Quantities ordered (.340*)

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

## INTERPRETATION AND DISCUSSION

What to do with the results of the factor analysis? Do we discuss them as extensively as in the other paper, or do we focus on performance here.

No, only focus on uncertainty related to performance issue

An overall assessment of the results presented in table 1 seems to support the propositions. The different supply chain practices, patterns and attitudes have a higher impact on performance improvements if uncertainty is high. This is especially true for technology uncertainty. For the group of companies with low technology uncertainty table 1 reveals only one positive correlation between integration and performance. This is in clear contrast with the 15 positive correlations for the group with high technology uncertainty. This provides strong support for the proposition that high levels of integration are only necessary within buyer-supplier links with a high level of technology uncertainty.

The same is to some extent true for demand uncertainty. However the contrast between low and high is less clear (7 versus 12 positive correlations). That means that contrary to our initial expectations also buyer-supplier links with low levels of demand uncertainty benefit from supply chain integration. A more detailed consideration of the results indicates that in these links specific practices or patterns might be beneficial. It is plausible that also in situations with low demand uncertainty frequent deliveries and EDI connections can contribute to improvements in the delivery performance. This is especially true under circumstances that allows for a regular flow of materials (stable demand, high volume, low variety).

*A list of references along with additional tables is available from the authors upon request.*

**LOGISTICS AND SUPPLY MANAGEMENT IN SERVICE INDUSTRIES  
THE PERSPECTIVE OF LOGISTICS, PURCHASING, AND SUPPLY  
MANAGEMENT IN THE GERMAN HOTEL SECTOR**

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**ABSTRACT**

The field of purchasing and supply management is gaining importance in service industries, including the hotel sector. The general trend towards friendlier service and extended service offerings is relevant especially for hotels and today's hotel managers are faced with new challenges. The leverage effects of purchasing and supply management in the German hotel sector have enormous potential to optimize and increase profits. Challenges in logistics have changed. Therefore, existing management practices need to be improved and integrated into the processes and structures of hotel management so that their competences are modified. The resource-based view and the competence-based view help to explain and confirm these results. However, substantial differences exist in the hotel sector, in comparison to other sectors, which impact supply management issues, as shown in an empirical study.

**INTRODUCTION**

Over the last few years, the field of purchasing and supply management has gained importance not only in the industrial sector, but also in service industries (*Pechek 2003 p. 24-28*). The hotel sector, which belongs to the tourism sector of the service industry, has received little attention up until now. But in today's service-oriented society, new management approaches are necessary (*Bruhn; Meffert 2001 p. 3-5*). An efficient process-oriented and customer-oriented, as well as timely supply management and logistics management is essential to achieve a competitive advantage and increase the value of the corporation (*Jahns 2004, Preamble*). Effective supply management and logistics are prerequisites before a company can focus on core competences and generate competitive advantages (*Pechek 2003 p. 24-32, Jahns 2004 preamble*). Therefore, successful supply management and logistics are significant for hotels. Hence, strategic and organisational changes are necessary (*Arnolds 1998 p. 35-36*).

Several authors have been investigating the different aspects of supply management since the mid 20<sup>th</sup> century; however, the main focus has been on the industrial sector. Service-intensive industries, such as telecommunications, banks, insurance, tourism or hotels, supply management and logistics, were

often disregarded (*Seitz 2006 p.1-3*). There are some articles about logistics and supply management in hotel magazines in which the need for scientific research is stated (*Spring 2006: Top Hotel, First Class, Hotel Management*). Despite the call for more theoretical and strategically-oriented work in purchasing and supply management, the dominant streams of research in strategic management over the last decade, including the resource-based theory of the firm, the related competence-based theory, and the capabilities approach (*Olavarrietta; Ellinger 2005 p. 559*) have not been prominent in purchasing and logistics literature. However, they have implicitly influenced recent work in purchasing and logistics. Therefore, they were used as instruments to help explain the results of the study.

The goal of the first purchasing and logistics survey in the middle class to luxury class hotels in Germany was to present the status quo in the hotel sector, to identify optimizing potentials and through this, provide recommendations for action to the executive directors responsible for supply management in hotels. A calculative example proves that supply management is an effective tool in the German hotel sector: a 1% reduction in purchasing costs by a 70% degree of vertical integration leads to an operating profit of 4-6 % on average. Sales would need to increase their turnover by 5-10% in order to achieve the same profit effect. Therefore, supply management has great potential to optimize and increase profits. The growing awareness of purchasing's and logistics' significance requires a reconfiguration of competencies in supply management, logistics and supply chain management, resulting in optimized processes and structures of hotels. According to various criteria, enormous differences exist in the hotel sector. The hotel sector can be differentiated by: classification (middle class, upper class and luxury class hotels); hotel type (hotel or hotel garni); location (city or countryside); character (business hotel, holiday hotel); size of the hotel (less than 100 rooms, 101-250 rooms, greater than 250 rooms); affiliation (single hotel, hotel chain). The main focus of the study was based on the following subjects, which also reflect the most important issues of supply management and logistics in the hotel sector according to expert interviews:

1. Systematic appointment of the purchasing directors in hotels.
2. Identification of savings potentials in procurement in individual departments.
3. Strategical and organisational aspects of purchasing and logistics.
4. Methodical evaluation of supplier management and logistics aspects.
5. Data collection of strategies and methods in supply management.
6. Identification of organisational processes in logistics and supply management.
7. Identification of investments in personnel and further executive trainings.

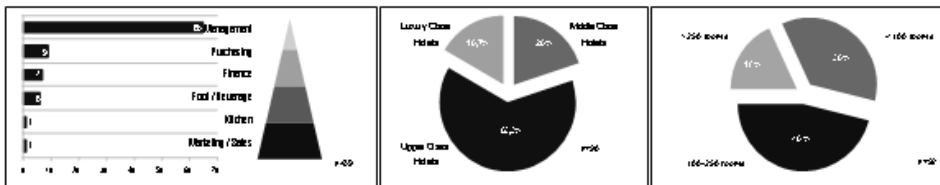
German literature concerning hotel issues was mainly used in the paper due to the focus of research in Germany.

### **PROCEDURES AND METHODS OF THE EMPIRICAL RESEARCH**

The study "Purchasing in the Hotel Sector" focuses on the middle, upper and luxury class hotels and was set up by the Supply Management Institute SMI™ in cooperation with several associations of the hotel trade – the German hotel association (IHA), the Food and Beverage Management Association (FBMA), the Association of Hotel Managers in Germany (HDV) – and the purchasing service provider, progros. The study is based on a standardized questionnaire which allows for a fundamental statistical evaluation. The questionnaire included 25

questions, with 20 closed-answer and 5 open-answer questions. First and second tier managers were interviewed. The population of the investigation included three to five star hotels which are members of the associations mentioned above. Therefore, all hotels in Germany which are classified and registered, including those with international activities or subsidiaries/franchises of international companies, hotel chains and private hotels were contacted. Approximately 1,184 hotels were approached, of which 96 hotels participated in the survey. Thus, the rate of return was 8.1% and is satisfactory considering that this study was conducted for the first time. The following figures give an overview of the participants:

Figure 1: Overview of the Participants of the Empirical Study (own illustration)  
Participants structured by ... departments ....hotel classification ...hotel size



The collected data was evaluated with statistical programmes (i.e. SPSS version 12.01), according to various criteria and specifications, and intensely researched with scientific methodology. A complete descriptive evaluation was performed. In addition to frequency investigations, discriminant and cluster analyses as well as contingency and correlation analyses were performed and evaluated. First, basic data was collected quantitatively. Experts for questionnaire design from related fields were consulted. Explorative and known constructs for similar topics were used for the questionnaire. The non-response bias was tested concerning the absolute or relative responses. The survey can be considered representative because a significant difference does not exist. A 5-Point-Likelihood scale was used. A value of 1 corresponds to very high significance/ importance and a value of 5 to low significance/ importance. This scaling was selected according to the German grading system, since those questioned were, to a large extent, German and the evaluation was accommodated for them (Stier 1999 p. 79f.).

Case study research followed with focus on hotel chains due to the following facts: a) the questionnaire was general and detailed information about complex organisations could not gathered, b) hotel chains are a step further in implementing supply management in their processes, c) smaller hotels have different problems in logistics and supply management, i.e. a hotel on a "car-free" island has special logistics needs.

## **THEORETICAL BACKGROUND OF THE RESEARCH DESIGN**

*The Resource-based View (RbV)* explains the observable performance differences between corporations, especially for available resources within a certain timeframe, in the constitution and orientation phases of the resource-based research and is substantiated by a set of publications. (Gersch, Freiling, Goeke 2005). While the causal structures of the RbV focus on the availability of resources within a certain time, this perspective is substantially enhanced by *Competence-based view (CbV)* and *competence-based considerations*. The

dynamics of the approach have intensified because the challenges have received more attention as a result of increasing changes in the market requirements. In order to generate concrete competitive advantages from available resources and thereby realize performance potentials, numerous competences are necessary. In addition to cooperative and acquisitive possibilities, proprietary development and adjustment of existing resources and competences were analyzed. Hamel and Prahalad significantly affected the emergence of a core competence perspective in 1990 and 2005. Sanchez et al. developed 1996 the competence-based strategic management approach from a cognitive and wholistic perspective, which is different from the Dynamic Capabilities Approach from Teece.

For this new research field, the RbV and especially the CbV were chosen because hotel sector resources, competences, as well of the organisation of the employees are crucial success factors to achieve competitive advantages.

An overview of important steps in the field of resource-based research are listed in the following illustration.

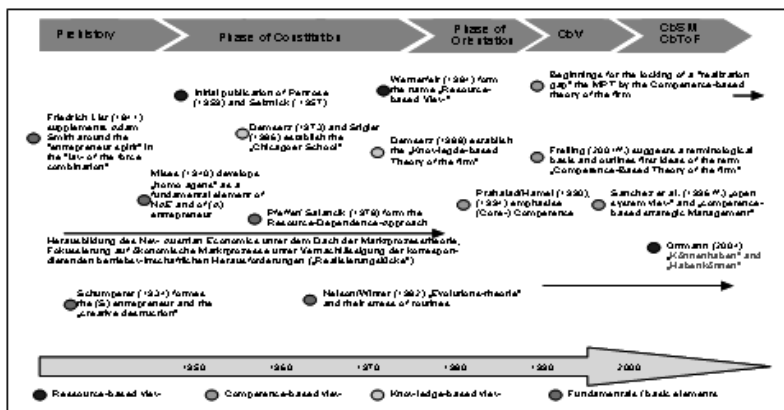


Figure 2: "Historama" of Resource-Based Research according to Gersch, Freiling, Goeke 2005 p. 6 (own illustration)

## THE STATUS QUO OF LOGISTICS AND SUPPLY MANGEMENT IN THE HOTEL SECTOR: CORE RESULTS OF THE STUDY

1) *Decentralised structures of purchasing responsibility are predominant and "double" responsibilities exist.* In many hotels, the organisation of purchasing is performed by the managing director of the hotel and/or the specific department. Strategical decisions are generally not made by a purchasing department. Thus, effective realisation of the corresponding core competences is not entirely implemented in supply processes and resources are not aggregated properly (Atkinson 2006 p. 20). Hotels rarely follow an integrated procurement process. In fact, purchasing is only operatively integrated. Logistics is not even considered at the moment. According to Arnold ((Arnold 2003 p. 143–158), clearly defined structural plans and organisational charts allow all involved a quick overview of the respective responsibilities and the most effective and efficient processes. The organisation of purchasing can be centrally or de-centrally set up, depending on the affiliation, either individual

hotel or hotel chain. One hotel which uses such a purchasing organisation is Hilton. Supply management is organised at the corporate level with six regional locations, which allows the company to leverage national and regional opportunities (*Higgins 2005*).

*The results of the satisfaction-importance-analysis for individual assortments of purchased goods correlate with the responsibilities.* In the categories of assortments for which the purchasing department is directly responsible, the level of satisfaction is at the highest. By intensifying the level of collaboration between the internal customer and the purchasing department, supply management can be positively influenced, both directly and indirectly, within the hotel. In hotel chains, there is often a great deal of competences and resources compare the example of Marriott International's procurement department which includes purchasing specialists according to Gunter 2005.

2) *Supply management should be strategically positioned in top management.* There is a difference between how the strategic position of the purchasing department is set up and how different levels of employees perceive it. Managers consider the organisation of the purchasing processes from different perspectives than their employees.

*Co-operations and collaborations with purchasing associations and other hotels are increasing.* The co-operations and collaborations will increase with hotels in the future, especially with purchasing associations, as in the US (*see Adams 2003; Parker 2004*). The outsourcing of operative supply management tasks will remain the exception.

3) *Logistics management needs to be improved. Strategic supplier management is not utilised.* As a result, a large number of suppliers are used, making the situation quite complex. Therefore, it is difficult to control suppliers' performance with evaluation systems and clear supplier selection criteria do not exist. Many time-consuming discussions are held with suppliers and are often not reported in written form. The low degree of logistics and purchasing resources and the incomprehensively defined purchasing strategies decrease process efficiency and process effectiveness. Employees waste too much time in this area, especially with operative logistics and purchasing tasks, and do not have time for more important job issues, such as customer service.

4) *Neither bundling effects nor economies of scale are utilised.* Due to the high level of spontaneous purchases and pickups by the customer, bundling potentials and the consolidation of purchasing and logistics tasks are not fully realised. In addition, redundant work is performed repeatedly because purchasing structures are unclear and better delivery conditions, such as one-stop-shopping, are not taken advantage of. Competences and resources have to be re-distributed. Purchasing guidelines and/or purchasing policies, which make a structured proceeding possible, (*Monczka, Trent p. 75*) are already used by some hotels.

*The purchasing trend in 2010 will be: "Less paper and more new media."* Internet and e-mail, in addition to the telephone, will become the most important ordering methods. Basic agreements and standard ordering sequences will increase. "Document logistics" will gain in importance. (*Walter 2003*).

5) In the context of purchasing and logistics optimisation, invoice controls and food / beverage cost analyses are predominately performed on a regular basis.



However, a *comprehensive performance-measurement system usually does not exist and will be necessary to optimize controlling possibilities.*

6) *Further training of purchasing and logistics professionals is neglected.* The education of buyers and their purchasing and logistics competences are ignored, leading to detrimental consequences. Employees are a decisive success factor. Currently, only the 5 star hotels invest in training for its personnel. Purchasing and logistics lack an integrated human resource management in the majority of the hotels. Topics, such as finance, controlling and performance measurement, are insufficiently taught or not trained at all. Thus, gaps in knowledge exist.

### **IMPLICATIONS FOR FUTURE RESEARCH**

Efficient supply management and logistics in the hotel trade proved to be crucial success factors. Firstly, this empirical research points out that supply management is capable of yielding significant profits. Secondly, it shows that large potentials are present in logistics and supply management in the hotel trade - and are not used. Thirdly, it reveals opportunities for the hotel trade to exploit and use to their advantages. By professionalizing hotel purchasing strategically, competitive ability and net profit can be increased. Core competences in the hotel sector need to be re-aligned in order to realize performance potentials and competitive advantages.

The intense statistical evaluation allows direct recommendations for action to be made to the hotel managers according to the different classifications. Here, strategical and organizational success factors are addressed which are crucial for the optimization of hotel purchasing. The establishment of strategic supplier management, logistics management, standardized order processes, as well as the implementation of an efficient performance measurement system are instruments which can be used to improve the purchase structure, increase process transparency, align purchasing structures and reassign responsibilities. By implementing these different systems and mechanisms, hotels will be able to recognise and maximally utilise the optimization potentials in logistics and supply management in the future. These modifications will also generate competitive advantage. The human factor, which represents a core differentiation characteristic of the hotel trade in comparison to other industries, can contribute to a professional supply management; increase the value contribution of purchasing and better position the hotel on the market.

The case studies were used to fill research gaps (*compare Kotzab, Seuring 2005*) and especially to obtain more detailed information about supply management in hotel chains. The significance of logistics and supply management as integrated systems have already been recognised as core competences by hotel chains in Germany. Hotel chains implement supply management in their processes and structures for approximately 10 years, but many struggle with operative aspects, such as establishing (worldwide) IT-Systems for purchasing and logistics tasks.

The results of the study help to develop a basis in this new research field. Further research is necessary in order to fill research gaps.

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## **CREATING A LEAN UNIVERSITY**

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### **ABSTRACT**

This paper contextualises the lean implementation methodology used by the Lean Enterprise Research Centre (LERC) to catalyse and embed lean practices within a client University by briefly discussing a history of process improvement activities within academic institutions (notably within the U.S.A.) and stressing the importance of pursuing a lean value system (Hines, Holweg et al. 2004) as the ideal "Lean University" future state. This methodology is then illustrated by describing two early projects respectively at a strategic and operational level within the University.

### **INTRODUCTION**

The client University's aim is to "create momentum that secures and sustains external recognition as one of the 50 World Leading Universities by 2020". A series of large scale projects have been initiated by the University in order to realise this aim, one of which is the Lean University.

The project has been initiated in order to enable internal and external users to value services as being timely, responsive and uncomplicated. It will achieve this via a combination of lean improvement programmes, robust strategy formation and deployment activities and "transformational leadership" (Bass and Avolio 1994). The Lean University project also needs to ensure that the cultural environment is vibrant and creative so that people are confident to act and innovate.

### **THE EVOLUTION OF LEAN**

The term "lean" was popularised by Womack et al. (1990) as part of an extensive investigation to understand the reasons why Japanese manufacturing industries were outperforming the rest of the world. Later work (Hines, Holweg et al. 2004) shows that Lean Thinking has evolved through many different stages since its first inception. This evolution has occurred as learning has progressed. Authors such as Williams et al (1992) and Christopher et al. (1999) have highlighted the weaknesses of early iterations of 'Lean Thinking'. As a result, a number of developments and additions have been suggested to allow for a more sustainable approach or "Lean Value System" (Hines, Holweg et al. 2004). These include, in particular, greater attention to Strategy and Alignment, Leadership and Behaviour & Engagement (Hines, Found & Griffiths, 2007).

The LERC, with a newly created Lean core team within the client University, is currently in the process of translating the "lean value system" (Hines, Holweg et al. 2004) to this new environment. In common with other service environments, lean thinking has very rarely been applied to universities and, in comparison with manufacturing environments, universities are in the early stages of improvement activities.

## UNIVERSITIES AND LEAN

Introducing lean into an academic organisation first necessitates an appreciation of the distinctive environment, an environment, from a lean perspective at least, that Bateman et al (2007) term as an “unconventional” system. Lean has been implemented widely within conventional organisations, those characterised as relatively stable in terms of producing high volumes of goods of limited variety. An unconventional system can be seen as one which deals with a great deal of variety, in this case, a University, although it deals with large numbers of students, each student has a distinctive route through the system via the vast range of different courses delivered by numerous individually schools and centres.

Older, more traditional Universities also pose additional problems within a lean transformation because of the complex Committee structures that exist. These structures do not provide a clear and quick mechanism with which to deploy lean strategies.

<b>'Conventional'</b>	<b>UK University</b>
High volume	Low volumes with a large number of courses
Stable	Stable year-on-year but highly variable within the year
Moderate variety	Great variety
Straightforward management structure	Complicated and dislocated 'bureaucracy' management structures
Understand the importance of a unified strategy	Strategic vision needs to incorporate three distinctive aspects: teaching, research and innovation which can be in conflict, particularly for resources
Clear view of customer	Confusion of multiple customers and stakeholders often with poor customer focus
Quick response to market	Slow response to market
Employees identify with Parent organisation	Few people identify with Parent organisation, more likely to identify with Unit, Centre or School
	Encourages specialisation – collegiate

Fig. 1. Following Bateman et al, 2007

It can be seen therefore that implementing a lean transformation within this unconventional *academic* system poses particular challenges. Bateman et al (2007) corroborate Hines et al's (2004) Lean Value System ideal in that they state that it is essential to address more than just processes within a lean transformation in order to affect sustainable positive change. Bateman et al (2007) propose a model to examine how traditional lean transformations within unconventional systems compare to conventional ones. The model accepts that techniques such as Hoshin Kanri are an important aspect of a lean system. It also introduces the concept of “Pillars” and “Platforms” as a useful way to distinguish between different lean implementation approaches. “Pillars” refer to approaches which instil a range of lean tools and techniques within a particular local area within organisation, creating small lean ‘island of excellence’. These

“pillars” are then used as an advertisement of lean success which hopefully will enthruse other sections of the organisation to follow their example and morph into their own lean ‘pillar’. A ‘platform’ approach refers to the widespread introduction of one or two lean implementations, such as 5S<sup>1</sup> or Visual Management<sup>2</sup> across the whole of the organisation in question. Each approach offers both positive features and implementation challenges.

The development of the Lean University approach has been very much guided by the extensive experience of the LERC to identify the optimal ‘pillar’ and ‘platform’ approach. After many years of research in this field, it has been very evident that some improvement programmes, despite initially experiencing many benefits, soon found that their efforts were not sustainable. Resources and enthusiasm waned and consequently the programme’s true success is put into jeopardy (Bateman, 2001).

Research began within the Centre to develop a Lean Implementation model that sought to provide a more concrete, holistic approach to transformations within organisations. Lean concepts are grounded within Systems Theory and this model acts as an aide memoir in order to encourage improvement teams to think about the academic organisation as a holistic, interdependent system. Improvements should be made with an awareness of the effect that these changes will have on other aspects of the organisation. For real change to occur, major mental, transformational shifts need to take place at the upper levels of the institution. These shifts in thinking need to then be effectively communicated and cascaded through all levels of the organisation.

### **INCIDENCES OF LEAN IN OTHER UNIVERSITIES**

Extensive case based primary research and secondary research has shown that whilst there are many examples of attempts that have been made to improve processes within Universities (Rice and Taylor, 2003), there have been few examples of such an holistic, “lean value system” approach to organisational change within academic institutions. The majority of the literature focuses on Continuous Improvement activities, notably within the U.S.A.

The prevalence of C.I. in U.S. Universities is thanks to several key drivers, such as the ability for institutions to apply for a prestigious Baldrige Award for example, and initiatives such as the National Science Foundation Quality Research Programme (Rice and Taylor 2003).

Much has been written about U.S. Institution’s endeavours in this regard but, confirming the findings of (Hines et al. 2004) these examples concentrate on improving quality, cost and delivery through a variety of Plan, Do, Check, Act cycles within the value stream and have yet to evolve into full strategic and operational value systems.

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<sup>1</sup> **5S** – A workplace organisation methodology in order to eliminate waste and increase organisational effectiveness. Derived from the Japanese words: seiri, seiton, seiso, seiketsu, and shitsuke which can roughly translated as: set in order, shine, standardise, and sustain.

<sup>2</sup> **Visual Management** – An easily understandable mechanism to illustrate and communicate the individual and collective management of people and projects

Early continuous improvement attempts have often been too technically bound, merely focused on the removal of *muda* (or waste), rather than a more holistic approach drawing on the full *muda*, *mura* (un-evenness), *muri* (overburden) approach advocated by Toyota (Toyota Motor Corporation 2006). It is our contention that in a professional service environment it is more appropriate to focus more broadly and initially, especially on *muri*, in order to engage staff in a lean transformation. The reason for this is that large parts of the activity within a university are of a support nature and hence would, within a traditional lean thinking approach, be regarded as necessary-but-non-value-adding or non-value-adding. However, the clear implication that many staff may gain of applying lean would be that their jobs are at risk. Hence, starting with a *muri* approach of lean where lean is seen as 'making their job easier' is far more likely to be engaging and result in sustainable benefits.

Some authors have specifically addressed lean within an academic environment. Alp (2001) discusses the need to consider lean principles in everything that the University does. Alp is mindful of the need to deliver value to students, however, no methodology is suggested about how to do this. Comm and Mathasiel (2005) seek evidence of lean implementations within academic institutions as opposed to describing the effects of such endeavours. In summary, the implementation of lean within universities has, to date, largely been delivered from a theoretical, generalist perspective with little attention on what to do and how to go about it.

An exception to this is Emiliani (2004), who has shared his experiences of applying lean within an academic environment. These experiences are very localised and specific, for example, Emiliani uses lean principles to approve business course content. It is only Moore and Nash (2004) who have explicitly discussed how they plan to create a **Lean** University at the University of Central Oklahoma in unpublished work shared with the current authors.

Interestingly, whilst they have instigated many "bottom up lean projects" (Craycraft, 2002), they have also included "top down" Lean implementation activities. They held a "Strategy Day" which invited many different stakeholders and key personnel within the University to work together to develop the "vital few" key strategically aligned actions which supported their vision and were able to be cascaded throughout the organisation.

## **INITIAL CASE STUDY FINDINGS**

### **STRATEGY DEVELOPMENT AND DEPLOYMENT**

Within the strategy project case, emphasis is placed on understanding and analysis of the current strategy situation, the issues and problems that exist, the needs for change as well as the early work with the Vice-Chancellor to develop a lean strategy formation and deployment system. The case draws on earlier Japanese and Western literature on the subject. Specifically the fact that Hoshin Kanri, Policy Development and Deployment (Akao 1991) is recognised to be an integral aspect of a "lean value system" (Hines, Holweg et al. 2004). In summary, it was observed that the existence of multiple committee structures was likely to impede rapid and effective decision making (Mintzberg, 1983 in (Roffe 1998)) and would benefit from the use of Hoshin Kanri. Indeed, within the context of a university, this was felt even more important than in a conventional manufacturing environment.

Conscious of the importance of Strategy within a "Lean Value System" (Hines et al 2004), the first real Lean activity that took place was within the University's Strategic Development and Planning and Registry departments. The intent being to enact a "Hoshin Kanri" and "Issue Driven Strategy" (Dale 2002) based policy formation and deployment process throughout the organisation.

This process involves first understanding the University's core values and strategic aims and then, through a series of workshops with key stakeholders, assisting the development of relevant and comprehensible purpose statements which clearly articulate their strategic intent, position and competences. All of these actions are then combined to produce a coherent, succinct, strategic plan which is able to respond to emergent issues simply and quickly.

### **PURCHASE TO PAY PROCESS**

The improvement team reviewed the 'end to end' process associated with the purchase of a variety of different profile commodities. Currently, the process is lengthy, complex, non-standardised across users and as a result of the difficulties associated with the process, compliance to the University's preferred supplier panel is thought to be lower than ideal. The project is therefore focused on working with key users of the process throughout the University to re-design the purchasing process and create a simpler and user friendly system. This will have the additional benefit of enabling the University to achieve improved spend visibility, with the potential for supporting enhanced supplier management practices and therefore total cost and service performance.

An initial workshop has taken place which has asked a cross functional team to identify all of the process steps in the current value stream and developed ideal and future states. Action plans are now being developed in order to realise these more efficient processes.

### **CONCLUSIONS**

This paper has discussed the approach that the team is taking in order to create a Lean University. As the project is in its early stages, there are only a few case studies available in order to illustrate the approach. Yet from our early work, it is clear that there is much potential to improve customer value and eliminate waste within the University. Whilst there are many staff members who have welcomed the project and shown enthusiasm towards the various project themes, it is increasingly evident that the academic environment is less familiar to change than many conventional lean environments. In addition to this, like many older Universities, strategic structures are bureaucratic and seem unaccustomed to rapid change. Change can only ever occur at the rate of volition within the University and it seems that much work is still to be done in terms of encouraging employee engagement at some levels.

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## MANAGING CUSTOMER EXPECTATIONS: THE KEY TO SUSTAINING CUSTOMER-SUPPLIER RELATIONS

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### ABSTRACT

The purpose of this paper is to present a model for understanding the product and service elements that customers value and expect; and it measures customer's perceptions of the organisation's performance in delivering these expectations. The Lean term Voice of the Customer is really in two parts, pre- and post-purchase, and the supplier needs to hear and react to both parts.

The case study presented here demonstrates the results of the model in the context of a large company and focuses on the customer-supplier relationship elements of a developing and sustaining a global lean supply chain.

### INTRODUCTION

In today's highly competitive environment the ability to capture and deliver enhanced customer value is seen as a way of differentiating and gaining market share (Christopher, 1992; Womack and Jones, 2005). It is no longer sufficient to compete at a business level as supply chains are now viewed as a source of competitive advantage (Mentzer *et al.*, 2001; Zokaei and Hines, 2007). To be able to compete, supply chains must be both *efficient* and *effective*, which means developing closer customer-supplier relationships.

Applying lean thinking to logistics and supply chain management is considered to be a way of improving the *efficiency* of the supply chain. However, the first principle of lean thinking, as defined by Womack and Jones (1996), is understanding customer value, but how well do we really know and understand what customers value?

This poses the question:

*How can you remove waste from a process unless you understand what the customer values from the process?*

This paper proposes a model for understanding the product and service elements that customers value and expect, and it measures the customer's perceptions of the organisation's performance in delivering them. The outcome of the model is to inform other processes such as sales acquisition, order fulfilment and new product development. Understanding the voice of the customer helps to guide strategy. It does this by identifying critical success factors and key measures, so that the organisation is flexible and responsive to customer needs; this delivers real competitive advantage. Understanding customer perceptions of value and managing the expectations is about improving the *effectiveness* of the supply chain.

## RELATION TO EXISTING WORKS

Oliver and Webber are described by Svensson (2000) as the founders of the concept *Supply Chain Management* (SCM). They concluded that traditional approaches to integrate logistics channels failed. "*We needed a new perspective and, following from it, a new approach: supply-chain management*" (Oliver and Webber, 1982 p. 64). They contend that SCM differs from traditional production and materials management in four respects.

1. SCM views the supply chain as a single entity rather than relegating fragmented responsibility;
2. It calls for, and in the end, depends upon, a strategic approach;
3. It provides a different perspective on inventories;
4. It takes a systems approach.

According to Christopher (1998, p.18) the focus of SCM is on co-operation and trust so that the whole can be greater than the sum of the parts. He then defines SCM as: "*The management of upstream and downstream relationships with suppliers and customers to deliver superior customer value at less cost to the supply chain as a whole*". He further contends that "the focus of supply chain management is upon the management of *relationships* in order to provide a more profitable outcome for all parties in the chain". This view is supported by Sharma and Sheth (1997) Understanding the customer's perceptions of value is also crucial to maintaining long-term supply relationships. According to Reicheld (1996) it is the value that customers *feel* that they receive that stops them from switching suppliers.

SCM and supply chains are concepts that are closely related to lean. Ellram and Cooper (1993, p. 1) define SCM as "*an integrating philosophy to manage the total flow of a distribution channel from supplier to ultimate customer*". The integrated supply chain is in many ways synonymous with the *Lean Enterprise* described by Womack and Jones (1994 p. 93-4, 1996) as "*a group of individuals, functions, and legally separate but operationally synchronised companies. The notion of the value stream defines the lean enterprise. The group's mission is collectively to analyse and focus on the value stream so that it does everything involved in supplying a good or service in a way that provides maximum value to the customer*".

Lean is described as a process-focussed management system (Jackson & Jones, 1996) and the sales acquisition / order creation process as one of the core business processes (Dimancescu *et al.*, 1997) yet there is little literature specifically on the lean order creation process and, in particular, any evidence that supports sales people as process-thinkers. This paper demonstrates how the VoC is used to inform the order creation process at a number of points to help improve business performance of winning and retaining customers.

The model builds on the wealth of literature on the implementation of lean and value stream management (Womack, Jones and Roos, 1990, Womack and Jones, 1996, Drew *et al.*, 2004; Liker, 1996; Liker and Meier, 2004; Hines and Taylor, 2000; Hines *et al.*, 2000) by addressing the gap that links these to the marketing

literature (Webster and Wind, 1972; Sheth et al., 2000; Leonidou *et al.*, 2006) and approaches such as Kano analysis (Clausing, 1994) or Order Qualifiers and Order Winners analysis (Hill, 2000).

## RESEARCH APPROACH

The research approach taken in this work has been based around theory development reached by synthesising a range of industry cases and practical approaches available within the existing literature. The industry cases have been studied using a case study approach that Yin (1994) contends is appropriate for organisational and management studies and Saunders, Lewis and Thornhill (2003) suggest has the potential to answer *why* as well as *what* and *how*. Within this approach a range of research techniques, including direct observation, semi-structured interviews and action based research (Hakim, 1987; Hartley, 1994), were used to develop the model.

## CUSTOMER VALUE MODEL

The customer value model was developed and tested in a major heavy engineering company that processes steel in plants in the UK, Sweden and Canada. The company was selected as it represents three scales: the individual business unit, a group of companies and an intra-organisational supply chain.

The Lean term Voice of the Customer (VoC) is really in two parts and the supplier needs to hear and react to both parts. The model is designed to do a specific job by gaining insight into the two distinctly separate elements of the VoC as follows:

- **Recording and measuring Customer Value** - pre purchase - What the customer values and expects in a product/service – The model achieves this by identifying their Value Criteria and understanding expectations at selected “touch points” within the customers business (decision makers and influencers to the buying decision). This offers real pre-sale benefits and informs strategy and new product development (NPD/NPI).
- **Recording and measuring Customer Satisfaction** – post purchase - Once the customer has received the product/service, the model measures actual performance against expectation. This is really valuable in terms of informing factors such as: the marketing mix, new product/service development and strategy. Identifying what needs to change within the business (often at more than one level) to align more closely with the Value Criteria of the Customer.

For the process to be successful the Customer Value Perception Survey starts with recognition, at the supplier board level, that the supplier will have to act on the outcomes of the survey. Therefore, the process must include some preparation in how the intervention is presented to the customer. The purpose of the survey must be put into words that reflect the integrity of the process by not promising anything that the supplier cannot deliver; managing the expectations of the customer is critical to success.

The interviewing skills of the lead participant are key to success of the survey. In the case study a "lean standard" was given interview training to develop the necessary skills before the survey commenced. The lean standard was neither a technical expert, nor part of the commercial sales and marketing team. He was selected to be impartial and non-threatening. Consistency in the interview data gave the analysis more rigour; this was provided by having only one lean standard throughout the whole survey. The lean standard was supported by a technical expert whose role was simply clarification, and who did not participate in the interview questions. Although, if areas of specific interest were being explored, the expert was encouraged to ask detailed enquiring questions to help get a deep understanding of the subject under discussion. To demonstrate senior management commitment and support, the commercial director personally attended as an observer at many of the interviews.

This survey differs from a standard market research approach in that it identifies all of the "touch-points" in the delivery of the products or services to the customer. In this case study 17 companies were surveyed and 130 people interviewed. Each customer was asked to identify the criteria that they valued. The interviewees were then asked to rank how they thought that the company performed in delivering these, and how they performed against the competition. In addition the customers were requested to rate them against the best supplier of any product or service. Finally, each customer was asked to give a comment that sums up the supplier "in a nutshell".

The customers' views were analysed to give an overall Customer Perception Index (Figure 1) and from this a VoC Scorecard was produced. The value criteria and performance statistics were generated to identify major areas of improvement. Figure 2 shows the results of some of the analyses.

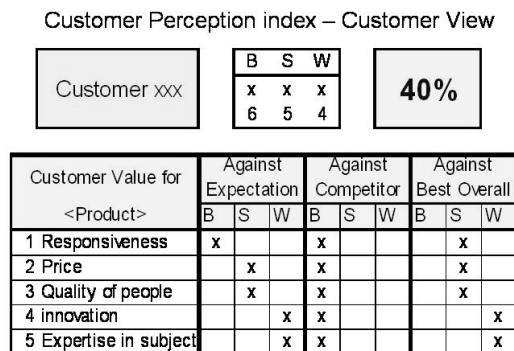


Figure 1 Customer Perception Indices

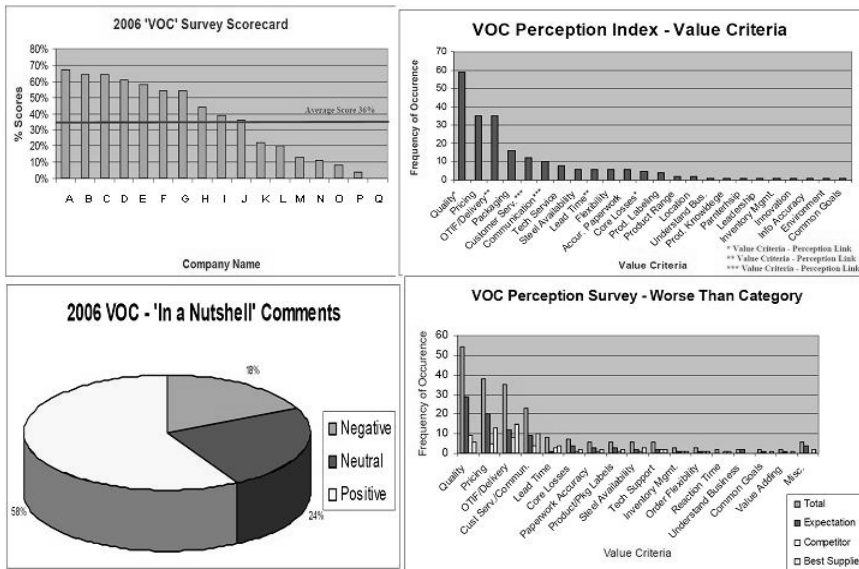
Finally Kano analysis was used to categorize the performance against the value criteria and to prioritize the improvements. The basic and performance factors were addressed immediately and then attention was given to the delighter factors. The performance of the best supplier in each of these was used as a standard. Not all of the actions could be taken immediately, but the analysis

provided the opportunity to prioritize these based on real customer perception data rather than a biased or narrow view of "customer value". However, it must be recognized that customer expectations are dynamic and change with time. As high performance becomes standard, Kano delighter factors become the performance and basic factors. It is therefore important that the analysis is repeated periodically, in order to understand and manage the customers' future expectations, to achieve sustainable supply chains and long-term customer-supplier relationships.

**MAJOR RESULTS**

Since completing the work, the company has been unable to satisfy all the customer demands, but it is now focusing on offering value added products/services that were never envisaged before commencing the process; which has resulted in some major new business. The survey changed the face of the company, which is now seen as much more customer-focused; in an industry where this is unusual. As a result of developing stronger relationships with the customers, new markets have opened where the customers have transferred part of their processing to the supplier. The company is now responsible for some of the customers' pre-processing and now supplies sub-assemblies rather than just components. This has expanded the product range and developed new customers and markets, which has been reflected in the financial profitability of the company and has helped to turn the company around.

In addition, when the company started this process, they thought they knew who the influencers to the buying decision were within each of their key customers. It became apparent during the course of the survey work that they had not recognised that the *real* influencers were people with whom they had little, or no, relationships; this drove them to restructure their Key Account Management process to address this finding.



### Figure 2 VoC Perception Survey Analyses

Finally, within the case company, all the employees now understand what it is that the customers value. This has helped to define their own roles and responsibilities by clarifying how they can contribute to delivering that value to the customer. As a result, the lean implementation has been extended, and sustained, into the office and commercial areas, specifically within the order creation process, where the potential has been demonstrated

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## **THE ROLE OF CONTEXTUAL INFORMATION IN EVALUATING DEMAND PREDICTABILITY**

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### **ABSTRACT**

This paper deals with evaluating the predictability of demand in industrial markets. The role of contextual information in demand forecasting is clarified. The paper provides an approach for evaluating the predictability of demand, which caters for both demand history and the availability of relevant contextual information. Managerial implications of the approach are discussed.

### **INTRODUCTION**

To be able to set a realistic target for forecasting accuracy, the theoretical predictability of demand should be known. Traditionally, the predictability of demand has been evaluated by measuring the forecast error. However, this measure reveals only the performance of the present forecasting system, but does not show the accuracy that could be achieved if the forecasting process was managed more efficiently. Individuals in the organization develop their own views on the predictability of demand on the basis of their experiences with certain customers and from their own viewpoint. The views tend to be diverse, due to the differences in job descriptions and different contacts with customers. Therefore, there is a need for an approach that can create an objective picture about the predictability of demand in the company as a whole.

In industrial markets, evaluating the true predictability of demand is challenging for several reasons. First of all, in many real-life situations the customer base is heterogeneous in terms of demand patterns. Dealing with the heterogeneity of demand patterns in forecasting has been studied for example in the work of Kalchschmidt et al. (2006). Secondly, the predictability of demand cannot be evaluated merely on the basis of past demand. Even if the past demand patterns are irregular, the demand can still be predicted to some extent on the basis of so called contextual information. Contextual information can be for example information about a price increase, an impending strike, or new policies that may affect the demand. Domain knowledge enables the practitioner to evaluate the importance of specific information (Sanders & Ritzman, 2004).

The research question of this paper rises from a real case example that shows that there is a need to consciously manage the collection of contextual information in the forecasting process.

### **FORECASTING IRREGULAR DEMAND**

Demand forecasting is commonly effective with consumer products, where the demand patterns are relatively smooth and time series methods can be successfully applied. However, since the 90's there has been a growing interest in the demand forecasting of so-called lumpy or sporadic demand. Several authors have found that in many industrial contexts, companies are encountering



increasingly uncertain and irregular demand (Kalchschmidt et al. 2006, Bartezzaghi et al. 1999, Miragliotta & Staudacher 2004).

Various approaches have been suggested for forecasting lumpy demand. The first approach is to apply the traditional forecasting techniques based on the analysis of past demand information, but these techniques are susceptible to large forecast errors, since lumpiness breaks the series. Another option is to model the demand creation process, focusing not only on forecasting order sizes but also order intervals (Croston 1972, Syntetos & Boylan 2001). Other approaches extend the information base of forecasting by looking directly at future requirements. In the method called early sales method (Bartezzaghi 1999), the main idea is that the estimation of unknown future demand is based on the actual orders that have already been received for future delivery. Another approach to anticipate future requirements is to exploit the early information that a customer generates during his purchasing process before he places his actual order. This approach is called order overplanning (Bartezzaghi 1995). In a business-to-business environment, judgmental methods are commonly used, and there has even been increasing interest in judgmental methods in the recent years. (Mentzer & Moon 2005, Lawrence et al. 2006). The strength of judgmental forecasting is the possibility to combine contextual information and domain knowledge into forecasts.

It can be said that the predictability of demand depends on the regularity of historical demand patterns and availability of relevant contextual information, but combining these two factors in forecasting is an issue in itself. Different integration methods for combining quantitative and judgmental forecasting have been studied (Goodwin, 2000; Sanders & Rizman, 2004). The impact of judgment on demand forecasting has been studied both with laboratory research (Wright & Goodwin, 1998, p. 91-113) and some field studies (Lawrence et al. 2000; Fildes, 1991). In general, judges will outperform models when they have contextual information to help them comprehend discontinuities in series. Human judgment is most effective if "broken leg cues" are available (Webby & O'Connor, 1996). A broken-leg cue refers to an unusual important piece of information whose presence would dramatically alter the judgment compared to a model of that judgment (Kleinmuntz, 1990).

However, research evidence is mixed as regards the accuracy of judgmental forecasting in real life (Webby & O'Connor, 1996, Lawrence et al. 2006). Some results report the success of judgmental forecasting (Fildes, 1991), but there is also evidence that in many cases contextual information fails to influence forecast accuracy (Lawrence et al. 2000). Salespeople are closest to the customer, so they are assumed to have the best access to contextual information. However, judgmental forecasts, especially when produced by salespeople, are known to be prone to bias and inefficiency (Mentzer & Moon, 2005). That is why also the manager of the forecasting process should understand the available contextual information and its potential contribution to forecasting. Without that understanding it is impossible to say if the cause of forecast inaccuracy is due to the forecaster or lack of relevant contextual information.

There is evidence that judgmental forecasters carry out voluntary integration of statistical methods and judgmental forecasts inefficiently (Goodwin, 2000). It has

been found out in laboratory studies that forecasters tend to ignore cues, especially if there are several available (Wright & Goodwin, 1998). Therefore, there is a need to provide tools and instructions to achieve better understanding of the forecasting task in practice. It should be known what is the theoretical accuracy that can be achieved and what are the most important cues that the forecaster should follow. Also Lawrence et al. (2006), after reviewing 200 studies about judgmental forecasting, state that much remains to be researched to develop improved methods for supporting judgmental forecasters, particularly in identifying when judgmental intervention is needed and when it is not needed.

### **SETTING TARGETS FOR FORECASTING**

Setting the accuracy targets for forecasting is a very company-specific task. Field studies have shown that in many companies it is not possible to measure the benefits of accurate forecasts in terms of their impacts on business performance (Mentzer & Moon, 2005). One interesting issue in target setting in real life is that forecasting is mixed with planning, and so in practice high accuracy is not the target after all (Lawrence et al. 2000). In some cases, sales are manipulated to meet the target that was set (Lawrence et al. 2006). So the problem of target-setting is finding out what the accuracy target could be rather than what it should be.

Bunn and Taylor (2001) state that cross-company comparisons have not generally been relevant or feasible in the area of setting the goals of forecasting quality. According to them forecasting error consists of irreducible error due to intrinsic unpredictable uncertainty and error due to less than perfect, estimation and forecasting, and their derivation of an accuracy target is based on the measurement of this irreducible uncertainty. In this paper, the aim is basically the same, but taking into consideration not only the historical demand patterns but also the contextual information available.

More important than accuracy is the efficiency of the whole forecasting process, finding a cost-efficient forecasting approach. In many forecasting approaches, demand history is a necessary input despite the irregularity. Demand history is relatively easily available, compared with other information that can be used as the input for forecasting. Using qualitative methods in the forecasting process is more expensive, and the accuracy achieved usually weaker (Menzer & Moon, 2005), so this makes it relevant to think where the forecasting effort should be focused and how statistical forecasts can be exploited in the forecasting process. In practice this means that most of the forecasting effort should be focused on the most important customers/products, because the time used for forecasting is taken from other activities that salespeople are responsible doing. (Mentzer & Moon, 2005). Some authors (Caniato et al. 2005, Thomassey et al. 2005) suggest that proper categorization of customers is a good way to focus forecasting efforts. In this paper, the aim is to find a basis for clustering customers on the basis of the predictability of their demand.

### **RELEVANCE OF THE RESEARCH PROBLEM IN REAL LIFE**

In the case company operating in industrial markets, it is difficult to get a picture of the true predictability of demand. Still, forecasting systems are used actively in planning, and accuracy targets are set.

Demand forecasts are produced individually in separate sales units, and only the salespeople know what kind of information their predictions are based on. It is difficult for the general management to lead the work of the forecasters, since they do not have sufficient knowledge about the sources of the forecast information.

The sales people produce sales forecasts for each customer on a monthly basis, since it is considered natural to produce forecasts on the same level as the everyday communication happens. However, typical order frequency is one order per month or less. As a result, forecasts are made on a higher frequency than orders arrive. It is impossible to translate contextual information into reliable forecasting data when the time span of the contextual information is longer than the forecasting time span.

The customer base is heterogeneous, and the customers operate in distinct businesses: contractual markets and spot markets. On the latter markets, each order is competed for, so predictability can be assumed to be considerably lower than in contractual markets. In addition, a considerable part of the irregularities in demand patterns are explained by the company's own actions, such as substituting a product with a similar product or redirecting the orders between the sales units.

For the above reasons, true predictability of demand cannot be concluded from the measured forecast accuracy, and the value of contextual information in forecasting remains fuzzy. This problem can be assumed to be quite general. Therefore we claim that the value of contextual information should be systematically and critically evaluated, if judgemental forecasting is planned to be applied.

### **AN APPROACH FOR EVALUATING THE PREDICTABILITY OF DEMAND**

As noted in the literature review, judgemental forecasting outperforms quantitative forecasting if such contextual information is available that enables predicting considerable changes in demand patterns. However, salespeople are known to be unwilling to take responsibility for forecasting voluntarily, since it is not their primary task. It is reasonable to focus the salespeople's responsibilities only on collecting relevant contextual information. Therefore, the relevance and value of contextual information should be consciously and systematically evaluated. Here we suggest an approach for evaluating the predictability of demand that consists of two steps, analyzing demand data and analyzing contextual information.

In the first step, irregularities in demand patterns are revealed through analyzing the demand data. Historical demand patterns are categorized in order to identify and categorize irregularities in the demand patterns. The idea is to find situations where quantitative forecasts fail, such as unpredicted pikes or drops. The aim of this first step is to find out products that have stationary demand and thereby to outline typical characteristics of the demand environment, and to identify

irregularities and changes in the demand patterns, so that reasons for the irregularities can be studied further in the next phase.

In the second phase, the availability of contextual information is studied by interviewing key informants, and the relevance of available contextual information is evaluated with logical reasoning. This phase aims at explaining the changes in the demand patterns and evaluating if such contextual information is available that similar changes can be predicted. Especially the most significant points where quantitative forecasts fail are studied further. The potential reasons for changes in the demand patterns can be divided into three main categories: own actions that manipulate the demand, customers' actions, and environmental changes. Reasons for changes in the demand patterns can be for example price negotiations, the seasonality of end products, the project nature of customers business, strikes of interest groups, and competitors' actions. The ultimate goal of this analysis phase is to map the most typical situations and reasons that cause irregularities and uncertainty in demand, and what kind of information is available about the root causes.

If the timing and magnitude of a change in demand is known accurately beforehand, this information can be treated in the same way as a confirmed order. It can be said that contextual information is demand information that is inexact about the timing, magnitude or probability of an arriving order. In addition, contextual information may contain information of whether the change in demand pattern (drop or rise) is temporary or permanent. The main point of analyzing contextual information is to find out if such contextual information exists that is truly valuable in forecasting and available only for the salespeople.

The value of contextual information is easily intuitively overestimated, but in many cases it can to some extent be concluded with probability calculations<sup>1</sup>. Contextual information is of value in forecasting only if the expected value of a forecast error decreases with using it. Therefore, information about a certain and permanent level change is always relevant contextual information, regardless of inaccuracy in its timing estimation. Also information about a temporary change in demand is valuable information, if the exact timing and the direction of demand change is known, regardless inaccuracy in the magnitude estimation. Contextual information that might seem relevant, but is irrelevant with regard to forecasting, is for example information about temporary demand pikes or drops for which the timing is not accurately known, regardless the exactness of the magnitude estimation. Also information about the risk of a permanent level change is irrelevant for forecasting, unless the probability of the change is over 50%.

Figure 1 illustrates the goal of the analysis: different categories for predictability. The idea of forming these categories is to focus the forecasting resources and facilitate the choice of the forecasting method and practices. Measuring forecast accuracy in these categories gives a better picture about the predictability of demand as a whole. If the demand patterns are highly irregular and relevant contextual information is not available, the prerequisites for forecasting are low regardless the method used. In other cases, the choice of the forecasting method

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<sup>1</sup> Analytical proof omitted due to space limitations, available on request

is made on the basis of the regularity of demand history and availability of relevant contextual information.

Characteristics of demand  Smooth, continuous	No forecasting	Forecasts based on contextual information
	Quantitative forecasting	Judgmental adjustment only in case of pre-determined relevant contextual information
	Low	High
	Relevance of contextual information	

Figure 1: Predictability of demand and its implications for forecasting

## CONCLUSIONS

The role of contextual information is substantial, but has remained fuzzy in the literature. However, the value of contextual information in forecasting can to some extent be logically concluded. Critical evaluation of contextual information and its value is in order in the following situations: 1) the forecasting accuracy does not meet the targets that have been set, 2) there are conflicting opinions about the predictability of demand inside the company, 3) forecasting is too time-consuming considering its benefits, 4) there are plans to increase the use of forecasts in production planning and inventory management

The approach presented in this study maps the prerequisites and opportunities for producing reliable forecasts, and therefore forms a better basis for focusing forecasting resources, as well as for possible development actions, such as incentive systems or inner benchmarking.

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## **AGILITY IN A PROJECT-ORIENTED SUPPLY CHAIN**

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### **ABSTRACT**

This study contributes to the discussion on agility in supply chain management (SCM) and provides a novel focus on the development of an agile supply chain in a project-oriented supply chain. The object of this study is to develop an agile supply chain for the case network which is moving towards project-oriented business. It is concluded that in project-oriented supply chain, agility is necessary for competitiveness, and comprehensive implementation of information and communication technologies (ICTs) throughout the supply chain is of utmost importance in the development of an agile supply chain.

Keywords: agent-technology, agility, project-oriented supply chain

### **INTRODUCTION**

Today's dynamic business environment requires frequent changes both in the way organisations operate, and in their organizational structure. Change in business is nothing new, it is only occurring faster and more unexpectedly than ever before (e.g. Drucker 1968, Gattorna & Walters 1996). Surviving and prospering in these turbulent situations will be possible if organisations have the essential capabilities to recognise and understand their changing environments and respond in a proper way to every unexpected change. The ability to respond appropriately to changes would only be achieved by changing the way companies look their business, their relationships with customers, suppliers, and competitors. (Goldman et al. 1995) The new manufacturing paradigm in today's changing business environment is agility, namely, the ability of a supply chain to rapidly respond to changes in market and customer demands (Sharp et al. 1999). Developing agility means not about small-scale continuous improvements, but radical changes - an entirely different way of doing business. Above all, to achieve agility, the use of advanced information and communication technologies (ICTs) is needed.

This study is done in the Finnish steel manufacturing industry, which is moving from traditional mass production towards project-oriented business, where quick response is a key issue and agile practices more attractive. In this study, the new agile supply chain for a case steel manufacturing network is developed. The agile supply chain, called SteelNet system, functions through the Internet and agent software technology. Even though agent technology is in the early stage of research and practice, it is been seen one of the most promising technologies to enable flexible and dynamic coordination in the business network and support decision-making in every-day logistics activities and operational duties. The development of SteelNet system is based on the principles of the agile supply chain framework, which also is reported in this paper.

## **METHODOLOGY**

### **Research problem**

The trend in today's B2B markets is towards more innovative, value-added products, total solutions that are customized to the individual customer needs. That is also the trend in the case steel manufacturing network, which is moving from mass production towards supplying systems and turnkey deliveries of one-of-a-kind products, in other words, towards project-oriented business. The case network consists of a group of 19 small and medium size enterprises (SME), typically component suppliers or service providers, and the large steel corporation as a focal company. The focal company, which previous has concentrated on the basic steel producing, is now integrating upstream of the supply chain in order to raise the value-added. The focal company has outsourced many manufacturing activities and today is more and more focusing on engineering, brand building, customer service management, and management of supplier network. However, among its suppliers, there is a shortage of medium size companies that can take care of more comprehensive outsourced operations. Thus, small suppliers with the focus on the manufacturing of parts and components have to increase their role and take more responsibility of the development of products, manufacturing and logistics. Traditionally locally-operated suppliers find themselves in the global business, characterized by increasing uncertainty and competitiveness. The suppliers are not sufficiently cost-effective or nimble for the international competition and they are losing business to more cheap or agile competitors. A focal company, with suppliers with a poor agile supply chain level (meaning poor collaboration and visibility in supply chains), will find it very difficult to provide high levels of products to customers even in stable environments. Place these companies in a more uncertain changing environment as is today's global business, and it will be eliminated from participation in the competitive game altogether.

In this transformation, companies are increasingly forced to use ICT and new manufacturing concepts, and combine them in different activities to avoid the risk of becoming less competitive or obsolete. The main problem in the case network is in information integration and in communication styles. Communication between the companies today is mainly based on mail, e-mail, phone calls or company visits - that do not give much visibility in the network. Few companies have advanced ICT systems, all of them point-of-solutions, and the majority have no advanced electronic information systems at all. The case companies have discovered that ICT utilization could bring great challenges for their collaboration activities. To achieve more agility, effective ICT utilization is needed. The research question of this study is therefore stated as follows:

*"How to develop an agile supply chain for a project-oriented supply chain?"*

### **Methods and data collection**

Initially, the essential principles of agility concept were studied from a theoretical perspective. Also, literature review related to ICT in Supply Chain Management (SCM) was done in order to select the suitable technological solution. After theoretical review, qualitative methods such as interviews, observations, questionnaires, process modelling, and documents were used as data collection methods to find out the requirements and potential for the agile supply chain development. The findings from different sources were qualitatively analysed by



the research group, and sometimes also by the case company personnel. In the hermeneutical, qualitative research, there is no clear separation between data collection and data analysis. It is a more iterative process where an analysis takes place while the data collection is in progress, and these understandings are incorporated into future data collection situations to check out the emergent ideas and understandings (Easterby-Smith et al. 2002).

Parallel to the process modelling, the software development was going on. The software development process was adapted to the principles of the agile software development. Therefore the technical research was based on iterative prototyping with close discussion and collaboration with the real end users. Theme interviews were held and a technical questionnaire was carried out to gather requirements for an agent-based prototype system, which was selected as a technological solution for an agile supply chain. The agile supply chain, called later SteelNet system, was in the field-test phase in 3 companies. The objectives of the field test were to study the functionality of SteelNet system, to collect information for further development and maintenance, to give a possibility for the network participants to familiarize themselves with SteelNet system, and to help the companies establish shared practices.

This qualitative study can be located into the normative area of business studies comprising of a theoretical and an empirical analysis. It is thus characterized as modelling, prescriptive, or recommending. This study uses the qualitative approach, and it is interpretative. For interpretative research, a given amount of subjectivity needs to be approved – interpretation is somewhat subjective in nature.

## **CASE STUDY**

### **Agility in project-oriented supply chain**

The need for agility has traditionally been associated with the supply chains in high technology industry products. However, traditional industries also face similar challenges in terms of speed, flexibility, increased product diversity and customization. In the project-oriented business, each project is unique in terms of design, manufacturing and technological requirements and precedence constraints and processing times are highly uncertain. The high level of uncertainty, with respect to routings and processing times and uncertainty of customers orders, makes the production planning and control problem a difficult one (Babu 1999). In such a business, typically several companies are involved in the supply, and visibility and collaboration, which can be seen as the main elements of agility, are the key issues. During a project there are many things happening simultaneously, creating a lot of information that needs to be distributed and handled in real time. Open information sharing is the key issue, and information transfer must be in real time, not only inside the own organization, but also between all the companies and partners in the supply chain. (Kiianlinna & Simula 2004)

Christopher (2000) has identified a set of characteristics that a supply chain must have in order to be truly agile. Van Hoek (2001) presents the interconnections of the key agile elements. According to them, an agile supply chain is:

- *market sensitivity* (capable of reading and responding to real demand),

- *being information driven* (or virtual) (it involves the use of information technology to share data between buyers and suppliers and hence, enabling the supply chain to become demand driven);
- *having integrated processes* (achieved through collaborative working between buyers and suppliers: joint product development, common system design, shared information); and
- *being network based* (being able to leverage the respective strengths and competencies of network partners to achieve greater responsiveness to market needs).

The author has gone one step further and combined those and several other characteristics in SCM literature. In the Figure 1, the combined agile supply chain in project-oriented business is presented. The underlying assumption in this model is that of open relationships between the supply chain participants, the sharing of information and the use of technology to create connectivity (i.e. ability for organizations to share information in real-time).

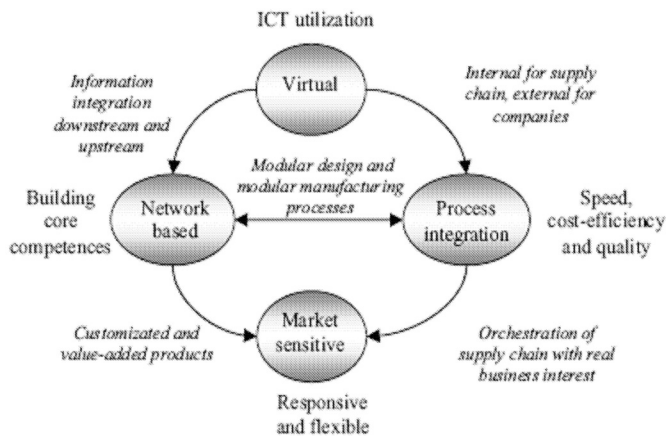


Figure 1. Project-oriented agile supply chain (Iskanius 2006)

### SteelNet system

SteelNet system is an agent-based system that uses Internet as a communication channel among enterprises. Agent technology, which is a promising software technology for enabling a flexible and dynamic coordination of distributed entities in business networks, provides a feasible solution for information sharing. Agents can be described as software systems that are autonomous, co-operative (social behaviour), reactive and pro-active (Wooldridge 1995), thus efficiently improving the decision-making in collaborating companies. Agent technology can be used for information sharing among heterogeneous applications and systems and to support networking in industrial environment despite the domain. The prototype implementations ensure the flexibility and reconfigurability of agent-based solutions while it strongly supports a plug-and-operate approach. In SteelNet system, companies can do the following tasks electronically, which really makes the supply chain more agile:

- Send and receive tenders and requests for tenders in the network Controlled transparent needs to be taken into account (the request for tender is sent to all companies or to selective ones only);
- The changing of tendering data into order data is possible for the network members;
- Sending work orders to all member firms simultaneously using the Internet;
- Follow-up of products under production is possible in different firms within the network in real time;
- Centralized documentation handling for the whole network. Support for document handling of orders;
- Reservation of free resources through the net. Resources can mean persons, equipment or services;
- Usage reports for the firms: volumes of usage, usage times, services used, change management, etc.

SteelNet system, in its nature, is an open shared information system between multiple companies, where each company has equal rights and responsibilities in a supply chain and each company can act as a project owner or as a supplier to other company. In other words, each company can independently request quotes or make orders in SteelNet system, unlike traditional subcontractor systems which are typically designed for the focal company and for the supplier management. Figure 2 presents the structure of the SteelNet system. The SteelNet system management takes place from service provider's premises. Yet the service provider can be, for instance, the focal company of the supply network and no external service provider is needed.

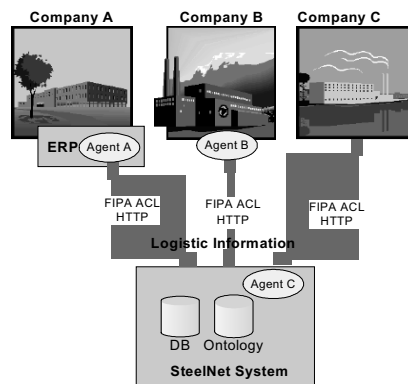


Figure 2 – Agents delivering information in various ways in SteelNet.

## CONCLUSION

The SteelNet system, reported in this paper, gives an opportunity for real-time and transparent information sharing. It is generated to fit the needs of both small and large companies with different levels of ICT systems. The companies operating in the project-oriented business together exploit market opportunities and share costs, skills, and core competences. Intensive co-operation between personnel of the companies and researchers has formed the system that provides answers for the requirements of every day duties. Yet it is important to note that the implementation of a new ICT system poses a number of challenges

for the companies in the network. Companies of all sizes participating in the SteelNet showed determination and willingness to learn the benefits of the new ICT system. Interestingly, the personnel at the operational level were in many cases the first ones to realize the benefits of the new system and practices. To further develop the SteelNet system, commitment in the top management level is of crucial importance.

The benefits that agility, achieved by SteelNet system, offers to the network in terms of flexibility, costs, lead times, efficiency, business volume and profitability are very attractive and capable of ensuring better competitive edge in meeting greater and serious challenges that lie ahead in the future. It is concluded that in project-oriented supply chain, agility is necessary for competitiveness, and comprehensive implementation of ICT throughout the supply chain is of utmost importance in the development of an agile supply chain.

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## **EXPLORATORY RESEARCH INTO SUPPLY CHAIN VOIDS WITHIN WELSH PRIORITY BUSINESS SECTORS**

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### **ABSTRACT**

The paper reports the findings resulting from the initial stages of an exploratory investigation into Supply Chain Voids (SCV) in Wales. The research forms the foundations of a PhD thesis which is framed within the sectors designated as important by the Welsh Assembly Government (WAG) and indicates local supplier capability voids within their supply chains. This paper covers the stages of initial data gathering, analysis and results identified between June 2006 and April 2007, whilst addressing the first of four research questions. Finally, the approach to address future research is identified in order to explain how the PhD is to progress.

### **INTRODUCTION**

The paper reports the findings resulting from the initial stages of an exploratory investigation into SCV in Wales. In this context SCV has been defined as *'Immediate and potential gaps in capability within the Welsh Business Community for products and/or services. Identifying and satisfying these gaps will strengthen the Welsh economy and individual supply chains'*. These have also been described as *'supply linkages'* (Crone and Watts, 2000), *'local linkages'* (Crone, 2002), *'sourcing patterns'* (Hewitt-Dundas et al, 2005) and *'material linkages'* by Phelps (1993a and 1993b).

The 'Source Wales' programme encouraged inward investors to use local suppliers (Hines, 1992; 1993) and has been acknowledged as a best practice model (Crone, 2002). This study further develops its predecessor by identifying and investigating SCV, before designing a framework to address them. Specifically, it builds upon pilot work conducted in Welsh manufacturing sectors, addressing painting and forging capabilities (Supply Chain Management Development Centre, Swansea Institute, 2004 and DMC Consulting, 2005).

The research forms the foundations of a PhD thesis. This paper covers the stages of initial data gathering, analysis and results identified between June 2006 and April 2007, whilst addressing the first research question:

*'Which of the priority industry sectors in Wales could potentially deliver the most economic growth and benefits (over the next 5 to 10 years) and do SCV exist in these sectors?'*

### **RELATION TO EXISTING WORK**

From an initial review of the literature it appears that few academic studies have focused on reporting the mechanisms or models employed to identify and respond to SCV. Crone (2002) proposes potential policy interventions for regional development agencies (RDAs) in relation to addressing weak supply linkages. Much of the previous research around the area of the supply network has focused on improving the performance of existing members (Hines, 1992, 1994).

Regional development and regional sourcing literature has largely focused on attracting out-sourced and/or off shored activities and embedding overseas investors within their chosen locality (summarised in Bryan and Jones, 2000; Munday, 1995). Other economic development literature has focussed on the competitiveness of nations and regions (Porter, 1990, 1998 and 2003).

Previous research in manufacturing has quantified the percentage of local linkages, whereas the research into SCV seeks evidence of specific products or services. Hewitt-Dundas et al, (2005) specifies sourcing patterns of foreign owned multi-national (MN) plants in Ireland and the reasons why they do not source locally. Crone and Watts (2000, 2002) identify local supply linkages in Yorkshire and Humberside within MN plants owned by both United Kingdom (UK) and foreign companies and compare the results with previous research in other UK regions, including Wales, concluding that supply linkages are weak in the UK. In addition, Phelps (1993a and 1993b) investigates material linkages in the north of England in both UK and foreign owned MN branch plants.

Crone and Watts (2002) indicate difficulties for RDAs to effect change in supply chain patterns of MN plants through policy interventions such as increasing the use of local suppliers. Subsequently, Crone (2002) highlights possible policy interventions where there is a lack of local availability. Munday (1995) and Crone and Watts (2000) suggest that policies directed at encouraging second round inward investments, and the development of linkages between larger firms, would probably offer greater potential for successful cluster development in less favoured regions. Twomey and Tomkins (1996) state that local sourcing by MN plants might be increased by policies designed to 'fill' gaps in the local supply base to capitalise on unfulfilled 'supply potential'. The literature however does not introduce any framework to aid implementation of policy interventions.

## **METHODOLOGY**

A critical realist perspective has been adopted for the PhD research (Lovering, 1990). The overall approach is exploratory and inductive, adopting a case study strategy (Yin, 2003) and although the study is mainly qualitative in nature (Denzin and Lincoln, 2000) the design employs a multi-method approach (Saunders et al, 2003). Research methods utilised to date include the use of secondary data in order to assess the differing economic characteristics of the important sectors in Wales, along with a number of semi-structured interviews with companies to identify and quantify SCV.

## **MAJOR FINDINGS**

Research between June to October 2006 targeted the first part of the research question: '*Which of the priority industry sectors in Wales could potentially deliver the most economic growth and benefits (over the next 5 to 10 years)?*' Initial research addressed in excess of ten sectors identified by the WAG (WAG, 2005 and Welsh Development Agency (WDA), 2004). These included Automotive, Aerospace, Agri-Food, High Technology (ie Electronics, Biosciences, ICT, Materials, Nano & Micro Technology, Combined and Converged Technologies), Pharmaceuticals & Biochemicals, Financial Services, Creative Industries, Construction, Hospitality, Leisure & Tourism and Social Care with the potential for addition of Energy and Environmental-related sectors.

Statistical data from the WAG web site (<http://www.statswales.wales.gov.uk>) and previous research by the Welsh Economic Research Unit (WERU) (2002) and the Institute of Welsh Affairs (IWA) (2005), utilising the Multi-Sectoral Qualitative Analysis (MSQA) framework introduced by Roberts and Stimson (1998). Finally, data was analysed from the WERU Input-Output Tables 2002 (WERU, 2004), identifying that £7059.7M is spent by Welsh sectors on global procurement from outside UK.

The IWA (2005, p9) conclude that sectors could be selected for further research based on the following criteria:

- *To support where necessary, current areas of strength.* The financial services sector focussing on financial intermediation and insurance services aligns to this.
- *To develop new/latent sectors.* This targets the biosciences (and pharmaceuticals) sector. Opto-electronics or the creative industries could equally have been investigated under this category.
- *To ameliorate problems in sectors likely to decline further.* This criterion does not ideally match the results of the data analysis. However, whilst the aerospace sector is not in decline, environmental and technological challenges could impact it in the short to medium term (WAG, 2006 and Noor et al, 2000). It is also forecast that both passenger and cargo requirements are increasing (WAG, 2006).

Nine semi-structured interviews were conducted between November 2006 and April 2007: three in bioscience and pharmaceutical companies and six in financial and insurance companies. These addressed the second part of the research question: *'do SCV exist in these sectors?'* The questions relate to current SCV based on purchasing budgets and the largest expenditure with suppliers outside of Wales. The top five SCV by value for each sector are depicted in Table 1.

The bioscience and pharmaceutical sample all have 50 – 250 full-time employees and have all been operating in Wales for over 15 years. Other voids identified during the interview include a fermentation facility and a 'catalogue company' that provides general chemicals to universities and companies for lab-scale projects.

The financial and insurance sample includes a mix of banks, building societies, an on-line aggregator and comparator, and insurance companies. All companies employ over 250 full time employees except for one that employs 50 – 250. All companies have operated in Wales for up to, or over 15 years, except the on-line aggregator who has operated for up to 5 years. Skills gaps were highlighted particularly in ICT, supply chain account management and legal or contracting. Two companies identified a lack of disaster recovery sites.

<u>Sector</u>	<u>Product/Service Description</u>	<u>Supplier Country/Location</u>	<u>Total Value in £ p.a.</u>
Bio & Pharma	Capital Equipment e.g. Bio process rigs – specialist equipment	UK/Europe	Varies £2m - £5m
	Contract Manufacture eg freeze drying	USA	Approx £1.4m
	Process Chemical	UK/Europe	Approx £850K
	Contract Testing Houses	UK/Europe (Ireland)	Approx £1.25m
	Consultancy Services (Regulatory advice, to achieve FDA accreditation etc)	UK	Over £1.5m
Fin & Ins	Insurance services including general	UK	Over £100m
	Building Repairs	UK	£23.4m (£5.4m fees plus £18m spend on building repairs)
	Advertising Space (Various Media) On-Line & Off-Line	UK - Manchester & London	Over £22m
	Loss Adjusting (Subsidence)	UK	£13.2m (£3.2m fees plus £10m spend)
	Large Loss	UK	£11.7m (£0.7m fees plus £11m spend)
	Glazing	UK	£6m

**Table 1 –The Top Five Supply Chain Voids by Value (£) per annum**

### **CONCLUSIONS AND FUTURE RESEARCH**

In addressing the research question: '*Which of the priority industry sectors in Wales could potentially deliver the most economic growth and benefits (over the next 5 to 10 years) and do SCV exist in these sectors?*', it can be seen that three of the sectors could potentially deliver the most economic growth and that current voids have been identified in two.

Further research will adopt a case study strategy investigating three significant SCV identified during previous phases. This will involve understanding the extent to which the case study voids are an issue for Welsh companies across the respective sectors, to enable quantification of market demand. The PhD will refer to the significant SCV during the development of a framework that assesses the benefits, feasibility, affordability and capability of local sourcing over the existing solution.

This research is appropriate to academics, practitioners and policymakers.



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## **HOW TO MANAGE PURCHASING RISK: THE SUPPLIER PORTFOLIO SEGMENTATION APPROACH**

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### **ABSTRACT**

The paper investigates the supplier portfolio segmentation process. Drawing on the analysis of various academic works, we discuss and examine the paradoxes and the contradictions that purchasing managers are facing in the building and management of their portfolio of suppliers. The discussion demonstrates the necessity to adopt an integrative approach of supplier portfolio management including first, the analysis of internal and external supplier critical position, and second the alignment of purchasing policy with corporate strategy. Analysis of practices banking sector is provided to illustrate different ways of implementation.

**Keywords:** purchasing, supplier portfolio management, supply chain management

Some attention is here given to the matter of supplier segmentation. The segmentation chosen by shippers remain for the most part economical or logistical. Segmentation tries essentially to identify suppliers which need to be supervised continuously. The question is, among others, to focus on core relationships by which high level of commitment and involvement can be developed. Here cultural aspects can be taken into account in order to align with corporate strategy.

The purpose of the paper is to describe new trends in supplier selection process. That trend consists in adopting risk management approach in the management of supplier relationships. The paper proposes an overview of the work developed at the Purchasing function of Natixis, one of the biggest banks in France.

### **PURCHASING RISK AND SUPPLIER MANAGEMENT**

SCM defines the supply chain as a mix of activities that perform the functions of procurement of materials from a network of suppliers, transformation of these materials, and the physical distribution of end-products to customers (Chopra and Meindl, 2004 ; Wisner and Tan, 2000).

Our paper examines one specific side of SCM: the purchasing and supply perspective of shippers who need to focus their resources on critical risky suppliers for a number of reasons, including economic, strategic and financial ones. The fact is that supplier selection directly determines the performance of the supply chain (Bowersox et al, 2002). According to logistics management literature, 80 per cent of logistical costs associated with the sale of a convenience good are determined at design stage in which suppliers are involved

(Grégoire, 2000). Selecting suppliers efficiently should better control future logistical costs.

Logistics literature insists on the central step of prequalification in which shipper can eliminate suppliers unable to comply with a number of basic conditions, particularly logistic ones (Cooper and Ellram, 1993). According to this, purchasing managers have to be focus on minimizing the risks of non-availability of external resources (Trim, 1998). For that, compiling retrospective data on suppliers seems to be essential.

A first question lies in knowing which criteria should go into the vendor rating purchasing risk. Three types of standard attributes appear: economic attributes, process attributes and product/service attributes. The trend points to a clear reduction in the influence of economic attributes (e.g. purchasing cost) to the profit of process attributes (e.g. reliability) and product/service attributes (e.g. strategy for instance).

Recent papers include this idea and try to contribute to the construction of an integrative approach. Suppliers have to be evaluated with regard to their profile of risk (lead time, reliability, etc.) and internal cost generated (resources implemented within the organization) (Carter *et al*, 2000 ; Franceschini and Rafele, 2000). An effective risk supplier evaluation will thus imply a subtle balance between external and internal indicators.

There are two complementary perspectives of purchasing risk assessment, an accounting and a strategic perspective.

*The accounting perspective* The purchasing risk may be measured through its possible destruction of margin (i.e. the benefits for the firm). That leads to reasoning in terms of total cost of ownership (TCO), highly useful in selecting a supplier, requires taking into account a series of often neglected cost factors: the costs related to unreliable deliveries, the costs associated with quality shortcomings, etc. (Degraeve and Roodhooft, 1999).

*The strategic perspective* Shippers have to be taken into account qualitative criteria and to weigh all risks to make his decision (Vokurka *et al.*, 1996).

Both the accounting and the strategic perspectives of purchasing risk contribute to the performance of the supply chain. The portfolio supplier segmentation offers one way to manage these risks.

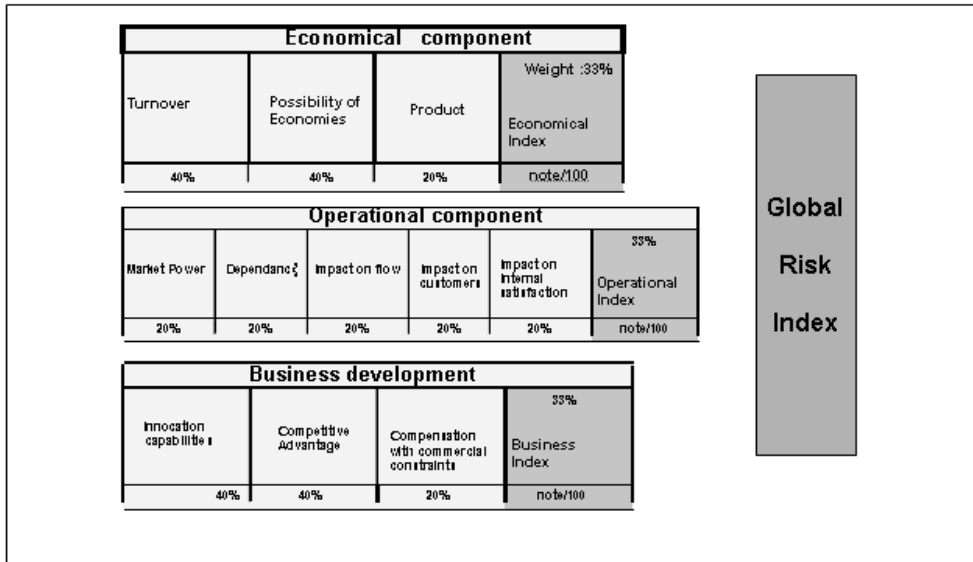
## **THE PORTFOLIO SUPPLIER SEGMENTATION**

The academic literature indicates the need to apply a discriminated approach of supplier risks (Dyer *et al*, 1998 ; Monckza *et al*, 1993,). That entails the coexistence of various types of exchange relationships between buyers and sellers, each relationship defining a given purchasing risk management strategy and a given negotiation style. The purchasing efforts made by the shipper should be in correspondence with the stake in terms of purchasing risks. Bensaou (1999) work indicates that purchasing efficiency lies in choosing a type of risk management adapted to the nature of the purchase, then in using an appropriate management method by adopting differentiated behaviours.

In that paper, we refer now to a qualitative research developed by 2 firms: the French bank Natixis and Airbus. The research deals with Purchasing risk management practices. One of the main results was to identify how these 2 firms evaluate their suppliers' level of risk (figures 1 and 2).

The two firms observed evaluate their suppliers' risks through a purchasing global risk index including 3 components (figure 1).

**Figure 1: Process of supplier risk level evaluation**



**Source: MASC, Institut of research and training in Purchasing and Supply Chain, Audencia**

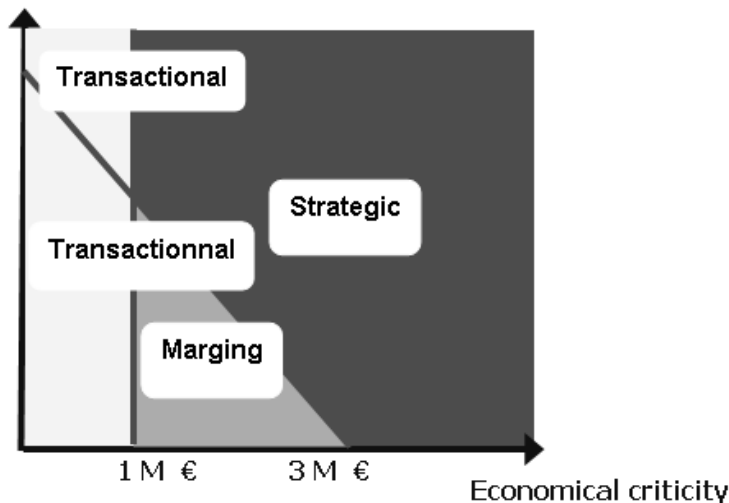
### Conclusion

This paper provides a preliminary overview about management of purchasing risks. It proposes an integrative approach of purchasing risks and induces a new segmentation of suppliers, complementarily to Kraljiik work (1983). That segmentation (figure 3) identifies:

- strategic suppliers, including economical and operational criticality, sometimes monopolistic situations
- margin suppliers, including economical medium level criticality without operational criticality (>1million and <3 millions euro turnover by Natixis)
- transactional suppliers, with no economical criticality

**Figure 3: segmentation of suppliers versus purchasing risks**

Strategic index



Each group of suppliers entails a specific approach of supplier relationships management.

Relationships with strategic suppliers lie on the development of continuous progress plans, which need cooperative and trust relationships.

Relationships with margin suppliers are based on the establishment of productivity plans, in which the management of power relationships is the norm.

Relationships with transactional suppliers are process oriented and rationalized in order to minimize the wastes of time and resources.

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## **CHALLENGES FOR THE INTEGRATION OF EUROPEAN AND CHINESE VEGETABLE SUPPLY CHAIN MANAGEMENT**

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### **ABSTRACT**

A key element for the food industry to be competitive on global and local markets is the constant improvement of the business processes. The usage of modern information and communication technology (ICT) is an opportunity for the improvement of the supply chain of vegetables and fresh food agribusiness. This paper introduces a reflection on challenges for the integration of European and Chinese Vegetable Supply Chain Management by the usage of internet technologies.

### **INTRODUCTION**

The rapid pace of technological development in ICT also affects industries outside the ICT sector. Most businesses are users of ICT. Modern information and communication technology also fundamentally shift structure in these user businesses. Supply chain architectures can be redesigned using ICT [1].

The growth of Internet has presented the supply chain with many significant opportunities for cost reduction and service improvement. [2] People believe that the Internet has the great potential to revolutionise the entire supply chain. Beside developments and research in the web technology (e.g. Web 2.0) and mobile technologies (e.g. UMTS, GPS) also developments on product (e.g. RFID) and infrastructure level (e.g. EPC) are playing an important role for improving the food supply chain [3]. To integrate internet supported European and Chinese vegetable supply chain management the results of an analysis regarding the Challenges for the Integration of European and Chinese in adopting advanced SCM techniques and use of ICT in supporting vegetable supply chain will be presented. This analysis contains existing problems and gaps in agribusiness SCM and adoption of ICT and Internet enabled technologies in Europe and China and will introduce possibilities for compiling solutions regarding these problems. The analysed supply chain functionalities (process oriented tasks, object oriented tasks and technical gaps in ICT and interfaces) which are embedded along the whole supply chain are shown in figure 1:



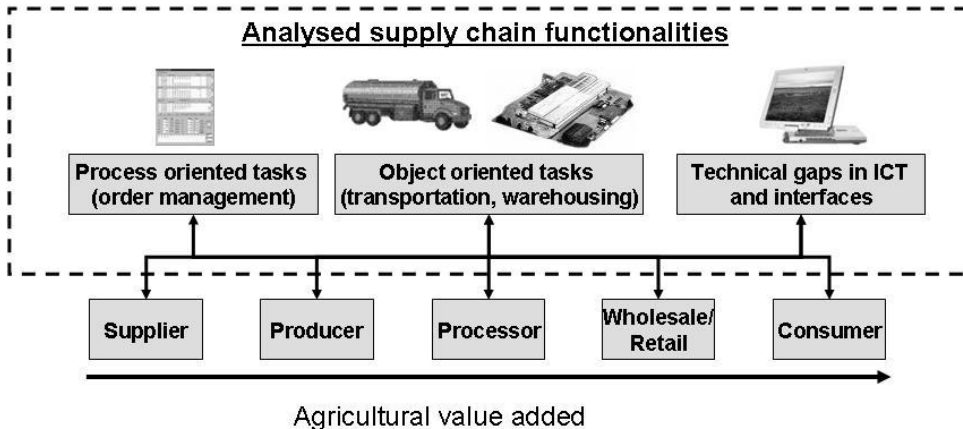


Figure 1: Analysed supply chain functionalities

The identification of challenges, gaps and problems has been done by comparing the sources from State-of-Art and State-of-Practice in some European countries and in China. The focus was on important points, like technical and methodological standards in the respective countries, as well as analyses of existing projects or initiatives oriented towards development of ICT adoption or improvement of SCM. Guidelines in the research were the practitioners' point of view (for short and medium term tasks) and the scientific sources (for long term tasks). The results from the analysis will be presented in the next chapter of this paper.

### **PROBLEMS AND GAPS BETWEEN EUROPEAN AND CHINESE VEGETABLE SUPPLY CHAIN MANAGEMENT**

A systematic comparison of the existing situation and possibilities of development within a nearer future is the base for an analysis on existing challenges, gaps and problems between Europe and China in adopting advanced SCM techniques and the use of modern ICT in improving the vegetable supply chain. The order processing which is the complete transaction between the buyer and seller is a vital link in the vegetable supply chain. 5 case studies were carried out in China and the United Kingdom (UK). The comparison shows the challenges by underpinning the gaps and problems in the fresh produce industry in China and UK. In each case, the order processing is the key area for the investigation. Both Chinese and British companies recognized the benefits of the Internet, such as cost saving, time saving, efficiency, and consider them as the main reasons for the Internet adoption. However, regarding the barriers to adoption, Chinese companies exhibit more barriers than UK companies. The reason for this is that Chinese companies limit their Internet usage on basic communication, online searching, and emails, while, besides these applications, the companies in the UK have higher Internet adoption rate and more advanced internet application, such as the use of Intranet, Extranet, and other software packages. This situation is understandable, as the UK is a high Internet usage country with 62.9% adoption rate, while Chinese adoption rate is only 9.4% [4]. As UK companies have adopted more advanced integrated software packages, the order processing is conducted more accurately as well as automatically. The analysis of the case

studies leads to the following gaps and problems. Firstly Chinese companies have a lack of integration and are less productive. It was noticed that Chinese agribusiness managers do not trust the information online. Though the Internet is used on supplier and product search or the communication for order processing, they have to process a manual document along the online information to validate the process. Secondly the technology adoption in the UK is more rationalized. The whole adoption is within the company business strategies. People from different department are aware of the strategies of the Internet adoption. However, in China, most companies have a lack of proper strategies. The Internet adoption is sometimes an idea from the managers' brainstorm, without the cooperation from the other department or partners. Another problem is the low awareness of supply chain management and the internet enabled supply chain in Chinese fresh produce companies. The case companies in China have no strategies regarding the supply chain management. Additionally to the aforementioned gaps and problems is that in many rural areas, farmers switch their production varieties according to the previous market information, without reasonable analysis on the current market and a contract with perspective buyer. For example, in Shandong province, when the farmers knew the Chinese leafs were in high price in 2003, they chose to grow Chinese leafs in the following year. As a result, the Chinese leafs supply was full of the market in 2004. This result is caused by information asymmetry. If the farmer had obtained timely market information, they would plan to grow alternatives to niche the market. Another problem is that only one company of the case participants in China uses the "cool chain" during the transportation of the fresh produce, because they have international business and the fresh produce should meet the requirement and standards of their customers. The other companies have not even thought about of transporting the fresh produce by chill chain equipment. From the literature, the "chill chain"/ "cool chain" is not widely used in Chinese fresh produce market [5]. Additionally, other problems like the standards in fresh produce, lack of traceability, lack of packaging, high rot rate in the fresh produce, etc. are all problems in the transportation of the fresh produce in China.

The economic growth of China and especially the Chinese agribusiness goes along with an increase in highway and airport construction as well as the proliferation of highly competitive trucking firms, bus lines, and airlines. These provide alternatives to China's aging railways for transporting people and freight. From 1990 to 2000, highway mileages in China increased by 36 percent and existing highways were greatly improved. China's railways, already the longest in Asia, also increased track length by 19 percent. Double tracking, electrification, and higher speed trains were introduced throughout the country. Even the length of China's inland waterways has increased by 9 percent. Newly constructed rail and highway connections to networks in Southeast and Central Asia and Russia are opening additional avenues for trade. Despite this growth in capacity, China's transportation network remains strained because freight traffic is growing at an even faster rate. The total freight traffic increased by 39.6 percent from 1990 to 2000, with most of the increases hauled on highways. The highway share rose from 75 to 77 percent between 1990 and 2000 when on the other hand the railway share fell. Also more food is being transported by trucks; the rail remains the chief transport mode for grain and other bulk commodities. Civil air routes tripled in length during the 1990s and air freight has grown dramatically. But air transportation still accounts for only a small share of total freight traffic [6].

While the global shipping industry has generally been contending with overcapacity, China's seaports struggled to keep up with 160-percent growth in seaborne freight volume from 1990 to 2000. The country's ports handled 56 million tons of grain in 2000. Containerization and intermodal facilities account for a growing share of shipping freight. Container-handling facilities are in short supply in China. Warehousing and other storage facilities are critical to an efficient marketing system. In spite of the modernisation and increase of Chinese transportation sector this growth is not sufficient for the requirements of also emerging Chinese agri-business because many goods especially vegetables are produced for export and need a special treatment due to their perishable nature. With China's growing consumption of perishable foods, cold warehousing and transport facilities are becoming an important link in the country's value chain. The Cold storage capacity is believed to be only 20 to 30 percent of the growing cargo demand and spoilage losses of up to 33 percent of perishable freight are common. Most of China's food is still transported by rail, but the lack of temperature-controlled equipment and logistical problems make the transport of foods expensive, particularly frozen and perishable foods. Also China's lack of electricity and its inadequate infrastructure have indirect impacts on the food demand [7].

The next sector to be analysed regarding challenges for the integration of European and Chinese vegetable supply chain management were problems and technical gaps in ICT and interfaces because Agricultural producers already know that information is important and valuable. Many farmers in developed countries already pay for information ranging from updates on weather conditions, soil and nutrient status, pest management reports and recommendations, to advice on what genetic seed line to plant for various field conditions [8]:

Key findings concerning the adoption of ICT for improving vegetable SCM were issues like the limited availability of modern ICT in China, the insufficient education or training of practitioners and the missing standardization. Some main problems here are also the significant costs for purchasing the necessary hardware and software, the backward oriented information structure of the vegetable market, the small size of the vegetable web sites and the bad quality of the information there. Important gaps are the lack of professional technical education and investment attraction, the low application level of ICT, the small size of the websites and their unequal allocation in the Chinese provinces.

Over the next few years, the agri-food marketing, handling and processing industries are expected to become more efficient and expand considerably as World Trade organisation (WTO) accession results in more logistics service competition, and accelerated market and legal reform. Most observers expect double-digit growth to occur, provided institutional and regulatory impediments can be overcome. China could more than triple the gross output value of its food processing industry's output by 2015 and quintuple it by 2030 if the economic fiefdoms of different institutions could be dismantled or disciplined and the efficiency of the value chain improved. But this depends quite critically on how Chinese enterprises and commercial ministries respond, whether they respond to the new environment by trying to erect new barriers to entry or by improving their commercial and competitive orientation [9].

The next chapter deals with possible approaches for solving some or the identified problems and bridging these gaps.

## **APPROACHES FOR THE INTEGRATION OF VEGETABLE SUPPLY CHAIN MANAGEMENT IN EUROPE AND CHINA**

The analysis on challenges for the Integration of European and Chinese Vegetable Supply Chain Management also offered some possibilities for bridging these gaps and solving some of the existing problems.

Recognized as an important part for the quality of the perishable goods in vegetable supply chain management was the handling and packaging of the vegetables but this was nearly unrealized by the Chinese producers. There is also not enough and sufficient technical equipment for cool chain storage and transportation for European vegetable supply chain requirements. This problem could be solved by educating the involved supply chain practitioners and acquisition of more and suitable equipped transportation and storage facilities.

Because of a limited availability of modern ICT and an insufficient education or training of the supply chain practitioners the development of suitable supply chain management training material and education in usage of internet seems to be a promising possibility to bridge the knowledge gap concerning vegetable supply chain management. A increase of modern ICT is a mid- and long term task for a better integration but the development of training material and the training of the supply chain practitioners seems to be a good opportunity for a short- and mid term task for improving the vegetable supply chain. Incentives for cooperation along the supply chain could improve the order management and the initiation for enterprise spanning interfaces offer the opportunity for a better integrated process design and management in the vegetable supply chain.

## **OUTLOOK**

Due to the fact of globalisation and the increasing exchange of goods between the continents, ongoing research has to play an important role for investigating and elaborating the technological and environmental situation of the food supply chain on local and global level. This has to cover new concepts of sustainable production, to the supply chain management of vegetables and alternative concepts of information access and information management to perishable goods in the vegetable supply chain. The proposed solution approaches will enable a better integration in the vegetable supply chain. Realising a cooperation between market oriented suppliers, producers, processors and retailers regarding governmental regulations could enable a well integrated vegetable supply chain from "fork to fork".

Next step is the realisation of the proposed approaches and solutions to reach a satisfying level of ICT integration in agricultural supply chains for that accurate and timely information flows can be established.

## **ACKNOWLEDGEMENT**

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## **FROM THE UNMANNED FACTORY TO LEAN-SIGMA: THE ROLE OF MANUFACTURING IMPROVEMENT PROGRAMMES FROM 1980-2005**

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### **ABSTRACT**

Three improvement programmes; Lean, Business Process Re-engineering (BPR) and Managing by Projects (MBP) are disaggregated into: vision, principles, toolbox and learning organisation, and benchmarked against the TPS. MBP is found to bear the closest resemblance to the TPS, by virtue of its systems orientation and learning organisation.

### **INTRODUCTION**

Western manufacturing industry has been exposed to many different improvement initiatives. The 1980s started with the notion of the 'unmanned factory'; stimulated by advances in cybernetics and flexible automation, and leading to the development of the flexible manufacturing system (FMS). General Motors followed this trend through a massive capital investment programme, but found that the new equipment was inflexible, difficult to maintain and not cost effective, and belatedly moved to a more 'Japanese approach' (Towill, 1997). At Lucas Industries, John Parnaby's (1989) Manufacturing Systems Engineering was a well-resourced, but perhaps less well known programme, which ran through the 1980-90s. During the 1980s many other companies started looking to Japan for new solutions. Schonberger (2007) reports on the then activities of the US's Repetitive Manufacturing Group, which organised a series of factory visits for its members to view early Just in Time (JIT) implementations between 1979 and 1984 at Kawasaki (Nebraska), Briggs and Stratton, Champion, Bendix, Steelcase, Schlage Lock, Hewlett-Packard, Black and Decker and Deere and Company. The move towards JIT was closely associated with a shift from Quality Control towards Quality Assurance and Total Quality Control (TQC).

By the mid-1990s Hammer and Champy's (1993) Business Process Re-engineering had started to diffuse through some manufacturing organisations, and, although described earlier by Shingo (1985), the key messages of Womack et al's (1990) Lean Production had developed into a significant change programme by the late 1990s. Six Sigma; a quality oriented approach to eliminating the causes of errors and defects (Snee, 1999), was developed by Motorola and has also been diffusing through manufacturing industry since 2000. At Jaguar's Castle Bromwich plant it is now possible to see lean manufacturing and six-sigma implemented together as 'lean-sigma'. For anyone who has experienced this cavalcade of apparently different initiatives it is possible to descend into cynicism, as Smith and Tranfield (1996) remark:

*"The community of people working in manufacturing are subject to peer group pressure just like any other... They are exposed to a plethora of persuasive material from consultants, conferences, journals and books, etc. From this perspective there are no specific links between choice of improvement*

*programme and.. strategic competitive context – the lurch from one ‘three letter acronym’ to the next are merely manifestations of modish behaviour.”*

The simple message to management: caveat emptor, let the buyer beware (Towill, 1999).

### **CONTRIBUTION OF THE PRESENT PAPER**

Herein we present a way of analysing and comparing improvement programmes and attempt to identify some of the very elusive keys to success. There are some approaches which seem to have a good chance of success. As an example, the Management by Projects (MBP) methodology described by Parnaby et al. (2003) has been applied to several hundred enterprises worldwide. Furthermore, good outcomes have been achieved quite consistently across a wide range of market sectors, including: automotive, electrical, electronic, aerospace, and healthcare, and this has been independently recognised by recorded excellence in bottom-line performance metrics by Schonberger (1995 on “leanness”) and Velloci (1999).

It will emerge from the paper that we are, in general, sceptical of the name given to any improvement programme. In a previous paper on the impact of an agile manufacturing initiative on business performance we identified bottom-line benefits that would fit well into the lean paradigm; with both stock levels and bullwhip simultaneously and substantially reduced (McCullen and Towill 2001). So we are much concerned with what actually takes place within the package, how the constituent parts are integrated, how it marries in with company short term and long term strategies, who does what and how training and knowledge are organised?

### **MANUFACTURING IMPROVEMENT AND CHANGE**

In addition to the programmes mentioned in the introduction, the list of examples could be extended to cover others on Cagliano and Spina’s (2000) list including: environmental programmes, kaizen, manufacturing resource planning (MRPII), cellular manufacturing, total productive maintenance (TPM) and zero defects. In order to provide a general description of a manufacturing improvement programme it is helpful to refer back to Wheelwright’s (1984) distinction between structural decisions; concerning capacity, facility, technology and vertical integration, and infrastructural decisions; concerning workforce, quality, planning and control and organisation.

Importantly Cagliano and Spina identify improvement programmes as “the place where manufacturing strategy should be operationalized”, and define improvement programmes as “... ‘ready-to-wear’ sets of structural and infrastructural decisions that derive from the experience of a number of leading companies and that have proved to be successful.” Following Wheelwright, Kim and Arnold (1996) place the choice of improvement programme in the context of a ‘top-down’ manufacturing strategy process which involves: defining the business strategy, setting competitive priorities, identifying manufacturing performance objectives and developing action plans, including improvement programmes, to deliver the desired performance.

An implicit dimension of manufacturing improvement is *change*, since it is necessary to move the organisation from the current to the desired state.

External consultants are frequently appointed to guide and facilitate organisational change. In a study of five well established management consultancy firms engaged in process improvement, Werr et al. (1997) have sought to understand the role of the proprietary methods employed by each consultancy organisation, e.g. Method One employed by Andersen Consulting (now Accenture) and Time Based Management employed by the Boston Consulting Group (BCG). The authors conclude that these structured methods perform a number of different functions within both client and consultancy organisations. For example, they provide a common language and a means of building project ownership for the client organisation, and, by updating *the method* on the basis of recent experience, they enable the consultancy firm to assimilate and organise new knowledge, and thus to practice *organisational learning*.

Werr et al, (1993) conclude that "structured methods play an important role in providing a common interface to the change process". Commenting on the degree of convergence between the approaches of the different consultancy organisations, they note: "business processes cut cross-functionally through the whole.. " and "working with business processes involves both strategy, in order to assure the processes' alignment to customer needs, and IT and people, in order to realise maximum efficiency and customer value. This is reflected in the systems models of the organisation, which were presented as the bases of Andersen Consulting, Ernst and Young and McKinsey's respective approaches."

### **MISDIAGNOSIS AND THE WRONG PRESCRIPTION**

Christianson and Raynor (2003) have sounded a cautionary note to managers who find themselves tempted to follow the latest management theory.

*Imagine yourself going to the doctor because you are not feeling well. Before you have had a chance to describe your symptoms, the doctor writes out a prescription and says: "Take two of these three times a day, and call me next week". You say: "But I have not told you what's wrong. How do I know this will help me?"*

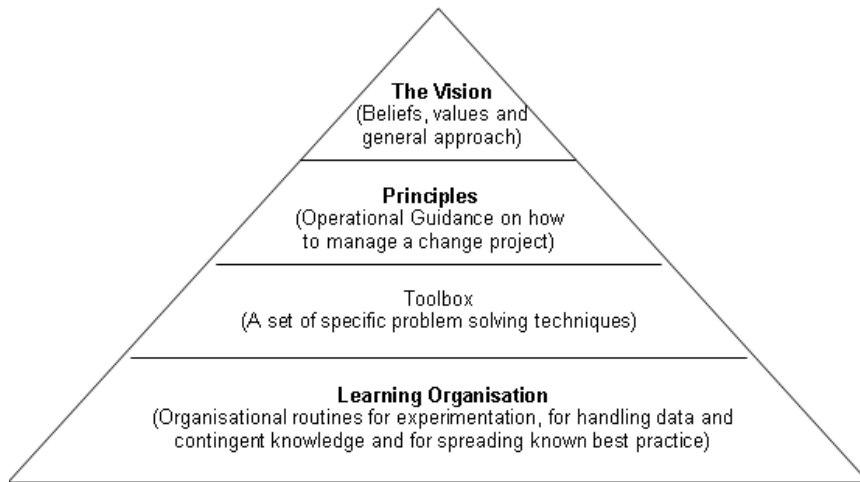
*"Why wouldn't it?" says the doctor. "It worked for my last two patients."*

Rather than imposing 'off-the-shelf' solutions to situations that are merely similar to the problems that the solutions were meant to solve, managers should instead seek-out circumstance-contingent theories. Circumstance-contingent theories enable managers to understand what it is about their present situation that has enabled their strategies and tactics to succeed (Christopher and Towill, 2000).

### **ASSESSMENT PROCEDURE**

In their analysis of the different consultancy firms, Werr et al. distinguish between the approaches and values of the consultancy firms, the methods employed, the tools used to support the methods, and the forms of organisational learning taking place within both client and consultancy organisations. This analysis is adapted in Figure 1 below and later used to 'disaggregate' improvement programmes using a prismatic analysis. (Towill and Childerhouse, 2006).



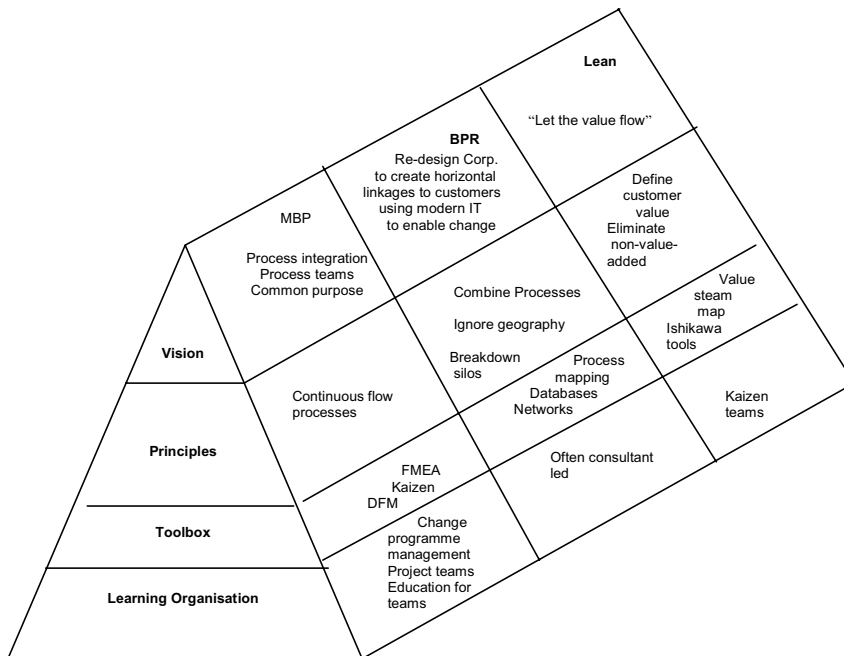


**Figure 1. Essential aspects of improvement programmes  
(Source: Werr et al, 1997)**

We have already noted that several major international consultancies employ systems models of their client organisations rather than a functional approach. This is consistent with the approach to production-distribution systems taken by Forrester (1961), Parnaby (1989) and latterly by BCG consultants Stalk and Hout (1990). Evidence of systems thinking in the vision and principles of the subject improvement programme is therefore an important criterion in our assessment. A second element of our assessment is to benchmark against the highly successful Toyota Production System (TPS), particularly with regard to the learning organisation, which incorporates: learner-leader-teacher roles, Operations Management consultancy and a supplier support centre.

### **SAMPLE ANALYSIS**

As space is limited, we have restricted our analysis to consider Parnaby's (2003) *Managing by Projects for Business Success* (MBP built on Business Systems Engineering), Hammer and Champy's (1993) *Business Process Re-engineering* (BPR) and Womack and Jones' (1996) *Lean Thinking*. The first because it is based on a far-reaching manufacturing improvement programme employed at Lucas (that is not widely known), and the second and third because of their wide diffusion. A sample analysis is shown in Figure 2. Drawing on research by Spear and Bowen (1999), the TPS is led by the vision of an efficient product delivery process and based on principles of simple pathways, unambiguous internal and external customer-supplier relationships and therefore effective task interfacing (a systems view) and scientific improvement. The TPS employs tools including standardisation, waste reduction, DFM, ideal batch of one, defect elimination, delay elimination, streamlining of flows and a balanced product mix. The learning organisation includes: learner-leader-teacher roles, Operations Management consultancy and a supplier support centre.



**Figure 2. Prismatic Analysis of MPFBS, BPR and Lean**

## DISCUSSION AND CONCLUSION

Across the four improvement programmes the closest similarity to the TPS is found in the use of tools. The most significant differences are found in the respective visions. Both the TPS and MBP have a strong systems orientation, with emphases on pathways, interfacing and integration. The notion of unimpeded value flow within lean implies a systems orientation, but this is not explicit. The vision of BPR is perhaps the most different, as it is driven by the possibility of facilitating a complete organisational re-design; based on the application of computer networks and relational databases, to streamline processes, to flatten hierarchies and to break down 'silos'. Some of the most interesting differences appear in the area of learning organisation. The use of external consultants and downsizing within BPR makes it difficult to retain learning within the organisation, although the use of proprietary methodologies by consultants (Werr) attempts to mitigate this to some extent. MBP was developed by John Parnaby in his role as head of Lucas Engineering and Systems. This organisation employed several hundred consultants who worked mainly within the Lucas Group, and who were able to share learning and to transfer best practice within the group. This is similar in many ways to the TPS, and thus we draw the possibly anachronistic conclusion; that MBP is most likely to hold the keys to success.

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## **THE MODERATING EFFECT OF SUPPLY CHAIN EXTERNAL AND INTERNAL CHARACTERISTICS ON ITS PRACTICE-PERFORMANCE RELATIONSHIP**

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### **INTRODUCTION**

Fierce competition and fast moving technology have contributed to the current market uncertainty. As a result, in search of new competitive advantage, firms have reshaped their strategies integrating their individual business processes across their supply chain (SC). Supply chain management (SCM), as a business network integrating approach, has proved to be an effective tool used to enhance firm's performance through customer value creation. However, SCM is not a one-size-fit-all practice, which calls for a better understanding of how its components and their interaction can affect its effectiveness.

### **RESEARCH RELEVANCE**

SCM is a core sub-field in operations management (OM), which is a relatively young field with its empirical research remaining to a great extent in its exploratory phase (Handfield and Melnyk 1998). In order to develop more relevant theory OM academics have indicated the need to engage in more empirical research, moving from popular mathematical modelling and laboratory simulation experiments to more integrative and cooperative research (Scudder and Hill 1998). Swamidass (1991) also supports this view noticing that complex fields such as SCM are unsuitable for purely deductive research methodologies and more appropriate for empirical investigation. On the practitioner's side, they have also observed this lack of strong applied theory and claim that OM theoretical contributions can be frequently unrealistic and impractical for the industry. Therefore, in order to narrow the gap between practice and research, it has been recommended that observation and testing should take place in the field where the actual phenomenon occurs (Chase and Prentis 1987).

As a result, the SCM academic community have reacted during the past few years redirecting more work towards a more empirical theory building process. A literature review reveals though, that the dominant SCM conceptual model has mainly focused on the practice-performance relationship, paying little attention to the importance of context under which SCM practices are implemented (Ho, Au *et al.* 2002). In addition, extant SCM research has focused largely on the buyer's perspective, ignoring the supplier's benefit. This last argument suggests a largely asymmetric relationship between buyers and suppliers, being the former who benefits at the expense of the latter (Subramani 2004). Accordingly, our model incorporates and tests the SC context and its impact on the SC practice-performance link using the supplier's perspective. This formally gives the following research question:

*"To what extent is the SC practices-performance link moderated by SC contextual factors"*

## **CONSTRUCTS AND CONCEPTUAL FRAMEWORK**

The environment has been viewed as a key contingency variable moderating the effect on the relationship between strategy and performance (Prescott 1986; Slater and Narver 1994; Ward and Duray 2000). Das et al. (2000) suggest that time; market forces and technology generate enough momentum to pressure companies to develop formal strategies accordingly. In view of that, these three main external variables are incorporated in our study: industry Clockspeed, competitive intensity and technology uncertainty.

Some industry sectors are continuously changing and accommodating their strategies to new prevailing conditions in their SC. Industry Clockspeed, which comprises three dimensions: rate of change in products, production process and organizational factors, attempts to embrace this rate of evolution. Two main drivers lead Clockspeed yet: Competitive intensity and Technology uncertainty (Fine 1998). Jaworski and Kohli (1993) explain that in the absence of competition an organization may perform well even if it is not customer oriented. Conversely, under competitive intensity conditions customers will have many options, and thus companies will need to change their business strategies accordingly. Technology uncertainty can also mediate the effect of competitive practices. Ragatz et al. (2002) show that particular strategies become critical in achieving desired objectives where complex or breakthrough technologies are developed. Accordingly, we posit:

*H1: The higher the industry Clockspeed, the stronger the SCM practices-performance link.*

*H2: The greater the competitive intensity, the stronger the SCM practices-performance link.*

*H2: The faster the technological change, the stronger the SCM practices-performance link.*

SC internal characteristics may also mediate significantly its practice-performance link. The literature shows these moderating effects tested separately in many studies; however, to our knowledge, a more cohesive model has not been tested. For that reason, our research integrates four main internal SC mediating characteristics: product type, relationship duration, supplier location and the type of industry award.

Understanding the product type is a prerequisite to match the appropriate SC strategy. Fisher (1997) supports this view suggesting that the SC is to a large extent a function of product characteristics and customer expectations. Relationship duration is another important moderator because what is effective in long-established relationships may not be in newly established ones (Fichman and Levinthal 1991; Kotabe, Martin et al. 2003). Therefore, it seems that any relationship based on exchange needs some time before its outcomes are realized. Companies have also claimed that in order to become more competitive and cost efficient, they will need to delegate important activities to few key suppliers in their SC. Therefore, suppliers will have to align their practices according to their relationship with their assemblers and their SC location (Kraljic 1983). Finally, firm awards and certifications are assumed to create firm value

through the use of benchmark. In other words, companies can compare and assess their practices upon ideal models. However, studies have suggested that there is not necessarily a causal relationship, and that only certain awards represent a real benefit to the firm. Hendricks and Singhal (2001) support this argument presenting a strong link between independent awards and higher growth in sales, in comparison to less considerable benefits from supplier awards. These four internal moderators formally give:

*H3: Given the type of product, certain SC practices will have stronger influence on SC performance*

*H4: Given the duration of the relationship, certain SC practices will have stronger influence on SC performance.*

*H5: Given the supplier position in the SC, certain SC practices will have stronger influence on SC performance.*

*H6: Given the type of industry award, certain SC practices will have stronger influence on SC performance.*

In formulating our conceptual framework, the contingency theory provides an oriented strategy to conceptualize and structure our hypotheses (Schoonhoven 1981). The foundation of this approach suggest that good practices affect an organization's performance, and this relationship is going to be mediated by external factors (New and Payne 1995). We synthesise our hypotheses below:

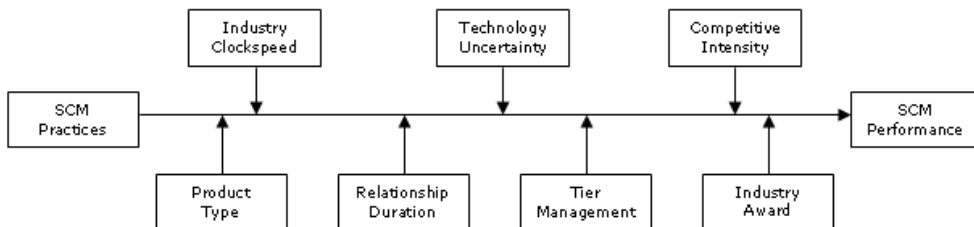


Figure1: Conceptual framework.

### **SCM PRACTICE AND PERFORMANCE INDICATORS**

Competition has forced companies to implement more strategic and effective activities. Although the SCM literature presents a variety of practices, little is known about the industry implementing them successfully and their relationship with performance. Tan (2002) and Li *et al.* (2005) present six main practices extracted from the literature and discussion with managers, which we believe consistently and cohesively reflect SCM practices: *strategic supplier partnership, information sharing, customer relationship, information quality, internal lean practices, postponement and geographical proximity.*

On the performance side, performance measurements need to accommodate to the prevailing business environment. However, traditional performance measurements in SC may be limiting its potential, and hence more integrated

indicators can better capture its process nature (Hoek 1998). The literature reveal a general agreement of four generic and more balanced SCM competitive priorities from which firms choose to compete: *Quality, Cost, Flexibility and Delivery*. We propose these measures as our performance indicators in addition to *Overall Performance*.

## RESEARCH DESIGN

Selecting a research design is a key decision for research planning because it serves as the architectural blueprint of a research project (Hendrick, Bickman *et al.* 1993). The research design in this study is a cross-sectional quantitative mail survey and the reason why this methodology was chosen is twofold. Firstly, the survey aims to examine the relationship between SC context, practice and performance at a given point in time. Secondly, as mention above, there is an urgent need to engage in more field-based research, as well as reducing the gap between practitioner and theorists (Chase and Prentis 1987; Swamidass 1991).

The population chosen for our study is the manufacturing sector in the Republic of Ireland. Economic facts and trends have shown that this is a highly competitive environment for our analysis. This can be observed in many foreign-owned enterprises increasing heavily their share of Irish manufacturing employment during the last twenty years. Irish indigenous manufacturing have also experience significant growth in production and exports in comparison to other EU countries (Clancy, O'Malley *et al.* 2001). It is expected then that sophisticated practices like SC are widely applied across the industry.

The questionnaire was designed using existing scales extracted from the SCM literature for our practices, performance indicators and moderating variables. The first draft questionnaire was based on Linkert scales, including also questions of general characteristics presented in a clearly and concisely manner and using rules of protocol and presentation. A final version of the draft questionnaire was sent to OM academics and managers to asses the precision of its language and content validity. A modified version will be pilot tested to check its suitability for the target group. For carrying out the main survey we will send the revised and improved questionnaires to the target recipients and set deadlines for distribution and collection. Reminders and telephone contact will be made to augment our rate of completed questionnaires.

For the analytical procedure, descriptive statistics are going to be used first to test our sample and its representativeness of the population. Construct validation is another important step in our research process because only through it we will assess the extent to which our measures reflect faithfully our constructs. Factor analysis will be used to examine the interrelationship among these variables. Testing reliability comes next because in the absence of valid constructs, reliability is almost irrelevant (Koufteros 1999). Reliability is related to the consistency of our measures and it is inversely related to random error. Therefore, in order to eliminate as much random error as possible the Cronbach's  $\alpha$  (alpha) coefficient, as one the most popular methods to test reliability, will be also used in this analysis. Finally, causal structural modeling will be carried out to test our hypotheses. Our analysis pretends to establish levels of causality among variables and predictability in our findings, instead of only explaining observations (Bertrand and Fransoo 2002). Asher (1983) argues however that if

causal analysis goes astray it will be mainly due to miscarriage of the previous steps above described. Therefore, we are highly focusing on how our measurements are assessed and our data collected before the structural model is tested.

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## LOGISTICS CONCEPT AS A MODERN FORM FOR PROCESSING TOTAL LOGISTICS INTEGRATION

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### ABSTRACT

In this work it is shown one approach to the development of logistics conceptual system's solutions as a modern form for modern connection of business, transit and supply's functions of urban and regional areas, in one multidimensional conceptual model aiming at the making base for the conveying the process of total logistics integration, and consequently for the reaching bigger economics, spatial, technical, technological and environmental effects.

**KEY WORD:** LOGISTICS, LOGISTICS SYSTEMS, and LOGISTICS CONCEPT

### INTRODUCTION

Intensive process of globalization, increasing the volume of logistics activities, technical and technological promotion in all logistics subsystems, fast development of new computer-based techniques and computer-based technology and equipment, development of procedures and working techniques, as well as increasing environmental demands for tenable ecological solutions, need making some concrete steps and accommodation existing logistics system to newly born needs and demands. In these circumstances, development of the model for optimization of all logistics flows, seems as necessity. Developed models are starting base of creating new logistics concepts. These concepts should present modern system's solutions, which will make all postulates for better projecting, organizing, realization and control of all logistics flows and systems on some geographic area, in the next period, on tenable bases aiming at the reaching bigger economics, spatial, technical, technological and ecological effects.

### IDEA AND IMPORTANCE OF DEVELOPMENT OF LOGISTICS CONCEPT

**Logistics concept** presents a form (figure 2.1.) based on the set of logistics principles and postulates, for optimal connection of *primary logistics elements* (structure of system, organization, logistics chains, logistics flows and telamathics structure) and *secondary logistics elements* (public, private, and public-private logistics measures) aiming at the development of new tenable system's solution of city and regional logistics. Form seen on that way, presents basic generator of development of business, transit and supply's functions of agglomeration aiming at the making bigger

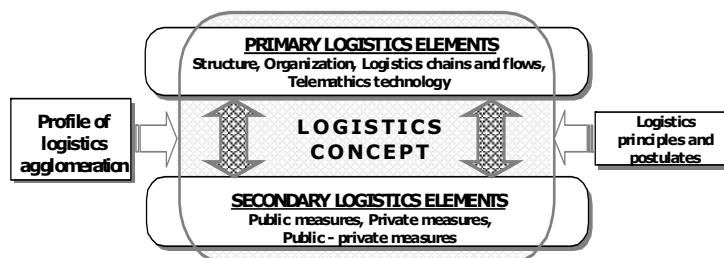


Figure 2.1: Logistics concept as a modern base

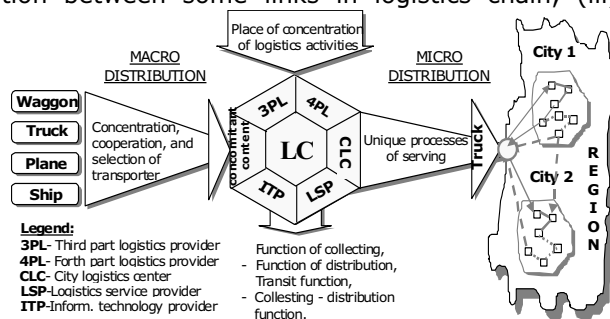
economics, spatial, technical, technological and ecological effects.

**Importance of development of modern logistics concept** stands in one correlative relation with: (i) reported process of urbanization, (ii) partial logistics solutions, (iii) expansion of number of demands for logistics service, (iv) limitations in logistics flows' realization, (v) increased demands for qualified logistics service. Development of new logistics concept needs to be satisfied three basic demands: **mobility, sustainability, and liveability**. For development of tenable logistics concepts, it is necessary overall strategic prognosis and planning, which should enable:

- ✓ connection of all subjects in logistics in one system aims to unique planning and projecting of transport and distribution's systems,
- ✓ elimination of "narrow necks", obstacles and limitations in the process of logistics flows' realization,
- ✓ elimination of goods' accumulation in city nucleus and disburdening of city streets from freight vehicles,
- ✓ application appropriate computer-based technologies in logistics chain,
- ✓ reaching bigger economics effects and giving qualified logistics service,
- ✓ decreasing the pollution and environmental saving, etc.

## BASIC TERMS FOR DEVELOPMENT OF TENABLE LOGISTICS CONCEPTS

**Term 1:** Existing of modern logistics centers (*figure 3.1.*) whose basic function is making the base for: (i) concentration of all logistics activities on one space, (ii) coordination and cooperation between some links in logistics chain, (iii) specialization of work of logistics systems, (iv) marketing approach and market animation, (v) offer of logistics services on one space, (vi) high quality of logistics service, (vii) application of ecological acceptable technologies of transport.



**Figure 3.1: Logistics center as a term for development of logistics concept**

**Term 2:** Use of new logistics strategies (*Make or buy, JIT-Just In Time, 3PL, 4PL, 5PL*). The goals of their use are: (i) decreasing of total costs, (ii) decreasing of financial resources, (iii) definition of optimal capacities of logistics centers, (iv) giving logistics service to the customer according to their demands.

**Term 3:** Application of modern logistics measures, which should promote the development of new tenable conceptual solutions.

**Term 4:** Existing of logistics experts who are capable and trained to realize and keep updated newly developed system's solutions.

## PROCEDURE OF DEVELOPMENT OF MODERN CONCEPTUAL SOLUTION

Development of logistics concept needs to be considered the next four questions: (i) how plan the system of logistics flows' realization, (ii) which organization's

structure is optimal, (iii) how manage the logistics processes, (iv) how realize the model of information's connection. Development of logistics concept shall have four phases (figure 4.1.): **preparation** → **analysis** → **synthesis** → **control**.

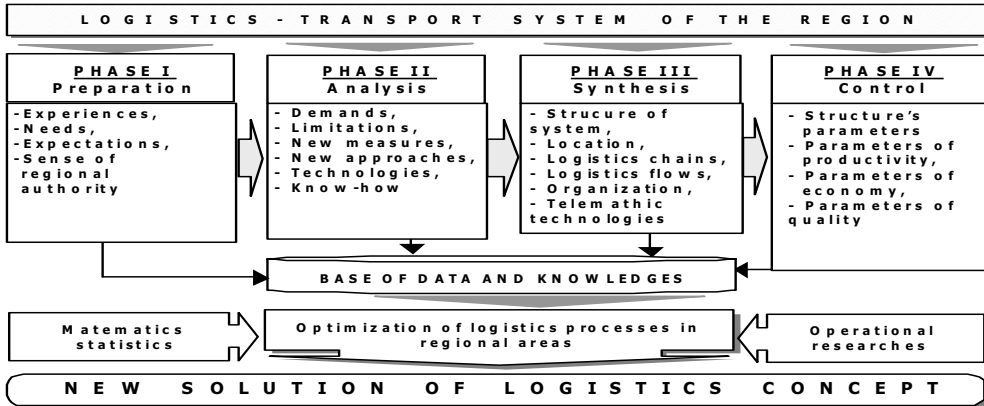


Figure 4.1: Phases in development of logistics conceptual solution

New solutions of logistics concept should be based on: (i) logistics principles and postulates, (ii) output of multicriteria's analysis, (iii) output of the model of optimization where time and cost are the main components, (iv) using top-down or bottom-up approach during the decision making, (v) application of modern logistics measures. Besides, logistics concept must be correlated to: (i) clear reported needs of the customers for logistics service, (ii) modern scientific accomplishments, (iii) modern technological movements and demands (iv) existing practical experiences and results. Such kind of approach in development of model needs to work on integration of three concepts: (i) concept of realization of logistics flows, (ii) concept of connection of information's flows, and (iii) concept of environmental saving where as the main multiple there are space, money, time and life quality.

**CONCRETE EXAMPLE OF DEVELOPMENT OF LOGISTICS CONCEPT**

Described procedure of development of tenable conceptual logistics solutions has been applied on the development of new logistics concept for the regional area of Montenegrin coast that presents unique geographic area on the southwest part of Montenegro. Consistently to the output of case study, it has been defined new solution of logistics concept, which has three possible solutions with defined structure of system and logistics flows. Base for development of logistics concept for the region of Montenegrin coast is that cargo center Bar should present central element of its structure (figure 5.1) where it will come to the concentration, cooperation and

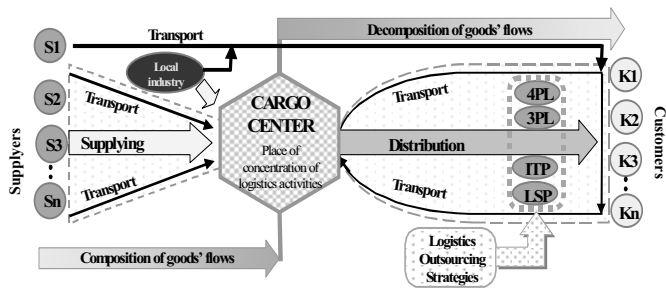


Figure 5.1: Base of development of new solution of logistics concept

transportation of all kind of goods' flows.

### Effects of the application of new logistics concept

On developed simulation model, for three proposed solutions, it has been made a simulation experiment using simulation software ARENA 7.01. The next results have been given:

- ✓ Structure of participation of single transport modes in goods' forwarding in newly developed solution compared to the existing solution is changed. Participation of road transport decreases from 56,72% for possible solution no. 1 and no. 2 and 52.62% for possible solution no. 3. Newly developed solution contributes to disburdening of transport network in this region from big transport vehicles by increasing of using of railway and sea transport and that is especially important during the summer tourist's season (figure 5.2.). New structure influences on the changing the structure of total costs, volume of the emission of harmful substances as well as the quality of logistics service.

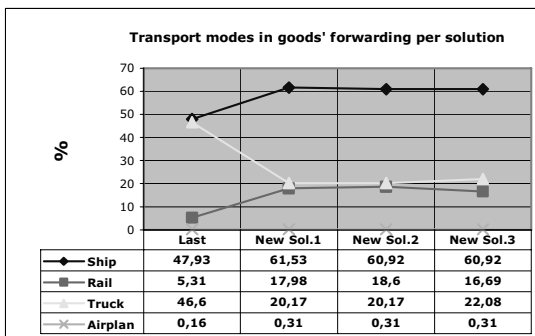


Figure 5.2: Transport mode/solutions

- ✓ It is evidently smaller participation of no consolidation's delivery to customers. The result of this situation is disburdening of road transport network in this region even to 95.86% during summer tourist's season and to 95.2% in the other moths.
- ✓ Economics effects of the application of newly developed solution per day in possible solution no. 1 are shown in the next table.

Table 6.1: Economics effects per city (EUROS/day)

CITY	SOLUTION NO. 1		SOLUTION NO. 2		SOLUTION NO. 3	
	OTHER MONTHS	SUMMER SEASON	OTHER MONTHS	SUMMER SEASON	OTHER MONTHS	SUMMER SEASON
Ulcinj	33662	77733	33969	78807	33428	78650
Bar	85258	262049	85243	262160	84669	262189
Budva	33090	99286	33138	97105	33212	98281
Tivat	12961	33628	13030	33536	13009	33610
Kotor	18558	41011	18633	41151	18609	41181
Herceg Novi	30267	108291	42858	131521	42905	131521

### CONCLUSION

Development of logistics concept presents set of principles and postulates, first of logistics, which according to system's approach, must be connected each other in one modern form. These concepts present modern generators of economics development of appropriate region. Their function is the connection of business, transit and supply's functions of the agglomeration in one model, which should contribute to total optimization of logistics processes. Because of all reasons

mentioned above, logistics concepts have to be created so it could be possible to reach bigger economics, spatial, technical, technological and ecological effects in the appropriate region.

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# **DESIGN AND ORGANIZATION OF SUPPLY CHAINS**





## **INTEGRATED ARCHITECTURE FOR DESIGN AND CONFIGURATION OF LOGISTIC NETWORKS**

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### **ABSTRACT**

Paper presents a methodology that considers different optimization models for network logistics, integrated in a simple and easy-solving mathematical problem. Starting from the definition of three common perspectives in approaching distributive configuration, the research proposes basic mathematical models of Risk Pooling opportunities, Merge-in-Transit strategy and Vehicle Routing problem. An integrated architecture is then proposed to define the critical impact of these dimensions and their effect in designing networks, identifying and evaluating equivalent alternatives.

Finally, an example of experimentation is presented, also illustrating how the full modularity of the methodology allows to integrate other optimization models on different criteria.

### **INTRODUCTION**

Distribution network configuration is one of the most aggressive competitive leverages for organizations as it's role is always more confirmed by many market-leader companies that tend to invest in this sector to obtain high profits. The environment where modern companies are operating has specific characteristics not to allow a static attitude. Global market creates important opportunities of improvement that need an harmonic growth of the whole organization. The simple rationalization of production systems is no more sufficient, while an attention to new perspectives and opportunities in *non-core* processes can affirm the position of a company (Chopra et al. (2004)). In particular, requirements of distributive logistics can be focused in managing transportations on extended geographic areas, with remote dislocations of production centres and points of sale, sometimes in different continents where general costs are limited. Along with this tendency, a new approach towards customers, products and organizations is appearing, where contractual and market inputs come mainly from the first one, with a consequent high variability of requests and high level of efficiency and effectiveness to reach: for example, a distribution network that works in an *e-business* environment has to manage a great number of different products, with no standardization, an increase in points of demand, a geographical and temporal fragmentation of orders, facing many different elements that generates both threats and opportunities. In the last decade, many studies were carried out to define principles and methods to design logistic networks that could grant an adequate service level, minimizing structural and management costs related to delivery processes. These researches were mainly addressed to a mathematical representation of logistic systems, individuating optimization algorithms that could solve complexity in an affordable computational time. The distribution network design is a classical system to balance from contrasting pushes where the equilibrium has to consider all the dimensions of the problem without underestimate or overestimate any effect. To these extent, the research investigates various aspects of logistic evaluation and

optimization to propose an integrated methodology that could adequately take in consideration and coordinate all of them in the design and configuration process. A general framework defines an interaction of different optimization models, singularly developed to find out the better response of logistic system to improvement opportunities. In particular, the project analyzes alternative but not exclusive configuration strategies that consider the possibility of distributing or concentrating warehouses (*Risk Pooling*), the potential aggregation of products in a single shipment (*Merge-in-Transit*) and the organization of vectors on delivery paths (*Vehicle Routing*), combining all their classical cost formulations. The methodology would try to give the network designer a support tool to evaluate different perspectives of modelling, every time computational time and costs do not permit to find an optimal solution.

### RISK POOLING

*Risk pooling* is the advantage that can be realized through large scale analysis and aggregate forecasting of particular products management (e.g. reduction of number and typology of components thanks to standardization): a risk pooling strategy can affect the choice of aggregating production systems of different products on different sites (from Production Plant Network to Process Plant Network – Fig.1).

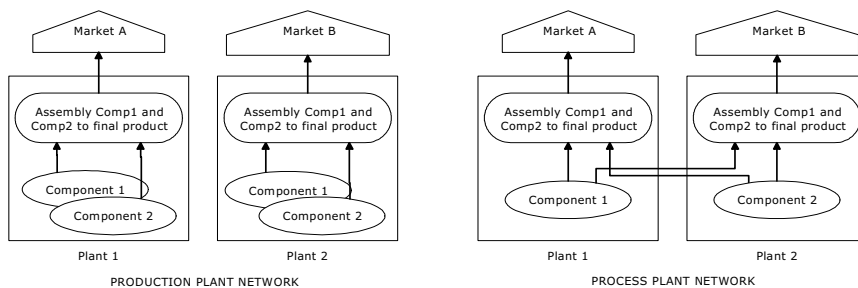


Figure 1 – Production network strategies

This behaviour, characteristic of the consolidation of distribution centres in a unique sorting point, was originally studied by Eppen (1979), the first to analyze effects in warehouse management. Considering a distribution network, where a unique plant feeds regional depots to supply local retailers or customers, operations generate two main costs: the first is directly related to an average value of goods transited, caused by stock and handling costs and order management costs; the second is related to safety stock of warehouses, depending on the value of the standard deviation of the customer's demand. Reducing the number of depots and aggregating demand smoothes variations and allows lower safety stock levels while generating an increase in complexity of physical distribution. The subsequent study of Barahona et al. (1998) put the basis of the more recent analysis in operation research, for example Schrijver (2000) and Iwata et al. (2001), that set up models to avoid exponentially increasing solving time depending on the number of knots in the network.

### **MERGE-IN-TRANSIT**

*Merge-in-Transit* (MIT) consists in a supply chain practice used where the product needs:

1. an aggregation of different objects from different sources in a single delivery;
2. an aggregation of on-demand orders with components in stock.

Fundamentally, Merge-in-Transit is based on the concept of substituting direct shipments of a multi-product order with a single aggregated shipment. Instead of effectuating many direct deliveries, the different lines of order are converged with a direct transport in a *merge centre*. Here the products are placed in the same vector, if necessary after an assembly or consolidation operation, and delivered to the customer, avoiding the costs related to specific warehouses. The advantage of a Merge-in-Transit system is related both to an higher customer satisfaction level and to a possible decrease of transportation costs and immobilizations (due to the elimination of warehouses) together with the possibility of increase a larger range of products on catalogue. This order management methodology was first introduced by Muller (1992), whose activity was enriched by many significant industrial experiences as Hewlett Packard, Dell, Cisco and Ikea. Many studies followed to constitute mathematical models of MIT (Ala-Risku et al. (2003), Croxton et al. (2003)) and to analyze its technical and informative requirements (Karkkainen et al. (2002)).

### **VEHICLE ROUTING PROBLEM**

Vehicle routing problem (VRP) has a well known mathematical formulation where cost optimization is related to the number of shipments and sequencing of journeys, as for Laporte (2000). Many solution algorithms were presented in literature, exact ones (Fisher (1994)), heuristic ones (Show (1998)) and meta-heuristic ones (Vigo (1998), Gambardella et al. (2005)). In this case, with multi-level networks the models have to be concerned with indirect deliveries, through multi-knots shipment. The total cost is the sum of activation and transportation costs, where the final customer routes (*last mile*) make the difference. The optimization process needs to evaluate every combination of assignment (of customers, vehicles and routes), defining the shortest path and the best configuration.

### **METHODOLOGY AND EXPERIMENT**

The research realized a three-stages modular framework to identify priorities and to take them into proper account in a step-optimization (Fig.3). Comparing these three basic problems we can face different strategic, tactic and operational levels: depending on the geographic context, infrastructures, products, company background and logistic network maturity, different cost issues can prevail. The first model optimizes transportation costs and immobilizations, depending on the number of the customer served by the distribution centre and on the procurement time to restore level of goods in stock. The second model evaluates the impact on the network configuration of a particular strategy, aggregating more product in a single delivery along the logistic chain and not in production sites. The third model determines logistic knots to activate and paths to cover, basing on the best routes for vectors.

As a first step of the methodology, the optimization analysis is effectuated on parallel branches to evaluate the impact levels of each perspectives of

optimization: this could be considered as the weight of not optimized configurations on the item in focus. In the second step, the methodology benchmarks the three different approaches by comparing the best and the worst cases investigated, calculating the difference between the two values and assigning a greater importance to the perspective of optimization with the higher spread or (as a second criterion of priority) to the one more significant in percentage. Characterizing the models with a degree of their relative impact allows to proceed with a stratified resolution of the problem, from the more relevant effect (Higher Impact Model – HIM) to the less one (Lower Impact Model – LIM). Therefore, in the third step, the optimization process considers the specific results obtained by the HIM, fixing results of the most important solution, and then running the middle impact model with more bounds and less degree of freedom. The new results create new added bounds, input for the last optimization problem (LIM), that completes the network configuration. Figure 3 shows the six possible combinations of priorities, explaining from each stage the bounds of the following optimization to the final logistics solution.

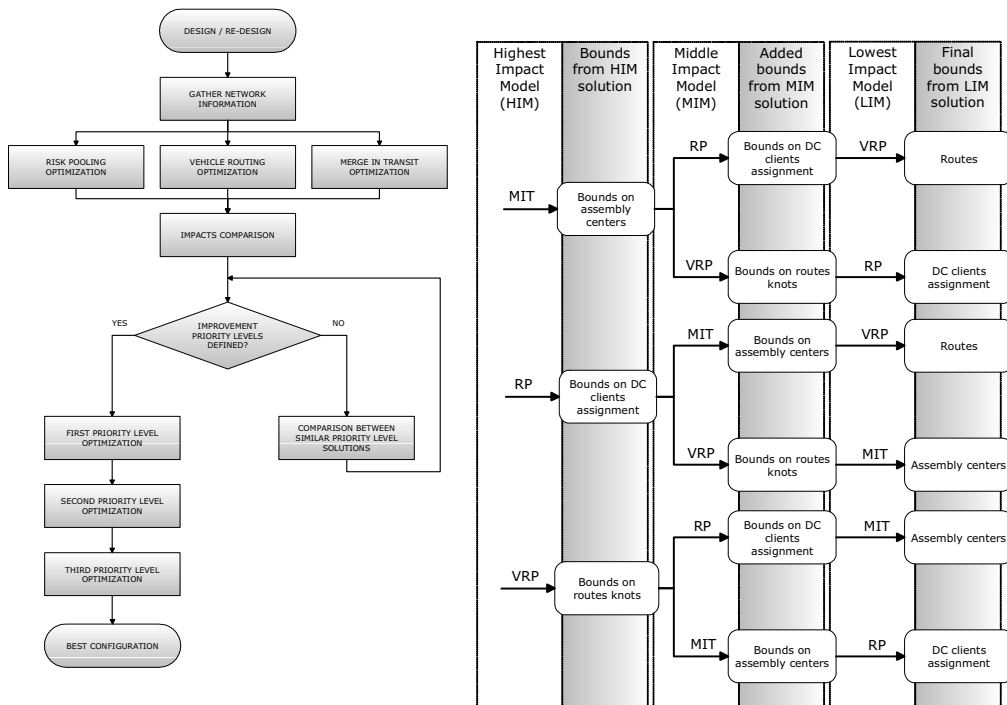


Figure 3 - Methodology framework

To avoid a classification priority where network characteristics do not permit to identify a sharp difference, a simple tool to measure the range of impact was developed, as shown in the example of Table 2. Every model is compared on cost results, considering the best and the worst solution, that means the biggest possible loss for a non appropriate configuration. Table inputs compares two perspective a time, by rows with percentage difference between two solutions, in

terms of absolute variation and relative variation, to consider the level of importance of the possible loss, related to total cost. The three combinations of the model can individuate balanced configurations when identifying the correct priority scale of strategies. When the result of the tool cannot identify a neat preference (values in table from 0,6 to 1) or gives a slight difference (from 0,3 to 0,6), the step-optimization has to be carried on completely for the two alternatives of path (in figure 3) to compare the final cost and define the better sequence.

To test this decision support system, a simple network was developed composed of two production plants with given capacity, three distribution centres (DC) and five points of aggregated demand, all placed around Italy as potential location points (as for Tab.1). Products are low value goods, with the possibility of aggregating different component in a single order: three input elements can constitute, according to appropriate assembly rates, two output products. A complete order is composed of two of input product A, one of input B and C while a partial order can be composed by just one input product A and C; in the test, Plant1 could supply input product A and C and Plant2 could supply input product A and B. The assembly process can be effectuated in just one knot, a production plant or a distribution centre or, in a Merge-in-Transit solution, every network point could merge components into order, with different cost of assembly. Every possible DC has a starting situation of activation or deactivation, with a fix switching cost. Two type of vectors can be chosen for shipping, with different fixed and variable costs, depending on their capacity. Avoiding the description of the mathematical models, in table 2 the final results are directly represented. Starting from the first issue, it's to notice how Risk Pooling absolute variation is about 7% of Merge-in-Transit, while the ratio between percentage weights, 9% and 20%, gives a relative variation of 45%: the second model it's strongly to prefer as HIM. Practically, the third model is recognised as LIM, due to its very limited impact both on maximum absolute and relative loss to the optimal value. At this point, once identified the issue that could cause the most significant effect, the architecture starts taking into account the HIM solution that returns bounds on assembly centres, finding out only one DC as the assembly point. With a new RP model solution where the assembly point is now forced, it is possible to find all the clients assignment to DC, that means who buys from who. The final step is a bounded network to solve with a simple VRP problem.

Table 1 – Distance table

	LT	VR	GE	FI	NA	MI	TO	RM	BA	BO
LT	1	585	580	355	167					
VR	585	1	290	231	716					
GE	580	290	1	225	715	140	170	507	945	670
FI	355	231	225	1	490	295	400	280	720	101
NA	167	716	715	490	1	785	885	219	260	590
MI			140	295	785	1	140	575	880	210
TO			170	400	885	140	1	675	1000	330
RM			507	280	219	575	675	1	450	380
BA			945	720	260	880	1000	450	1	670
BO			670	101	590	210	330	380	670	1

Table 2 – Classification table

PERSPECTIVE	BEST	WORST	DELTA	ORDER
Risk Pooling	230000 €	250000 €	20000 € (9%)	2
MIT	1340000 €	1610000 €	270000 € (20%)	1
VRP	134000 €	138000 €	4000 € (3%)	3

COMPARISON	DELTA VAR. %	RELATIVE DELTA VAR. %
Risk Pooling vs. MIT (#1)	20000/270000=7%	45%
VRP vs. MIT (#2)	4000/270000=1%	15%
VRP vs. Risk Pooling (#3)	4000/20000=20%	33%

Delta Variation	80% - 100%	0,2	0,4	0,6	0,8	1
	60% - 80%	0,16	0,32	0,48	0,64	0,8
40% - 60%	0,12	0,24	0,36	0,48	0,6	
20% - 40%	0,08	0,16 (#3)	0,24	0,32	0,4	
0% - 20%	0,04 (#2)	0,08	0,12 (#1)	0,16	0,2	
Relative Delta Variation %						
	0% - 20%	20% - 40%	40% - 60%	60% - 80%	80% - 100%	

## CONCLUSIONS

The research allowed to test a methodology that can integrate different mathematical models and propose a parallel and critic vision on different logistics aspects. The study of the literature shows a general difficulty in considering and analysing various configuration choices as the real context, not always suggesting a particular criterion to follow, leaves many different possibilities of improvement to test. The most significant results of the project are in the identification of a logic scheme, applied to three classic problems, that can be easily extended for a general plurality of optimization functions. Finally, the modular methodology could be fed up with different mathematical models and solving algorithms to grant an higher speed of calculus and integrate new performance issues, both strictly logistics and multi-criteria analysis to evaluate different solutions and performance parameters.

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## **COORDINATING A THREE LEVEL SUPPLY CHAIN WITH LEARNING-BASED CONTINUOUS IMPROVEMENT**

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### **ABSTRACT**

This paper investigates a three-level supply chain (supplier-manufacturer-retailer) where the manufacture undergoes a continuous improvement process represented by a learning curve. To attain this continuous improvement the manufacturer may need to coordinate its orders with its customer for finished products and with its supplier of raw material. A mathematical model is developed to determine the joint lot sizes for this supply chain and numerical examples illustrating the solution procedure are provided. The results suggest that the manufacturer should produce in smaller lots more frequently.

### **INTRODUCTION**

The modern market for products is dynamic, global and competitive. This environment imposes pressures on companies to deliver quality products at competitive prices at the time required. As product life cycles shorten, companies need to be responsive to market changes and to reduce the time from concept to market. The pressures compel companies to be responsive, efficient and flexible. Effective supply chain management involves the integration of functions such as production, purchasing, materials management, warehousing and inventory control, distribution, shipping, and transport logistics. This integration is needed within the operations of specific supply chain members and, more importantly, across all members of the supply chain. To maintain sustainable competitiveness, operations within the supply chain will benefit from continuous improvement programs that include fostering organizational learning. Historically, learning curve theory has been applied to a diverse set of management decision areas such as inventory control, production planning and quality improvement. These decision areas exist both within the individual organizations of the supply chain and, as a result of the interdependencies among chain members, across the supply chain as a whole. By modelling these learning effects, management may use established learning models to utilize capacity, manage inventories and coordinate production and distribution better throughout the chain.

The lot sizing problem with learning and forgetting effects in production has received considerable attention from researchers and a detailed review of this literature is found in Jaber and Bonney (1999). Jaber and Bonney (2003) also investigated the effects that learning and forgetting in set-ups and in product quality have on the economic lot-sizing problem. In recent years, the lot sizing problem with learning and forgetting has been investigated using various assumptions (e.g., Balkhi 2003; Chiu et al. 2003; Chiu and Chen 2005; Alamri

and Balkhi 2007; Jaber and Guiffrida 2007) and to a lesser extent, in conjunction with the Joint Economic Lot-Sizing Problem (JELSP), by Nanda and Nam (1992, 1993).

The JELSP forms the basis of a two-level supply chain with order coordination between the chain members. Nanda and Nam (1992) developed a joint manufacturer-retailer inventory (two-level supply chain) model for the case of a single buyer. Production costs were assumed to reduce according to a power form learning curve with forgetting effects caused by breaks in production. A quantity discount schedule was proposed based on the change of total variable costs of the buyer and manufacturer. To meet the demand of the buyer, the manufacturer considers either a lot-for-lot (LFL) production policy (e.g., Banerjee 1986), or a production quantity that is a multiple of the buyer's order quantity (Lee and Rosenblatt 1985). Nanda and Nam (1992) assumed a LFL policy, and did not specify the form of the forgetting curve. They extended their work in a subsequent paper (Nanda and Nam 1993) to include multiple retailers.

This paper integrates the work of Nanda and Nam (1992) and Jaber and Bonney (2003) to investigate a joint replenishment inventory model for a three-stage (supplier-manufacturer-retailer) supply chain with the manufacturer having learning effects in setups, production, and product quality. Munson and Rosenblatt (2001) were the first to model a three-level supply chain. They assumed that all parameters were deterministic and that: (i) the retailer orders a single product according to its economic order quantity (EOQ), (ii) the manufacturer optimises its lot-sizing policy according to a lumpy order pattern, which is an integer multiple of the retailer's order quantity, and (iii) the supplier orders according to the resulting lumpy ordering pattern of the manufacturer, which is an integer multiple of the manufacturer's order quantity. Munson and Rosenblatt (2001) further assumed that the manufacturer is the most influential player in the supply chain who offers quantity discounts to the retailer to entice him/her to order in larger quantities than the retailer's economic order quantity. Quantity discounts were computed in the model (e.g., \$/unit) as the difference in holding and ordering costs between the retailer's old ordering (no coordination) and new ordering (with coordination) policies divided by the annual demand. Jaber et al. (2006) extended the work of Munson and Rosenblatt (2001) by assuming a price discount approach, a price dependent demand and profit sharing scenarios. This paper adopts a centralized decision-making process for coordinating the supply chain model by integrating order quantities. When players in a supply chain coordinate their order quantities, it is possible that some players in the supply chain could benefit more than others; indeed some could lose. To overcome this, the paper assumes that the benefiting (dominant) player, the manufacturer, compensates the losing players by offering quantity discounts.

## **METHODOLOGY**

This paper investigates the coordination of order quantities amongst the players in a three-level supply chain with a centralized decision process. A mathematical model for a three-level supply chain (supplier-manufacturer-retailer) is developed. Integrating order quantity models among the three levels is a way to achieve coordination (e.g., Goyal and Gupta 1989). This paper assumes a uniform demand on the retailer that results in lumpy demand on the manufacturer and the supplier. It also assumes (1) a single product that requires  $g$  units of raw material, (2) no shortages, (3) zero lead-time, (4) imperfect

quality items, (5) unlimited storage capacity and (6) an infinite planning horizon. The manufacturer's total cost per cycle is the sum of its set-up cost, raw material procurement cost, labour cost, holding cost and quality cost. It is assumed that the manufacturer undergoes a continuous improvement program characterized by learning [measured by the learning rate (LR)] in setup (*LR-stp*), in production (*LR-prod*) and in process quality (*LR-q/ty*). The total supply chain cost (objective function) is the sum of the cost functions of the retailer, the manufacturer and the supplier. This is written as a mathematical programming problem of the form

$$\text{Minimize } \psi_{i,sc}(\lambda_s, \lambda_m, Q_r) = \psi_r(Q_r) + \psi_{i,m}(\lambda_m, Q_r) + \psi_s(\lambda_s, \lambda_m, Q_r)$$

Subject to:

$$\begin{aligned} \text{Order quantity: } & Q_r \geq (y_1 D / (1-b))^{1/b} \\ \text{Multipliers: } & \lambda_s, \lambda_m, \text{ which are integers} \end{aligned}$$

The terms  $\psi_{i,sc}$ ,  $\psi_r$ ,  $\psi_{i,m}$ , and  $\psi_s$  respectively represent the total supply chain, the retailer (customer), the manufacturer, and the supplier costs per unit of time for the manufacturer's production cycle  $i$ , where  $\lambda_s$  and  $\lambda_m$  are integer multipliers to adjust the order quantity of the retailer,  $Q_r$ , to that of the manufacturer ( $m$ ) and the supplier ( $s$ ), and  $D$  being the demand rate. The continuous improvement learning curve is assumed to be of a power form as advocated by many researchers, i.e.,  $y(x) = y_1 x^{-b}$  (Wright 1936) with  $y(x)$  being the time to manufacture the  $x$ th unit,  $y_1$  the time to produce the first unit,  $b$  ( $0 \leq b < 1$ ; corresponding to  $100\% > LR-prod > 50\%$ ) the production learning curve exponent and  $x$  is cumulative production. Due to the limit on the number of pages, we refrain from explicitly discussing the mathematics of the terms  $\psi_{i,sc}$ ,  $\psi_r$ ,  $\psi_{i,m}$ , and  $\psi_s$ . However, readers may refer to Jaber and Bonney (2003) and Jaber et al. (2006) for background on the mathematical modelling of the problem presented above.

The developed mathematical programming model was solved for various values of the input data for the cases of coordination and no coordination of orders among the players in the three-level supply chain using the EXCEL SOLVER optimization tool enhanced by VISUAL BASIC code.

### SOME NUMERICAL RESULTS

Several numerical examples are solved for a set of input data for the cases of coordination and no coordination of orders among the players (supplier, manufacturer, and retailer) in a three-level supply chain. To illustrate, this paper starts with a numerical example that assumes no improvement in set-up (*LR-stp* = 100%), production (*LR-prod* = 100%), and rework (*LR-q/ty* = 100%) take place at the manufacturer's side and no coordination among the players in the supply chain. For this case, the retailer orders according to its economic order quantity in lots of size  $Q_r = 1225$  units every 0.0082 years (cycle time) at a cost of  $\psi_r(1225) = \$24,495$  per year. In its turn, the manufacturer treats  $Q_r = 1225$  as an input parameter and optimises  $\psi_{i,m}(\lambda_m, Q_r)$  by searching for the values of  $\lambda_m = 1, 2, 3, \dots$ , with  $\sum_{i=1}^{10} \psi_{i,m}(1, 1225) / 10 = \$263,227$  being the minimum average cost per cycle  $i$  cycle; where the manufacturer's average cost is

computed for 10 consecutive cycles ( $i= 1, 2, \dots, 10$ ) after which no significant reduction is noticeable.

The manufacturer orders raw material from the supplier in lots of 2450 units (assuming 2 units of raw material per 1 unit of finished product) every 0.0082 years. In its turn, the supplier treats the 2450 as an input and optimises  $\psi_s(\lambda_s, \lambda_m, Q_r)$  by searching for the optimal value of  $\lambda_s$ , with  $\psi_s(2, 1, 1225) = \$22,045$ . The total supply chain cost  $\psi_{sc}(2, 1, 1225) = \$24,495 + \$263,227 + \$22,045 = \$309,767$ .

When there is coordination and no improvement in set-up, production, and rework (i.e.,  $LR-stp = LR-prod = LR-qty = 100\%$ ), the players in the supply chain coordinate their orders according to a centralised decision making policy. That is, the mathematical programming problem presented in the previous section is minimised for the decision values of  $\lambda_s$ ,  $\lambda_m$ ,  $Q_r$  and by optimising their values simultaneously, their optimal values are found to be  $\lambda_s = 3$ ,  $\lambda_m = 1$ , and  $Q_r = 667$  corresponding to a supply chain total cost of \$264,867.

The coordination reduces the supply chain cost in this case from \$309,767 (no coordination) to \$264,867 (with coordination); a 14.5% reduction. However, when players coordinate their orders, the savings are shifted to one or more players in the chain. To guarantee coordination, the players who may be disadvantaged should be compensated by the players who benefit from the coordination (e.g., Munson and Rosenblatt 2001; Jaber et al. 2006). In the numerical examples above, the manufacturer is the player who benefits from the coordination with its cost reducing from \$263,227 to \$210,033; a reduction of 20.21%. On the other hand, the retailer and the supplier are disadvantaged, with the retailer's cost increasing by 19.1% (from \$24,495 to \$29,167), and the supplier's cost by 16.4% (from \$22,045 to \$25,667). For the coordination to be successful, the manufacturer has to compensate the retailer and the supplier by offering them unit discounts for abiding with its order policy. This is similar to the method adopted by Munson and Rosenblatt (2001) although they compensated only the retailer. In this paper, we assume that both the retailer and the supplier are compensated. So, it is expected that the manufacturer compensates the retailer by \$0.031 per unit and the supplier by \$0.024 per unit. This will bring the retailer and supplier costs back to their no coordination values, which are \$24,495 and \$22,045 respectively. The compensation will increase the manufacturer's cost from \$210,033 to \$218,327 ( $\$210,033 + (\$29,167 - \$24,495) + (\$25,667 - \$22,045) = \$210,033 + \$4,672 + \$3,622 = \$218,327$ ).

When the manufacturer undergoes continuous improvement (e.g.,  $LR-stp = LR-prod = LR-qty = 90\%$ ) the supply chain cost reduces from \$292,587 (no coordination) to 240,187 (with coordination), where the lot size reduces from 1225 to 611 units. As improvement becomes faster (e.g.,  $LR-stp = LR-prod = LR-qty = 70\%$ ), the supply chain cost reduces from \$274,355 (no coordination) to \$206,110 (with coordination) for a lot size of 511 units.

The above results indicate that as improvement becomes faster (e.g., from  $LR-stp = LR-prod = LR-qty = 90\%$  to  $LR-stp = LR-prod = LR-qty = 70\%$ ), the retailer orders in smaller lots (the lot size reduces from 611 to 511) and subsequently the cost of the chain reduces and the manufacturer is able to offer larger unit discounts as a compensation to the retailer and the supplier. Results also show that when there is coordination among the players in the supply chain and the manufacturer undergoes a continuous improvement process (e.g.,  $LR-stp = LR-prod = LR-qty = 70\%$ ), the manufacturer's quality costs are reduced by as much as

58% (from \$183, 921 to \$77,850) because of less reworks when compared to the case of no coordination ( $LR\text{-}stp = LR\text{-}prod = LR\text{-}qlty = 70\%$ ). The sum of the holding and production costs for manufacturer reduced by 57% (from \$19,732 to \$8,489) because of lower inventory levels and shorter production cycles. On the other hand, the setup cost increased by as much as 140% (from \$24,163 to \$57,885) because of more frequent setups. In summary, the suggested policy for the manufacturer would be delivering in smaller lots more frequently.

## SUMMARY AND CONCLUSIONS

This paper investigated a three-level supply chain (supplier-manufacturer-retailer) where the manufacture undergoes a continuous improvement process. The continuous improvement process is characterised by reducing set-ups times, increasing production capacity and eliminating rework. The cases of coordination and no coordination are investigated. Traditionally, with coordination the manufacturer offers unit discount to entice the retailer to order in larger lots than its economic order quantity. In this paper, the opposite was true. The manufacturer entices the retailer to order in smaller quantities than it's economic order quantity. As improvement becomes faster, the retailer is recommended to order in smaller quantities as the manufacturer offers larger discounts. The results also show that coordination allows the manufacturer to obtain benefits from implementing continuous improvements.

## ACKNOWLEDGEMENT

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## **A DIFFERENT LOGISTICS MANAGER? - DIFFERENTIATION IN LOGISTICS BUSINESS PRACTISE**

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### **ABSTRACT**

Educating students to become a logistics professional, requires a certain set of competences to be attained. This study investigates which competences are required in logistics business practise, and whether a differentiation may be noticed in the actual profiles of logistics professional. It shows that educational institutions could fine tune training their students according to the required abilities, skills and attitudes.

### **INTRODUCTION**

The domain of Freight Transport, Logistics and Supply Chain Management (SCM) is much more elaborated and has much more faces now in 2007, than during the 1970's or 1980's. In fact changes in logistics are going rather fast. The diversity in business strategies, logistics strategies and positioning has grown substantially. What does that mean for any logistician working in this domain?

This question relates fundamentally for business practice. If a transport company wants to be successful in innovating its transport services, it needs to know whether its logisticians are provided with the required competences in order to be able to make this change. For example a Transport company that offers 3<sup>rd</sup> Party Logistics services (3PL), is it in a sound starting point for starting 4<sup>th</sup> Party services (4PL), from the point of view of required competences of its staff?

For Universities, educating logisticians, the challenge is the same, in fact. They have to find an answer to the question whether they do educate students according to the actual requirements in logistics business practise.

In the past, both universities for professional training of logisticians, and academic universities based their information about current logistics practice and about requirements of knowledge, abilities and attitudes, mainly on personal impressions and implicit general deductions of trend surveys. At least that counts for the Dutch situation. We think a research based approach may add a lot to our understanding of these requirements. Conclusions and recommendations for logistics study programs should be made based on empirical data.

So, our study focused on the question **which competences actually are required in logistics business practice for positions on bachelor level?**

### **COMPETENCES AS STARTING POINT FOR EDUCATION PROGRAMS**

Dutch education in general and the HAN University especially are focussed on helping students to acquire well defined competences. A competence can be seen as a combination of knowledge, skills, and attitudes for a certain profession. Not only universities, but more and more business companies base their human resource management on this kind of framework as well.

In order to be able to perform a professional task in his later business practice at the required level, the student should possess and/or develop the required

competences. Most professional tasks ask professionals to use more competences than one at the same time. In education, teachers help the student to acquire the necessary skills and tools, and coach them in order to ensure that the professional tasks are performed in an efficient manner. Next to that, in the Dutch system, a student guiding system ensures the student to reflect on his acts, and becomes conscious of his choices regarding the further development of his competences during his stay at the University.

The HAN University has developed a set of competences which a student should have acquired when leaving university with a Bachelor degree in Logistics. These competences have been translated into a study programme which enables students to acquire these competences in a logical and didactical sound manner. This list of competences for logistics was made up earlier by lecturers of the department, so not on the basis of our current research. Our research is set up in order to help our colleagues how to bring our logistic education best in line with the required competences in the actual work field.

### **RESULTS OF OUR EARLIER FIRST STAGE**

Required competences have their framework once and for all in the strategic (re)positioning of companies. From a company's point of view, the first question is what developments can be traced in its environment, and especially, what are the forces for change – including drivers, barriers and enablers? Secondly, it is important to know what the strategic response of the company is on the changes in the environment. This altogether is the background for the competences asked from logisticians. We reported earlier about this first step of our research program (Weijers, a.o., 2005). Our findings were that the forces for change are very strong, forcing companies to diversify and internationalize their strategies. That implies that also for companies in logistics it is very relevant to reconsider the knowledge, skills and attitudes of its staff – in order to be able to respond adequately to the new challenges to the company. Against this background we started the research stage that we present now in this paper.

### **LOGISTICS PROFILES**

This current study is based up on in-depth-interviews in combination with study of literature. Up till now we have conducted 60 in-depth-interviews with professional logisticians in different logistics functions. More interviews will follow. In these interviews the following themes have been discussed:

- What demands do companies pose on logisticians, including graduates in logistics, in terms of required competences?
- What logistics profiles can be distinguished in current logistics practice? In discussions with the field, expressed amongst others by Ploos van Amstel, a differentiation between three logistics profiles seemed to evolve.

Our starting point was the hypothesis that the profiles of logistics managers seem to diversify into three different directions. Ploos van Amstel suggests that some logistics manager focus just on process management, while others focus on designing and redesigning the logistics chain; and again others in fact work as an entrepreneur, looking for any new business in logistics (Ploos van Amstel, 2005). For our research we have asked the respondents to grade the various aspects which are part of the logistic function. We grouped these aspects in the three profiles inspired by Ploos van Amstel, and four focuses in order to be able to get a clearer picture about the precise content of the new profiles.

Altogether we asked the respondents to grade their own logistics function



according to the following profiles and four focuses:

- Profiles:** Is the profile of the function best described by being a process manager, an entrepreneur in a logistic service company, or a value/supply chain manager/designer?
- Focus 1:** Is the job focused on managing staff and processes? Or on external, or on internal communication?
- Focus 2:** Is the job focused on commercial knowledge? Or on knowledge and experience with either soft, or hard logistics?
- Focus 3:** Is the job focused on drawing back on existing routines and – in case new services are required – just creating new routines? Or is it focused on meeting all kinds of customer demands? Or on the creation of new methods and services?
- Focus 4:** Is the job focused on a strategic, tactic or an operational level?

The respondent was asked to award a maximum of 6 points to all three aspects. If he considered an aspect to be very important he could give this aspect 3 points, if he considered an aspect important 2 points, just 1 point for aspects which were occasionally important, and 0 if the aspect was not important or not applicable for him in this situation. In this way we obtained a personal view how a respondent judges his role from various points of view.

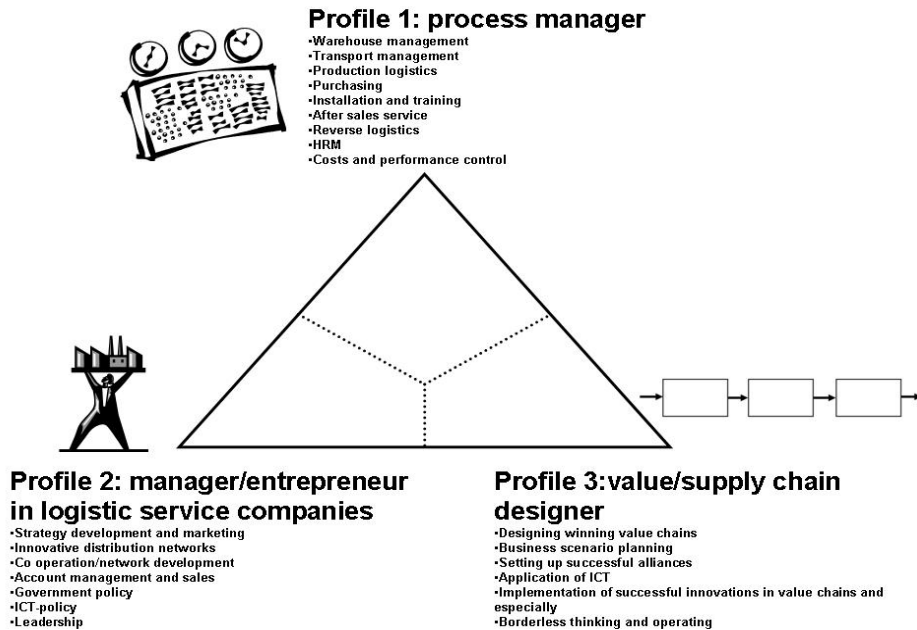


Figure 1 Three alternative profiles of a logistics manager

<b>Focus 1:</b>	External contact	Internal contact	Management
<b>Focus 2:</b>	Hard logistics	Soft logistics	Commercial knowledge
<b>Focus 3:</b>	Routine	Customer specific	Development
<b>Focus 4:</b>	Strategy	Tactics	Operations

Table 1 Characteristics of the three profiles

### **MOST IMPORTANT COMPETENCES**

With 60 respondents, the present database is still too small to derive statistical proof conclusions from. But we can derive some indications. The starting point was a list of 28 competences which form the basis of the logistic programme of the HAN University – quite comparable with lists of other universities. The respondents were asked to select the 8 most decisive ones which they require for their own job. The top 10 of the most decisive competences which were mentioned in order of importance are:

- Planning and organisational skills
- Verbal expression skills
- Flexibility
- Problem analytical skills
- Taking Initiative
- Co-operational skills
- Customer orientation
- Persuasiveness skills
- Creativity
- Target directive skills

If confirmed by additional research, this list will be a good tool to develop purposeful these competences for our students. If we focus on this top 10 competences, we must conclude that attitudes are considered to be decisive for a logistics manager, but to a lesser degree than skills. In our earlier research we had focussed on the required knowledge; that is the reason we now play less emphasis on knowledge aspects in this research project; so in this list knowledge features only indirectly as in “analysing problems” (rank 4) and in (surprisingly low rated) “expertise” (rank 13). Oral expression appears to be more important compared to written expression. Our University, as other universities in The Netherlands, at present puts more attention in the curriculum on the ability to write reports and memos, than on the ability to perform well with oral presentations. So, our findings question this historical practice. The remarkably low rates of many attitudes – social sensitiveness for example – must not immediately be interpreted as being not important. Apparently social sensitiveness is not considered by logistics managers as being decisive. That could mean they consider it as being a qualifier. Whether their superiors agree with them, we do not know yet.

Based on the first five competences we can create the following image of the logistician. He or she:

- organises and plans processes,
- communicates and cooperates often in order to achieve this,
- is flexible,
- recognises and analyses problems and
- takes initiative in order to solve these problems.

More than expected this confirms the traditional image of a logistics function.

Is this overall picture equally valid for a process manager, an entrepreneur or for a value/supply chain manager?

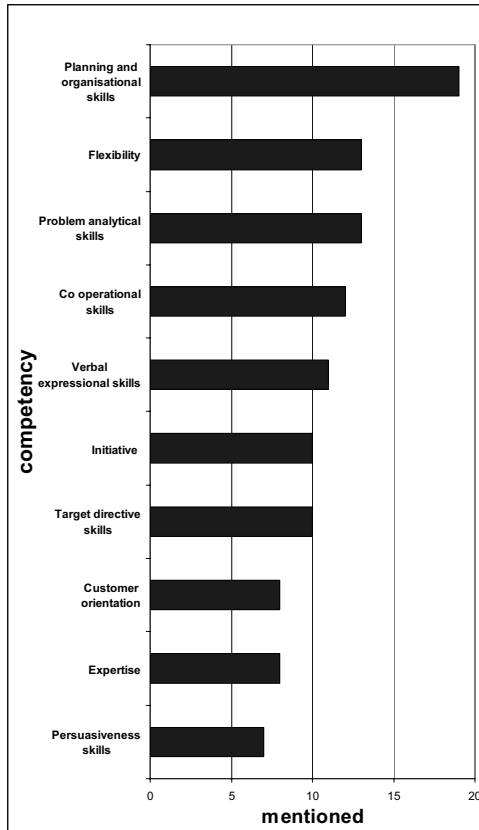
### **LOGISTIC PROFILES**

We expected that the required competences will differ at per profile and focus of the logistics function. Our findings show that in part this is the case. Overall *planning and organisational skills* are the most decisive competences. By far this

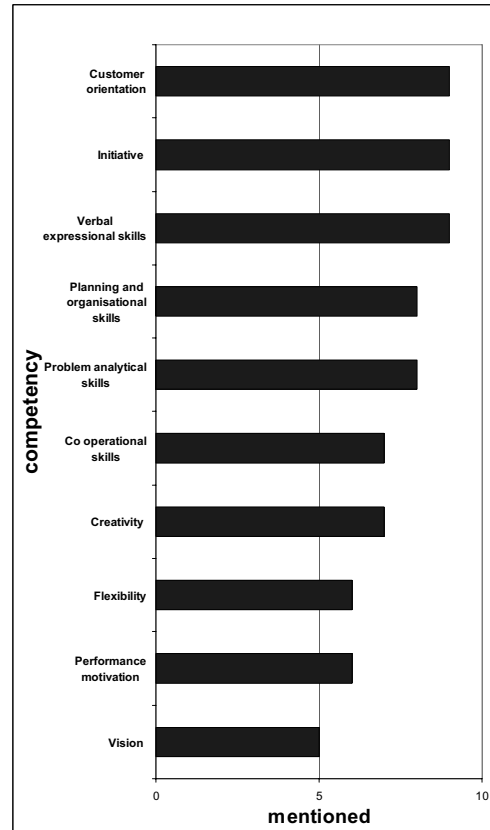
is the case for the process manager. But for a supply chain designer the pattern is more diversified: not only *planning*, but also *customer orientation*, *taking initiative* and *problem analytical skills* appear to be decisive.

We also differentiated between shippers (producers, retailers, wholesalers) and Logistics Service Providers (LSP). For a LSP *flexibility* appears to be more decisive than for shippers.

We will incorporate these findings into our curriculum. Next to that, these differences could help making students aware what kind of jobs would suit their personal attitudes and skills best.



Top 10 competences Process manager



Top 10 competences Supply Chain Designer

Figure 2 TOP 10 competences per profile

Finally, we tried to get more grips on the actual developing profiles in logistics functions. Figure 3 shows how current logisticians focus their activities. It is based on the respondents who declared themselves to be very outspoken in their logistics profile. We indeed could categorise them into three groups. So it appears that they recognise the three different profiles in their business practise. But in their day to day situation their actual focus does not seem to be that different. We must be careful with conclusions, but must we conclude that logisticians are caught between new requirements (profiles) and old competences? We do not know yet.

Profile \ Focus	External Contact	Management	Internal Contact	Commercial Knowledge	Soft Logistics	Hard Logistics	Customer Specific	Routine	Creative	Strategic	Tactical	Operational
Process Manager	Grey	Grey	Black	White	Black	White	Grey	White	Grey	White	Grey	Grey
Manager/ Entrepreneur	Grey	Grey	Grey	Grey	Black	White	Grey	White	Black	Grey	Black	Grey
Supply Chain Designer/Manager	Grey	Grey	White	White	Black	White	Grey	White	Black	Grey	Grey	Grey

black = very important; grey = reasonably important; blanc = little important.

Figure 3 Importance of a focal point for a logistic profile

## CONCLUSIONS

Up till now our findings show requirements on logisticians which seem to be rather conventional. At the same time, on an individual level, logistics managers appear to show sharp profiles, including several outspoken less conventional combinations. And between several individuals with similar functions we noticed remarkable similarities. This is a first sign of shaping new logistics functions.

Although the logistics functions seems to become differentiated to a certain extent, a certain 'common body of knowledge', or more precisely a certain common body of skills and attitudes, seems to fit with more than just one logistics profile.

Our earlier stage of this research project showed that the requirements on logisticians are very high. Business strategies are developed into different directions. It seems that logisticians do meet new requirements which have to do with new strategies. We must be careful to be outspoken in this conclusion, because, at this moment the number of respondents to our interviews is rather insufficient to be able to draw statistically based sound conclusions. We now work on extending our database. Many universities up till now have been hesitating investigating the ins and outs of the logistics profiles more in detail. We regret that. There is a lot to win. We are convinced about the importance to continue this research project. Eventually this will help us to redesign our logistics curricula and our logistics education.

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## **SIMULATION-BASED DESIGN OF SEQUENCING PROCESSES IN AUTOMOTIVE SUPPLY CHAINS**

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### **ABSTRACT**

Sequencing processes arrange specific items required by a customer according to their order list in the correct sequence. Not only are the components delivered just when they are needed (just-in-time), but they are also delivered in the right order (just-in-sequence). Thereby, the customer is of internal or external origin. In automotive industry networks, sequencing processes often represent a push-pull boundary within the supply chain. The initial stages are typically operating on a push-based philosophy, whereas succeeding processes are driven by pull strategies. This paper refers to the results of our research project "*Sustainable Net-by-Cube Logistics*" (SUCULOG 2007). The objective is to provide a simulation-based approach for the design of an exemplary sequencing system. With that in mind, we begin by discussing the nature of sequencing processes and develop an input-output model for sequencing systems. The second step is to show the application of this model on a selected business case in which the industrial partner is a leading automotive supplier. Our focus is on the inbound and outbound characteristics of the sequencing model and the design of its interfaces. This leads us to the third step: the design of the considered supply chain which is provided by simulation studies.

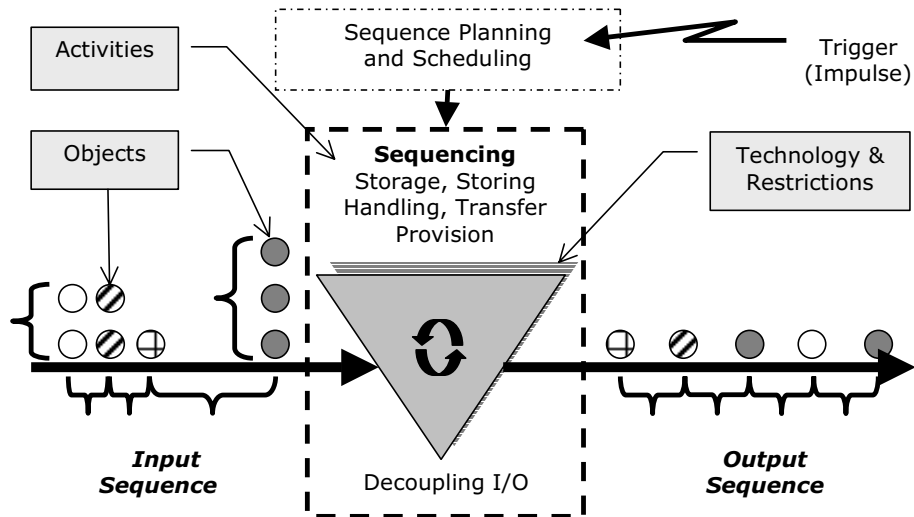
### **INTRODUCTION**

Sequencing processes are enabled by two (different) categories of systems: *First, materials handling systems*: designed for sequencing, they consist of functional elements, such as inbound activities, storing, sorting, transformation and related outbound activities. The second category is made up of *information systems*. These are based on information technologies on the one hand (e.g. Electronic Data Interchange (EDI) and internet concepts (Schmollinger, Siestrup 2006, pp. 36)) and sequence control systems on the other. A smooth information flow between supplier and manufacturer is a critical factor in supply chain management (Simchi-Levi et al. 2003, p 266). This holds true in particular for sequencing systems. It should be noted that due to the high amount of investment, the installation of complex sequencing systems presupposes the existence of long-term cooperation between supply chain partners in the automotive industry.

### INPUT-OUTPUT MODEL FOR SEQUENCING SYSTEMS

An input-output model for production and logistics processes is a framework for documenting and predicting the flows to and from individual organisational units such as companies, factories, factory units, distribution centres. Figure 1 illustrates an input-output model for a sequencing system on an actual business case from the automotive industry.

Fundamental terms describing the input-output relations are *objects*, *activities*, *technological aspects* and *restrictions* (Dyckhoff 2003, pp 20).

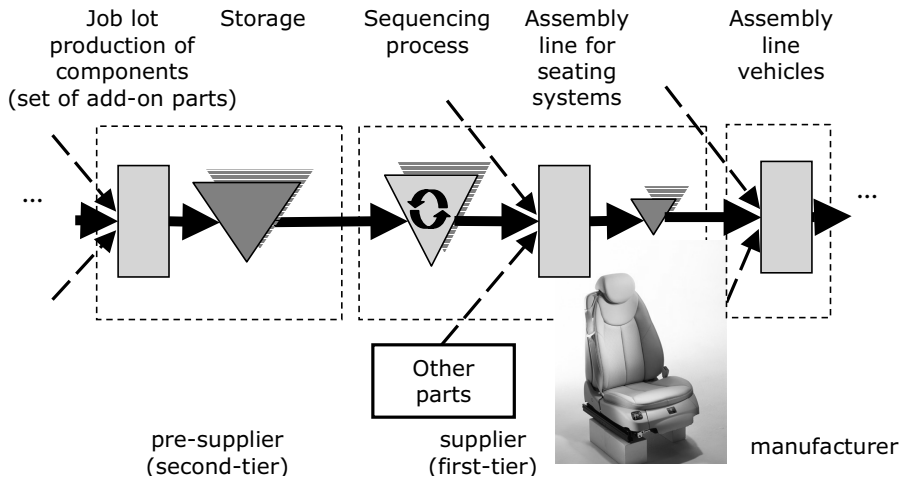


**Figure 1 Input-Output-Model**

### CASE FROM AUTOMOTIVE INDUSTRY

As mentioned above, this simulation model is based on a case that finds application in business practice. Following the process analysis, the collected and aggregated data is used to create a model of the supply chain including pre-supplier, supplier and manufacturer. Figure 2 presents an overview of this automotive supply chain.

The sets of components are produced in job lot production by the pre-supplier. They are packed in boxes (one set per box) and shipped to the supplier. The next process step within the supply chain is the target process: the sequencing system for the sets which are provided for the assembly line producing seating systems. The corresponding first-tier supplier delivers the seating systems just-in-sequence to the manufacturer's production line. In this respect the sequencing unit represents a push-pull boundary: the upstream supply process is based on forecast oriented production, whereas the downstream process flow planning is pull-driven and impulse-controlled.



**Figure 2 Automotive Supply Chain with embedded sequencing system**

### **SIMULATION STUDIES**

We use an event-controlled simulation environment (*plant simulation/UGS*) enabling the possibility to adapt and test the whole process without interventions in the running production process. The study of combining simulation methods with optimisation methods in an iterative way is seen as a promising area (Harrison 2003, p 10).

The considered supply chain (see figure 2) modelled with *plant simulation* is completed by the embedded *Cube-Sorter Model (CSM)*. It constitutes the sequencing transformation process and its control logic is developed by a project partner. This type of simulation can be classified as *distributed simulation* (Wenzel et al. 2003, Spiekermann 2007).

Distributed simulation offers various opportunities, e.g.

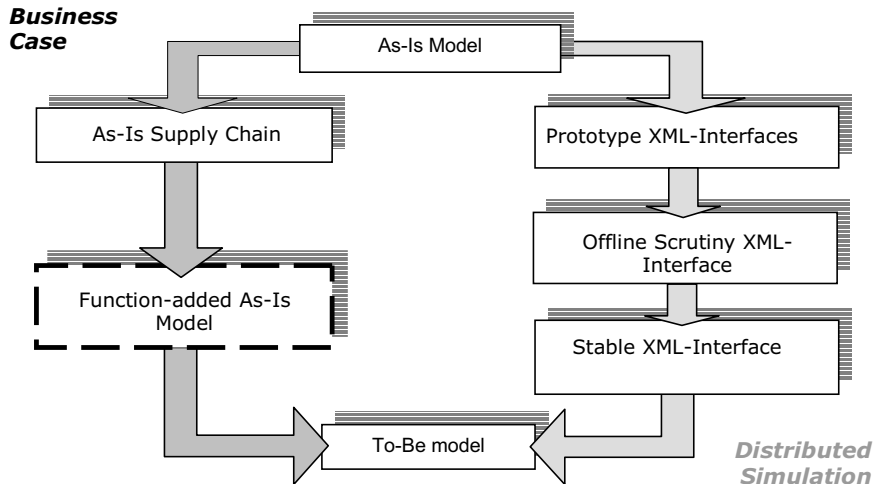
- recovery options concerning existing simulation models or model components,
- replacement of simulation components by real systems,
- possibility to keep specific process knowledge by building encapsulated modules within shared projects (Rabe 2003, p 137).

Primarily, within our project distributed simulation offers the possibility to integrate the respective developed modules of the geographically distributed project partners working on different design platforms.

### **The Process Model - Adaption**

Subsequent to the generation of the basic model, the aim of the following project continuation is to create an easy to handle and manageable way to implement the function of the well-formed XML-interface and the to-be process with the logic of the CSM. On its course to becoming the to-be model the as-is model bifurcates into parallel paths. On the one side, it has to be ensured that all significant changes to the to-be model, compared to the as-is state, are implemented along the way and work correctly. On the other side, the new XML-interface has to be defined and realised.

A definition describes the obligatory structure of the XML-files shared between the independent systems of the simulation and the realised CSM as well as the communication structure between these systems. Based on a prototype software of the CSM provided by our project partner, the interface is scrutinised and an iterative process of testing, bug reporting and bug fixing moves the interface toward its completion. Additionally, the implementation of the changes to the as-is model is executed and subjected to testing.



**Figure 3 Project process model**

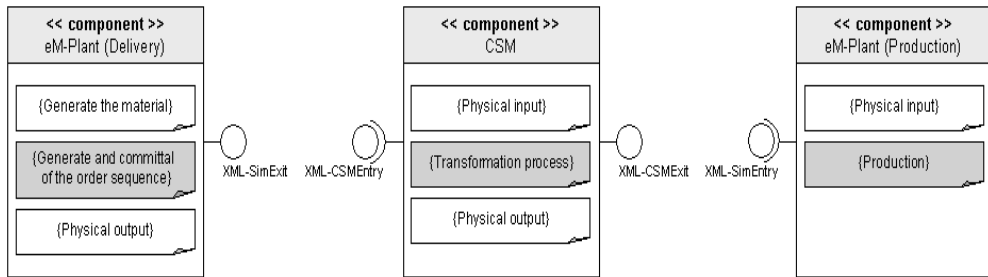
Because of the divided complexity this approach achieves an easy to handle and manageable version of the to-be model with an optimised way to define and fix errors arising within the respective models.

### **The XML-interface - design and structure**

The CSM is implemented as an embedded element interconnected with two well-formed interfaces. The communication between the different systems is carried out through *Extensible Markup Language* (XML) interfaces (W3C 2006). For synchronisation needs it is necessary to make sure that a uniform platform is being used and that the access to the XML files is being regulated. Both requirements are met in cooperation with our partners.

As mentioned, the communication between the logically and geographically divided systems is managed by XML. Besides the slightly higher demand on storage space, compared for example to the *Character Separated Values* (CSV), XML features two important assets which can be benefited from in the communication process between the interacting servers. The first one is the circumstance of the easily understood nature of the XML files. The hierarchical structure and the option of free nomenclature of the used nodes facilitate comprehension. The second and most important part is the option of defining a binding agreement of the interface structure and the corresponding procedure between the attending project partners. This allows for concerted action of the split team with a common understanding of the communication. To ensure that on both sides of the communication the respective needs are met, a component diagram in Unified Modeling Language (UML) was developed (see figure 4). Its functions being of prime importance.





**Figure 4 Component diagram (UML-Notation)**

*Delivery component:* The purpose of this part is to procure the required material for one production cycle of four weeks according to data that is stored in a document and which can be modified to suit custom needs and is loaded at the start-up of the simulation. Furthermore, the task of creating the order sequence and the corresponding handoff of the in XML-converted production need is accomplished with different methods within the administrative part of the model.

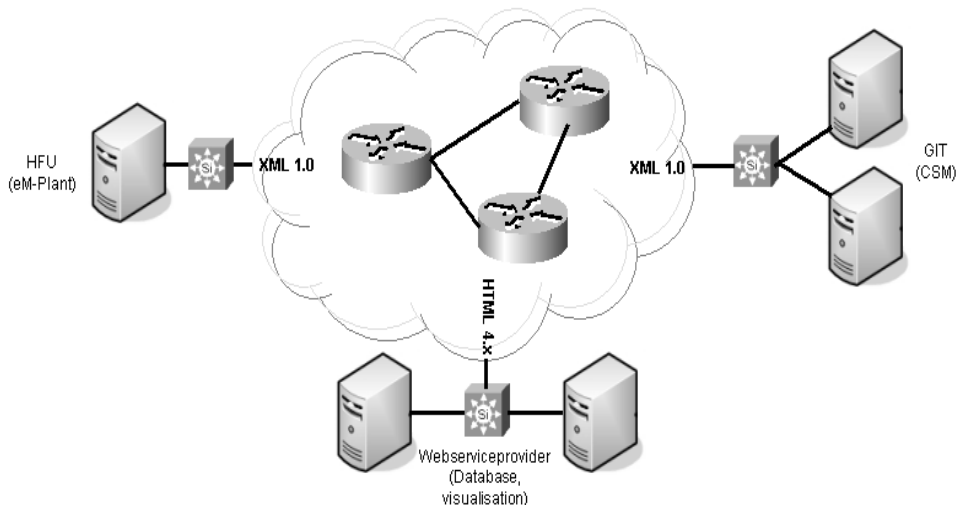
*CSM component:* As explained, our partners had to deliver the CSM. Its main task is the process of transformation of the material which was received from the delivery component.

*Production component:* Constituting the basis of the order sequence, the production receives the sequenced material which it then uses to produce the seating systems.

### The Communication – Logic and Structure

The physical structure and the programmed logic of the systems are designed to meet the requirements of an open and geographically divided system.

As figure 5 shows, it is possible to run the simulation connected through any network capable of transferring the XML data.



**Figure 5 Integration concept**

The HFU server simulates the production of the seating systems including the supplier, manufacturer and the customer. It transfers the material described in the XML files to the GIT server which starts the transformation process of sequencing the material. The material is delivered on demand back to the HFU server and used for the production of the seating systems. Storing the data and visualisation of the simulation results is realised by a web service provider.

## CONCLUSION

With this approach, the creation of distributed simulation studies with two different systems is achieved. On this basis, alternate process analyses (what-if scenarios) are designed and evaluated. The goal to gather information in terms of behaviour and performance of the CSM and the integrated supply chain is reached through measuring different key performance indicators. The results of the analyses complete further feasibility studies, forming a ground work for building and testing of a first physical prototype of the CSM.

As has been demonstrated, the applied distributed simulation is a powerful planning approach enabling the employment of different project partners for common supply chain design purposes, adding their specific strengths to the endeavour. In lockstep with these advantages there arise a number of challenges that will need to be resolved, especially issues of standardisation (synchronisation needs, interface specifications) requiring intensive communication and reliable agreements between the involved partners.

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## **SUPPLY CHAIN DESIGN OF VOLUNTARY SUSTAINABILITY INITIATIVES – ORGANIZATIONS' STRATEGIC ANSWER TO AN EMERGING SOCIETAL DISCUSSION**

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### **ABSTRACT: The emerging trend in the society towards sustainability**

Public opinion puts increasing demands on companies' environmental and social responsibilities. Agreements like the "Kyoto Protocol" made in 1997 and the Paris' "Climate Change 2007" protocol have encouraged politicians to think about stricter ecological standards. Changing public opinion and new government regulations can cause threats to a company's business. To avoid these risks, organizations experience a growing need to proactively manage compliance with social and ecological standards. Because the public hardly differentiates between the standards of the focal organization and those of its supply chain partners organizations actively responding to societal demands also have to guarantee that their global supply chains conform to the published standards. Organizations which can reliably ensure these standards in their supply chains are further able to set up market entry barriers and to put their competitors under pressure to also ensure sustainability within their supply chains. This paper reviews the current literature in management research on the question of how to collaboratively develop so-called voluntary sustainability initiatives (VSI) with supply chain partners and further stakeholders. VSIs refer to strategic programs which require organizations, being part of the supply chain, to improve the social and ecological performance of their operations or products beyond legal requirements.

### **Voluntary sustainability initiatives (VSIs) and supply chain management A definition of VSIs and the role of stakeholders**

Corporate sustainability combines ecological with social issues. The World Business Council for Sustainable Development defines sustainability as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". According to Elkington, "a business needs to measure and report economic, social, and ecological business performance in order to achieve corporate sustainability" Hamprecht (2006, p. 9).

VSIs are a specific kind of corporate sustainability initiated by an organization's free will to reduce its social and environmental impacts beyond legal requirements. With VSIs the participating organizations seek to improve their social and ecological performance in order "to accomplish social and ecological benefits along with the traditional performance gains which the business seeks" (Hamprecht 2006, p.10). VSIs include programs, codes, agreements and commitments aiming at leveraging the impact of information disclosure and transparency instead of using command and control mechanisms (Toffel 2005).

Engaging in corporate sustainability can enhance an organization's legitimacy (DiMaggio / Powell 1983), reducing the likelihood of fines, penalties or campaigns against it. Corporate sustainability can also contribute to an organization's environmental performance (Toffel 2005, p.33) and competitiveness. Drawing on rent-earning resources and capabilities may allow organizations to differentiate through beyond compliance leadership, green marketing, the development of ecoproducts or reduced costs by eco-efficiency (cf. Hart 1995). Social responsibility refers to the organizations perception to engage in environmental

bility refers to the organizations perception to engage in environmental issues without any economic rationales ("feel-good factor") (Bansal / Roth 2000). VSIs are means to actively develop societal rules, norms, and standards. Eventually, they influence societal demand and establish legitimacy for the organization's management practices (Hamprecht 2006). This proactive approach to corporate sustainability may limit the risk of new laws, norms and standards that could be imposed if no VSI exists (Aragón-Correa / Sharma 2003, p. 76). Also, VSIs encourage environmental "watchdogs" to investigate more intensely competitors' activities. This may eventually create market entry barriers (Hamprecht / Sharma 2006, p. 14).

Hence, in this paper we focus on legitimacy and competitiveness. By engaging in VSIs organizations make promises to their stakeholders to reliably possess corporate sustainability. Legitimacy is a key concern to the "strategic stakeholder management approach" paying attention on the impact of stakeholder claims towards organizational legitimacy and chances of long-term survival. This stakeholder approach advocates the imperative of organizations to identify key stakeholders who could either sanction the organization's business practices or which dispose of crucial resources for the organization (Rüegg-Stürm 2002, p. 29). According to Freeman "[...] a stakeholder is any group or individual who can affect, or is affected by, the achievement of corporation's purpose. Stakeholders include employees, customers, suppliers, stockholders, banks, environmentalists, government and other groups who can help or hurt the corporation" (Freeman 1984, p. 74). The strategic stakeholder approach advocates to sustain the willingness of all relevant stakeholders to cooperate and to secure legitimacy from important stakeholders (Rüegg-Stürm 2002, p. 29). Building up relationships with important stakeholders in VSIs may also increase organizations' social and economical image and therefore foster legitimacy. A large body of literature discusses collaborations with societal stakeholders. Especially, the collaboration with non-governmental organizations (NGOs) is said to be highly trustful for other societal stakeholders since they view, "both [NGO's] pure motives and statements about corporations as fact." (Argenti 2004, p. 92). In addition, also the economic stakeholders like creditors or shareholders play an important role for the initiation of a VSI (Hamprecht / Sharma 2006, p. 22) since they determine the maximum the organization is allowed to invest in corporate sustainability. Involvement of societal stakeholders in VSIs may enable an organization to sense emerging social concerns earlier than competitors (Sharma / Vredenburg 1998). Given the social complexity of stakeholder integration, such a strategy can lead to a first-mover advantage, which is difficult for competitors to imitate.

### ***Supply Chain Management (SCM) and sustainability***

SCM is a concept designed to manage entire supply chains consisting of numerous participating organizations (Mentzer et al. 2001, p.7). According to Cooper et al. SCM "ideally embraces all business processes cutting across all organizations with the supply chain, from initial point of supply to ultimate point of consumption" (Cooper et al. 1997, p. 176). Through the joint development of innovative solutions supply chain partners are able to create unique, individualized sources of customer value and may thus enhance competitive advantage of the whole supply chain, as well as each member firm (Mentzer et al. 2001, p. 7, 15). In the case of sustainable or "green" SCM, supply chain members are encouraged to fulfil customers needs concerning ecological or social products (Zhu / Sarkis 2004, p. 265). They also may satisfy customers' cost expectations by the envi-

ronmental sophistication of processes and the efficient usage of resources within the supply chain.

Although in business practice the majority of companies running sustainability restricts those predominantly to their own organization inhouse, a growing number of scholars argues that in addition to inhouse processes, organizations also need to consider inbound as well as outbound supply chain processes to pursue sustainable management (Vachon / Klassen 2006). The SCM model of Cooper et al. complies with this call moving forward a comprehensive return processes in order to strategically improve customer loyalty and corporate image in the society. Scholars identified also various inbound, inhouse and outbound activities how successful organizations improve sustainability performance, eventually enhancing their competitiveness<sup>1</sup>.

### ***How VSIs fit in the SCM concept***

When organizations make claims about meeting strict environmental or societal standards in order to enhance stakeholder and customer value, various individuals and organizations observe them whether they really stick to their claims and communicate openly their opinion in public. In many cases, they look at the output of the organization and do not distinguish in the supply chain between the organization itself and its supply chain partners (Roberts 2003, p.168). Consequently, if one supply chain partner misses on the environmental or societal standards, the responsibility is often transferred also to the lead company (Rao / Holt 2005, p. 899; Vachon / Klassen 2006, p. 803) and might put the legitimacy of the entire supply chain into question. For purpose of risk management, organizations have to foster the supply chain integration through either tight management or cooperation to ensure their profitability and continuity (Tang 2006, p. 453), motivating their supply chain partners to comply to the expected environmental and societal standards. Tight supplier management might be difficult if suppliers are numerous, distant, or independent. In such cases a cooperative approach might be more suitable. Organizations who want to use VSIs to ensure compliance of their activities with their public claims need to identify their relevant supply chain partners and integrate them into their initiative to demonstrate truthful commitment to sustainability.

Mastering sustainability throughout the supply chain also may increase the competitive position of an organization. The active development of supply chain-wide sustainability standards beyond legal requirements and their communication to customers and stakeholders – namely VSIs – can intensify the demands of the society concerning sustainability. This, in consequence, puts pressure on competing supply chains (Christopher 1998, p. 28) to also ensure the new level of sustainability in their supply chains.

A suitable case illustrating the competitive potential of a VSI in the context of SCM is the Migros case on purchasing sustainable palm oil. After sensing ecological, and thus societal problems with their usage of palm oil in various products, Migros, one of the big Swiss retailers, established cooperative talks with environmentalists. Together, they worked out several criteria for sustainable purchasing of palm oil followed by discussions with Migros 1<sup>st</sup> and 2<sup>nd</sup> tier suppliers convincing them to fulfil the criteria within three years. After the implementation of this VSI three worldwide operating NGOs launched a campaign on the role of palm oil on the deforestation of the rain forest. While some businesses found

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<sup>1</sup> For a collection of green management practices see Rao / Holt 2005

themselves the target of this campaign, the Migros VSI could be presented as a best-practice example putting the supply chains of Migros direct competitors under substantial competitive pressure (Hamprecht 2006, p. 78-86).

## **Theoretical considerations on the supply chain design of VSIs**

### ***Theoretical framing of VSIs***

Our research explicitly draws on institutional entrepreneurship. Institutional entrepreneurs are actors who "create a whole new system of meaning that ties the functioning of disparate sets of institutions together" (Garud et al. 2002, p. 196). The development of a VSI with supply chain partners and further stakeholders is an example for such a "whole new system of meaning". In this context, the institutional entrepreneur, is the actor who initiates a VSI.

The studies on VSIs in the institutional entrepreneurship literature have spent limited attention on the kinds of resources and capabilities organizations require in order to successfully engage in institutional entrepreneurship (Hamprecht / Sharma 2006, p. 4). This literature describes the actions of institutional entrepreneurs theoretically (cf. Oliver 1991; Zimmermann / Zeitz 2002) as well as empirically. But as long as the required organizational assets remain undetermined, studies on the creation of institutions may face difficulties in analyzing internal dynamics of organizational change. Scholars call for research that examines the resources and capabilities which allow an organization to be successful in the creation or the change of an institution (Wright et al. 2005, p. 25). A large body of literature on the resource-based view addresses questions on resources valuable for strategic initiatives, yet little in the context of VSIs. Consequently, scholars have suggested to integrate institutional entrepreneurship and resource-based view. Since interorganizational collaboration with supply chain partners and further stakeholders is a means in order to achieve institutional change (Lawrence et al. 2002, p. 281; Peng 2003, p. 283), we also take into account resource-based enhancements towards interconnected firms.

### ***VSIs and institutional entrepreneurship***

Institutional entrepreneurship examines how organizations actively shape institutional demands such as rules, norms, and standards. It is based in institutional theory, a literature developed in sociology describing how societal constraints lead to a set of organizations in a specific context ("institutional field") similar to one another in various aspects, even though they are managed independently (DiMaggio / Powell 1983, p. 147-148). If an organization or supply chain wants to maintain its legitimacy to enhance its chances of long-term survival, it needs to comply with the institutional demands (Meyer / Rowan 1977, p. 353), which could be either regulative, normative or cognitive (DiMaggio / Powell 1983). Changing institutional demands cause either threats (e.g. a campaign) or opportunities (e.g. regulation that creates market entry barriers) to organizations, urging them to respond by organizational change.

Institutional entrepreneurship emerged out of institutional theory, taking into consideration that organizations can also actively shape institutional demands (DiMaggio 1988). In this context, institutional entrepreneurs are actors who are interested in particular institutional arrangement. They integrate their institutional environment and its demands into their strategic considerations. Consequently, the decision to either conform or actively manipulate institutional demands "is not exclusively based on a social logic of long-term survival as the primary organizational objective. Rather the co-alignment of the strategy of a

firm and institutionalized demands can also be supported by an economic-rational logic linking the loss of legitimacy with the loss of competitive advantage for a firm" (Hamprecht / Sharma 2006, p. 3).

Agency and resources are the key factors enabling institutional entrepreneurs to influence institutional change (DiMaggio 1988, p.14). In agency theory, principals contract specific tasks to agents. It argues that in agency relationships all players are utility maximizers (Jensen / Meckling 1976, p. 308). In this context, the agent's advantage of possessing more information than the principal allows him to partially liberate himself from the contract and act opportunistically. In institutional entrepreneurship organizations also have the freedom of choice within constraints. This freedom is based on the ability of an organization to partially distance itself from institutional pressure from institutional embeddedness and act strategically beyond established boundaries (Battilana 2006, p. 654). In such cases, institutional entrepreneurs override the embedding institutional pattern via deliberate cognition (DiMaggio 1997, p. 271). A steady overriding of established boundaries may eventually change institutional environments as targeted by the institutional entrepreneur. Institutional entrepreneurship rely also on their resources to drive institutional change (Garud et al. 2002, p. 196). They access these resources from their position in the institutional field. Especially, by actively collaborating with institutional partners (such as stakeholders and supply chain partners) access further resources for successfully driving institutional change (Peng 2003, p. 283). Agency and resources are interconnected. In order to drive institutional change through deliberate cognition (agency), institutional entrepreneurs make use of specific organizational resources.

Recently, some empirical studies in the management literature have addressed how actors influence existing institutions. In this context, few authors have looked at resources and capabilities that have facilitated institutional entrepreneurship: the capability of writing widely acknowledged texts (Phillips et al. 2004, p. 641), profound technical know-how (Maguire et al. 2004), political and social skills (Garud et al. 2002, p. 196), and the ownership of scarce resources (Lawrence et al. 2005). Unfortunately, the level of detail of these investigated resources is mostly rather generic. Scholars from other disciplines in management research have reported much more detailed analysis of resources. For example, scholars of the resource-based view typically examine if complementary resources can support an existing resource in order to raise its profit-generating potential (Moorman / Slotegraaf 1999, p. 252). Furthermore, resource-based research increasingly emphasizes that the value of a resource for strategy implementation is contingent (Aragón-Correa / Sharma 2003). This insight might be relevant to analyze resources supporting institutional entrepreneurship in different industries or at different points of time.

### ***VSI and the resource-based view***

The resource-based view has become one of the most influential frameworks in the strategic management literature (Lavie 2006, p. 640). It provides an intra-organizational view, conceptualizing organizations as heterogeneous entities consisting of idiosyncratic resource bundles. The resource-based view suggests that resources play a key role to competitive advantage of a firm. They enable a firm to generate superior financial performance, say "above normal rents" (Peteraf / Barney 2003, p. 313). The resource-based view draws on a definition of attributes of resources that contribute to sustained competitive advantage: being valuable, rare, difficult to imitate, and non-substitutable (Barney 1991, p. 112).

The recent trend in research across company boundaries to explain horizontal and vertical alliances has triggered further research in resource-based scholars. Drawing on traditional considerations, resource-based enhancements with regard to relationships – such as supply chain relationships or relationships with strategic stakeholders – came up explaining relational or network resources as further source of competitive advantage (Dyer / Singh 1998; Lavie 2006). They argue that critical resources might span firm boundaries in interconnected constellations. Hence, a firm could extract value out of resources not fully owned by its internal organization (Lavie 2006). In order to distinguish relational resources from internal resources research highlights common benefits based on these resources which cannot be generated separately by one alliance partner in isolation (Lavie 2006, p. 644-646). In this context, resource-based considerations on interconnected firms stress relation-specific assets, complementary resources, knowledge-sharing routines, and effective governance mechanisms as sources of relational rents (Lavie 2006, p. 645).

In resource-based logic competitive advantage results from “implementing a value-creating strategy not simultaneously being implemented by any current or potential competitor” (Barney 1991, p. 102). Therefore, the assessment of the value of a resource is a central concern to resource-based investigations. Although critics of the resource-base view assume the definition of resource value to be exogenous to the theory (Bowman / Ambrosini 2001, p. 501-502), scholars of the resource-based view brought up some concepts contributing to the determination of resource value – namely complementarities and contingencies. Resource value through complementarities specifies the value of interdependent resources and therefore the analysis how a resource could increase the profit-generating potential of another intra- or interorganizational resource (Lavie 2006, p. 645). This phenomenon is mainly explained by two mechanisms. First, an organization might strategically develop resources based on the same routines that can be leveraged across them (Hamprecht 2006, p. 21-22). Second, efficiency effects of one resource might arise from the presence of another resource (Lavie 2006, p. 645). Furthermore, research suggests contingencies in the business environment (“context”) such as uncertainty and complexity to help explain the value of a resource (Aragón-Correa / Sharma 2003). Contingencies may cause some resources to be valuable in one context and not valuable in another.

With all these insights, the resource-based perspective of interconnected firms provides a fresh view to institutional entrepreneurship. The theory can be used to identify valuable resources for institutional entrepreneurship that can be for example leveraged between the work on a VSI and other intra- or interorganizational activities. Thus, resource-based considerations can estimate resource value for institutional entrepreneurship by means of complementarities, contingencies and relational considerations of resource value.

### **Conclusion and implications for further research**

Organizations engaging in VSIs intend higher legitimacy and superior competitiveness by complying to stricter sustainability standards. In order to enhance legitimacy, members of a VSI may collaborate with societal and economical stakeholders in order to smoother establish new rules of the societal game.

Empirically, we know that stakeholders keep organizations responsible for their supply chain partners’ compliance to the proposed sustainability standards. This urges organizations to convince also their supply chain partners to join their sus-



tainability strategies. Especially in cases where organizations rely to a large extent on the supplies from numerous supply chain partners, their alignment in the initiative plays a key role to ensure compliance to sustainability standards throughout the supply chain.

The current body of literature in institutional entrepreneurship addresses why and how organizations start and establish VSIs. But the discussion mainly focuses on organizations and less on interorganizational relationships to stakeholders and supply chain partners. However, as we argued, the involvement of stakeholders may be beneficial for establishing societal demands. Moreover, the predominant organizational form in western industries are fragmented supply chains. This has led to the research stream of SCM targeting the coordination of organizations involved in a supply chain. By working together with his supply chain partners an institutional entrepreneur is able to reliably give promises to the institutional field in order to change institutional demands over time and enhance his chances of long-term survival. Besides, the active shaping of institutional rules, norms and cognitions may increase pressure on competing supply chains enabling the institutional entrepreneur to improve his competitive position.

The activities of an institutional entrepreneur to change institutional fields and gain competitive advantage require specific valuable resources. These resources have to be unique in the institutional field ensuring that no other actors in the institutional field could draw on the same resources and thus prevent or reverse the achieved change (Hamprecht / Sharma 2006, p. 16). As we highlighted in this paper the identification of valuable resources is central to the resource-based view. Hence, we suggest that resource-based considerations could complement the perspectives of institutional entrepreneurship in further research to identify the specific resources that are needed to efficiently engage in VSIs in supply chains. Since reliable relationships with stakeholders and supply chain partners are a means to convince the institutional field of the VSI, we especially expect relational resources of the initiator and his partners to be important to an institutional entrepreneur. Further research therefore has to investigate how institutional entrepreneurship and the resource-based view of interconnected firms (Lavie 2006) fit together on a deeper level. Empirical investigations on the resources institutional entrepreneurs dispose might in addition allow scholars to identify valuable resources to efficiently develop VSIs in order to put pressure competing supply chains.

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## THE FUTURE OF DOCUMENT LOGISTICS

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### ABSTRACT

Document logistics comprises all processes of transporting, storing, handling and converting paper-based or electronic documents. It has significantly gained in importance over the last years. Efficient document logistics can cut costs, improve customer satisfaction and generate competitive advantages. However, technological innovations, such as speech and display technology, may change the business radically in the future. A central question that affects all companies is whether there should be an electronic substitution of paper. This article presents current expert opinions on the minimization of paper or even the complete extinction of paper in the future. Both secondary and primary data research has been conducted in order to evaluate to what degree businesses will reduce their use of paper, including printed media and physical mail, and electronically substitute paper in the long-term.

### INTRODUCTION

"Nothing is as consistent as change" – these wise words uttered by the Greek philosopher, Pythagoras, around 500 B.C. still hold true 2,500 years later. This proverb adequately describes today's world and the years to come. Especially the logistics business has transformed considerably over the last decades. Globalization, intense international competition, increased customer expectations and outsourcing have influenced the logistics industry significantly. Many large logistics service providers try to differentiate from competitors by positioning themselves as a 'one-stop shopping' provider, offering a broad range of traditional logistics services, but also document logistics solutions. In fact, the worldwide market volume for services and consulting in document management was expected to reach €22.5 billion in 2005 (Interim2000 2005, p. 6). In particular, Deutsche Post World Net, Rhenus Logistics and arvato Bertelsmann provide integrated service solutions for transporting, storing (saving, filing, archiving), handling and converting (printing, copying, scanning) paper-based or electronic documents from creation to usage and storage. Recent research (Jahns and Walter 2006) has shown that in two-thirds of all companies document logistics can be significantly professionalized. Various other figures underline the need for efficient and effective document logistics solutions:

- Employees spend up to 60 per cent of their time processing documents (Duyshart 1997, p. 18)
- 85% of customer documents are never retrieved, 50% are duplicates and 60% are obsolete (McKinley 1997)
- To store 2 million paper documents, an organization can expect to spend between \$40,000 and \$60,000 on filing cabinets alone (Sellen and Harper 2002, p. 28)

- Of the 1,200 pages the average office worker prints per month, some 21% are returned to the recycling bin the day they were produced (Markoff 2006)
- As a consequence, decisions on document logistics are strategic decisions. A recent study conducted by The Enterprise Content Management Association among 1,200 end-users and potential end-users of content and document management technologies in nine countries revealed that over 89% of those surveyed believe that the management of documents is important to their organization's strategic goals (AIIM 2006, p. 6). Craine (2000) suggests that companies have to design a document strategy in order to best realise their potentials. Since document logistics processes normally do not belong to the core competences of an organisation they are well suited for outsourcing.

### **FUTURES STUDIES IN DOCUMENT LOGISTICS**

Thinking about the future is not a recent phenomenon of mankind. It has been a central aspect of life since the beginning of civilization. Only the attitudes toward the future have changed over time, or the way people view the future. Contemporary values affect future perspectives (Masini 2006, p. 1158). Today, more and more companies have started to establish competences in futures research. The motivation is twofold: Firstly, corporations hope to gain a better understanding of possible futures. Secondly, they seek to better prepare for the future by incorporating the results of futures research into their strategies, either by adapting to changes or actively shaping the future. The same is true for the document logistics industry. Technological advancements in information and communication have significant impact on companies and markets. A central question affecting this industry more than ever is the degree to which paper will be electronically substituted in the future. Since BusinessWeek's article "The Office of The Future" in 1975 (Anon. 1975), a debate about paperless offices and the substitution of physical mail or printed media began. Roger Smith, former Chairman and CEO of General Motors, even predicted in 1986 that, "By the turn of this century, we will live in a paperless society". Futurists promised efficiency, productivity, cost effectiveness, and a new way of doing business. However, this prediction has still not become true. Advancements in technology, such as electronic paper and voice recognition, have enlivened the discussion of this vision once again. Pitney Bowes Inc., the world's leading provider of mailstream solutions, has invested \$1 billion in research and development over the past decade (Critelli 2005a, p. 50). Soon after becoming chairman of the board in 1997, Michael J. Critelli appointed Luis Jimenez as Chief Strategy Officer to anticipate and plan for the future. The company continuously scans and monitors the external environment and uses techniques, such as scenario planning, in order to identify future influencing factors and their impacts (Critelli 2005a, p. 49). Another prominent example of futures research in the field of document logistics comes from United Parcel Service (UPS) whose Chairman and CEO, Michael J. Eskew, recently underlined that he is "...convinced that it is possible and wise, indeed necessary, to develop a set of very long-range scenarios that can form the foundation for our [UPS] future strategic plans" (Garvin and Levesque 2005, p. 1). In fact, UPS managers successfully conducted scenario sessions in 1997 and 2004. The key results of these sessions re-defined the Corporate Charter and altered the company's mission statement, identified key themes and insights, created a platform for management discussions, and caused a mind-set shift for some managers (Garvin and Levesque 2005, p. 5). Deutsche Post World Net (DPWN) is also systematically investigating the future.

The company's Market Research Service Center (MRSC) has conducted studies on the impact of Internet technologies on mail, future customer expectations on transport services, as well as scenarios about the future of the personal letter market. In addition, an early warning system has been installed. It consists of prognosis models, a trend database and scenarios (Sibum 2003). These initiatives underline that the document logistics service industry is aware of the changes that technology may bring to its business.

### **RESEARCH DESIGN**

The aim of this paper is to provide insights into current discussions concerning the future of document logistics from theory and practice. The electronic substitution of paper in our future world was addressed in particular. In total, three areas have been identified where a substitution might exist in the long-term: (1) offices, (2) printed media and (3) physical mail. Analogue to these areas, the following research questions have been formulated:

- How realistic is the paperless office from today's point of view?
- Will technological innovations inevitably lead to electronic substitution of printed media?
- Will physical mail become obsolete in the future?

Both secondary and primary data analyses were conducted in order to thoroughly answer the research questions. Firstly, desk research provided valuable insights in the current discussions. Secondly, semi-structured expert interviews were conducted in order to validate previous results and to examine certain aspects in more detail. In total, ten possible interview partners were identified by purposive sampling, thus by the authors' subjective judgment. Selection criteria for suitable interview partners were expertise, job function, previous research and publications regarding the research object. Finally, five experts from the following companies/institutes agreed to participate in the research:

- Fraunhofer Office Innovation Center (OIC)
- OfficeTeam
- German Association for Postal Services, Information Technology and Telecommunications
- The Fraunhofer Center for Applied Research on Technologies for Logistics Service Industries (ATL)
- IZT - Institute for Futures Studies and Technology Assessment

Two of the interviews were face-to-face and two were by telephone due to geographical distance. One participant filled in the questionnaire himself. The four personal interviews lasted approximately 60 minutes each and were tape-recorded to better rework the data.

### **THE OFFICE OF THE FUTURE**

The office of the future has been discussed for over 30 years. Since the aforementioned article in BusinessWeek in 1975, many futurists predicted that future offices would not use paper at all. The phrase "paperless office" quickly spread as a vision of a future approaching quickly (Brown and Duguid 2002, p. 176). As yet, these predictions have not come true. However, recent technological innovations, such as wireless communication, speech technology and virtual conferencing seem to drive us towards this future. According to Paul Saffo (1992), board member of the Institute for the Future, "it will take about 30 years for the paperless future to arrive, but the process is well underway today".

He is certain that paper will never totally disappear, but may become irrelevant in business environments. Saffo (1992) compares paper and computers with horses and cars in the way that "horses are still around, but they are ridden by hobbyists, not commuters". There is no doubt that paperless offices would have significant advantages, such as reducing environmental stress. Changes towards such a future are thus highly desirable. But, with respect to prognoses in paper consumption, this vision is as much a mythical ideal today as it was thirty years ago (Sellen and Harper 2002, p. 2). In fact, offices consumed less than 100 pounds of paper per head in 1975. Today, up to 200 pounds of paper a day are consumed (Brown and Duguid 2002, p. 176). Thus, although many of the predictions assert that the use of paper will decrease, our consumption has actually increased.

According to the interviewed experts, the use of documents will primarily, but not exclusively, happen electronically in the long-term future. In many aspects of office life, electronic substitution has already taken place due to the numerous advantages of digital document handling. It is generally quicker, more flexible, and the work is not restricted to a certain location. However, the high complexity of electronic signature systems is considered the major obstacle of a fast substitution. The technology for corresponding systems is already available, but the implementation is still in its infancy. Many organizations consider these systems too complicated and expensive. These predictions are in line with other expert opinions, such as Liu and Stork, who believe that total substitution of old technology by new technology is rare. The introduction of new technologies has more frequently stimulated a synergy between old and new instead (Liu and Stork 2000, p. 94, 97). Also, people prefer to read on paper rather than on screens. Research reveals that paper use in offices doubled in the first ten years after the introduction of the PC and the total amount of information stored on paper is estimated to have increased by 36% between 1996 and 2002, primarily due to the creation of office documents (Szeto and Jimenez 2005, p. 40). The higher credibility of paper-based documents adds to peoples' reluctance to fully change to electronic means. According to experts, a truly paperless office will therefore never exist. Rather, organizations will evolve into "less paper" offices, with a long-term coexistence of paper and electronic documents where electronic and printed media complement each other. Andy Jones, a director at Xerox Global Services, claims, "Thirty years ago, paper was the definitive record of so many things that happened within business. Today, it is increasingly the case that the electronic record is the definitive copy, while paper is becoming much more a work-in-progress medium" (Condon 2006). As people become more comfortable working with electronic documents, paper will be used less often. But a preference for the tactility of paper makes many people reluctant to abandon it completely.

### **THE FUTURE OF PRINTED MEDIA**

The discussion regarding the office of the future is only one aspect of the overall debate on paperlessness. Another issue is whether printed media, such as newspapers, books and magazines, will still exist in physical form in the long-term. In fact, all experts expect technological innovations, e.g. digital paper or electronic paper (ePaper and eInk), to change patterns in media usage in the future. The technology is reusable, electrically writeable, erasable, and features many properties of traditional paper. However, as with the paperless office, experts do not agree that a full substitution of printed media will take place.

Instead, supplementation is more realistic. Nevertheless, according to the United States Statistical Abstracts, total expense for printed media is shrinking while the total expenditure on electronic media is increasing (Liu 2005, p. 705). On the other hand, production and consumption of printing and writing paper is steadily increasing. For Europe as a whole, production is expected to increase from 35.8 million MT (metric tons) in 2000 to 60.4 million MT in 2020, while consumption will double from 30.8 million MT per year to 61.8 million MT per year over the same period (UNECE/FAO 2005, p. 163). Experts believe the increase in consumption is due to people being confronted with more information in electronic form which they print out for convenience purposes. In addition, paper has proven to be better suited for in-depth reading.

A central point in the discussion of electronic substitution of media is the longevity of digital data. One expert used a NASA mission to Mars as an example. Nearly 20% of the collected information is lost due to technological obsolescence. In fact, digital documents are far more fragile than first expected. According to Rothenberg (1999, p. 2) digital information seems theoretically invulnerable due to its reproducibility, but some problems with storage media have been identified. Data may become unreadable due to rapid technological advancements. Conway (1996) clearly depicted information density and the life expectancy of various storage types in a useful graph (see Figure 1). It becomes obvious that the capacity to record information has increased exponentially over time while the longevity of the media used to store the information has decreased equivalently. However, recent innovations in storage media, such as rainbow technology, are efficient and effective. This particular type of technology allows for large amounts of data to be stored on an A4 sheet of paper or plastic by encoding it into coloured geometric shapes.

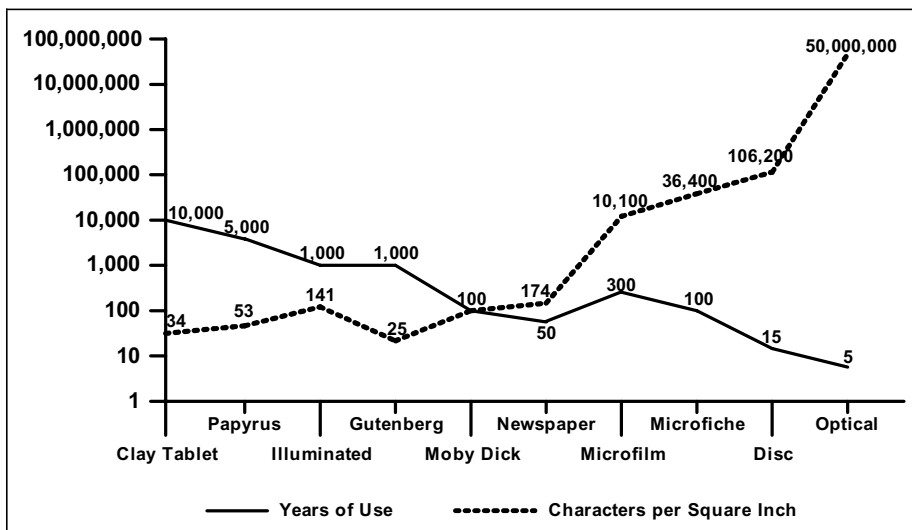


Figure 1 The dilemma of modern media – information density vs. life expectancy  
Source: Conway (1996).

Technological innovations have not driven the substitution of printed media as much as was previously expected. The interviewed experts contribute peoples' reading preferences, the properties of paper, and copyright issues as key reasons

for the situation. They propose a coexistence of printed and electronic media as most likely for the future. The form of reading a document user chooses depends on the purpose. Printed sources are particularly preferred for in-depth reading. On the other hand, specific kinds of books (e.g. encyclopaedias) would be more appropriate for electronic use. Over the next decade, the digitalisation of books and other printed sources will proceed. One of the experts interviewed added, "In the far future, a digital universal library may become reality". However, the storage dilemma of digital media will be the great challenge for the future. Sole system independency will guarantee longevity.

### **THE FUTURE OF PHYSICAL MAIL**

The Universal Postal Union (2006, p. 11) reports that more than 96 percent of the world's population is served by a postal system with a volume of more than 435 billion items annually. It is only possible to handle this volume by a global network consisting of over 660,000 post offices, employing approximately 5 million people. The technological developments of the past decades, in particular the Internet, have led to changes in the postal sector. Logistics service providers have broadened their portfolio and offer electronic as well as physical solutions. At present, physical mail is more popular than ever, but substitution may be a major concern in the future. In fact, e-mail messages already outpace physical mail by a ratio of 33 to 1 in the U.S. and 23 to 1 in Europe (Jimenez 2006, p. 2). Many people believe that e-mail will make all physical mail obsolete in the future and Internet advertising will replace all other media. For this reason, mail volume forecasting has received increased attention recently. However, it has proven to be quite complex since there are many influencing factors impacting mail volumes, including competition, consumer preferences, economics, regulations, and technological impacts.

According to the interviewed experts, there is no doubt that the paper letter will still exist in the long-term future. Their estimations of the total mail volume range from stagnation to modest growth. However, all interviewees expect significant changes to take place in future letter business. In recurring communication, e.g. bank statements, telephone and electricity invoices, volumes are likely to drop significantly and the physical letter will be substituted by online processes that are easier and less costly. Furthermore, the increased mobility of employees will lead to substitution processes. Scanning and electronic forwarding of incoming mail will be the standard procedure in the future. At present, there are still some obstacles of substitution, e.g. the acceptance of digital signatures, but these are expected to be resolved in the mid-term. Despite these changes, all interviewed experts agreed that direct marketing via mail will gain in importance and volumes will increase. However, high-value direct mailings with special colours, forms and design will partly displace low-value mailings, e.g. simple one-sheet flyers. In addition, direct mailings will become highly individualized. These estimations are in line with research conducted at Pitney Bowes. The company's strategists predict that direct marketing and customer relationship management tools, bills and statements, legal documents, and package segments will remain domains of physical mail. In contrast, areas such as business correspondence, tax returns and payments favour electronic solutions (Critelli 2005b, p. 3). Thus, it becomes clear that the choice of mail type is largely dependent on the type of service. Moreover, according to Pitney Bowes's Chief Strategy Officer, Luis Jimenez (2006, p. 2), "There are also untapped opportunities for the industry to expand mail use in



many ways, such as customer acquisition, building customer loyalty and retention, cross-selling, and low-cost package delivery for burgeoning Internet sales". Against this background, future communication may certainly be a multi-channel construct. At least for the next 20 years, physical mail and media will coexist in a multi-channel environment. As Walsh (2006, p. 26) constitutes, "Mail is not going away, but it is changing. People and businesses value the security of paper, its immediacy and accessibility, and the ability to touch, hold, share and retrieve it". Current research assumes that there will be complementarity rather than substitution. Changes are expected to be evolutionary and gradual, rather than revolutionary and sudden (Critelli 2005b, p. 3). In the long-term, technologies may push mail into niches, but it will always exist.

## **CONCLUSION**

People have speculated about the electronic substitution of paper for many years. Recent technological innovations have enlivened the discussion again. In the scope of this article, three areas have been examined where electronic substitution of paper is imaginable: offices, printed media and physical mail. Expert predictions are still rather controversial. Paper is easy to use, requires no machinery for interpretation and is trustworthy. However, it is disadvantageous in comparison to electronic media because of problems with production, resource consumption, storage and inefficient handling. Many futurists believe that a future paperless society is inevitable due to technological advancements. Others argue that new and old technology will coexist and complement each other. Surprisingly, electronic media has led to significant increases in paper consumption since people have access to much more information. In fact, 3% of most companies' revenues are spent on office printing (Craine 2006, p. 1), making it an important cost factor. Many organizations regard document logistics as a strategic task in order to cut costs, increase customer service and consequently realize competitive advantages. At present, the prosperous economic situation enables document logistics service providers to negotiate lucrative outsourcing agreements. Nevertheless, technological innovations may change the business radically. Therefore, it has become more and more imperative for the logistics service industry to invest in innovation and foresight in order to prepare for future developments.

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## **CREATING A SUSTAINABLE LEAN BUSINESS SYSTEM WITHIN A MULTI-NATIONAL GROUP COMPANY**

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### **ABSTRACT**

The lean sustainability model was developed to address the problems in sustaining the long-term benefits of lean implementation programmes. The case study, presented here, demonstrates elements of the model, in the context of a large multi-national company and focuses on the organisational and managerial aspects of a developing and sustaining a global lean supply chain.

### **INTRODUCTION**

In the current climate, the pressure is on organisations to improve their performance to be able to compete in a global marketplace and this requires being able to outperform low-cost economies. The way some organisations and supply chains are responding to this is to implement lean thinking across and within the extended enterprise (Womack and Jones, 1994). The aim for a manufacturing organisation is that by working with suppliers and customers they be able to keep the manufacturing close to the market and, as a result, are more flexible and responsive so that they can become the supplier of choice to strategic customers.

However, it has been suggested that at least 50% of business improvement programmes are deemed by the firms involved to be failures over the longer term and up to 70% fail to achieve all of their intended benefits (Hammer and Champy, 1993). This raises the question: *How can improvements in operational and commercial aspects of a manufacturing environment be combined and managed in a way that provides the business with long-term business success and the internal process and people capability to continuously propel that organisation to further improvement?*

The purpose of this research is to develop a systemic model for sustainable business improvement when implementing the principles of Lean Thinking (Womack and Jones 1996). This paper presents the findings from a study of a major international heavy engineering group of companies that has successfully implemented and sustained a lean transformation to effectively turn the company around and return substantial benefits. The findings can be used as a point of reference for academics discussing the development of holistic approaches to the subject as well as those from industry searching for a sustainable model for their own lean transformation.

The implications of this paper are that the existing business improvement literature, which focuses on the tools and techniques, has a number of gaps and weaknesses. These include, but are not limited to, a lack of focus on the leadership, organisational and managerial aspects that often impact on the success and sustainability of change. Due to the constraints on space, this paper

focuses on the development and testing of the model rather than the results of an extensive literature review. Readers will be pointed to appropriate literature and the main contributions will be summarized.

### **RELATION TO EXISTING WORK**

Lean has evolved from what was essentially a shop-floor, manufacturing focus during the 1980s to a *value system* approach that emerged in the new millennium. The value system extends the focus beyond manufacturing to service sectors and builds on the *value stream* concept, which developed during the mid-1990s. The values system takes lean beyond the single company to the whole supply chain. For a review of contemporary lean thinking see Hines *et al.* (2004).

As lean evolved it has attracted criticism. One of the key aspects of this has been the prescriptive approach and lack of contingency. The Womack and Jones's "Time Frame for the Lean Leap" (1996, p. 270) implies that there is *one best way* of implementing lean to a whole supply chain that tends to ignore that, within the chain, there are many differences: in the environment (Burns and Stalker, 1961), organisational size (Child, 1975), organisational strategy (Chandler, 1962) and technology (Woodward, 1965). Within a multi-national company, or global supply chain, there are also many cultural differences (Hofstede, 1991) to consider, and successful implementation is contingent on recognising the differences, and adapting the implementation, to suit the specific conditions of each value system. Lean has also been criticised for failing to understand the importance of human behaviours and the way that employees can be motivated to accept change (Hines *et al.*, 2004, Beale and Found, 2006). Linked to this is the lack of strategic perspective (Hines *et al.*, 2004) evident in many lean implementations.

Drew *et al.*, (2004) argue that successful lean implementation is the combined result of a well designed operating system, supported by an aligned management infrastructure and underpinned by the appropriate mindsets and behaviours of all employees. The management infrastructure in this context includes the organisational structure, management of support functions and performance indicators. Jackson and Jones (1996) refer to strategic planning, organisational structure and human resource capabilities as the three cornerstones of growth that are necessary to a lean management system. Our model, which includes strategy and alignment, leadership, process, technology and human behaviours, builds on the evolution of lean and all of the earlier work in this area.

### **RESEARCH APPROACH**

The research approach taken in this work has been based around theory development reached by analysing a range of industry cases and practical approaches available within the existing literature. The industry cases, used to test and refine the model, have been studied using a case study approach that Yin (1994) contends is appropriate for organisational and management studies and Saunders *et al.*, (2003) suggest has the potential to answer *why* as well as *what* and *how*. Within this approach a range of research techniques, including direct observation, semi-structured interviews and action based research (Hakim, 1987; Hartley, 1994), were used to capture the sequence, performance and perceptions of the change programme.

This case study examines how a large multi-national heavy engineering company with manufacturing units in UK, Sweden and Canada has responded to these pressures and realised a step change in performance to become more competitive and profitable.

### DEVELOPMENT OF THE MODEL AND ASSESSMENT TOOL

The Lean Iceberg Model of Sustainability (Figure 1), developed at Cardiff University IMRC, results from the synthesis of existing best practice from industry, consultancy and academia into a coherent model for the achievement of sustainable lean change.

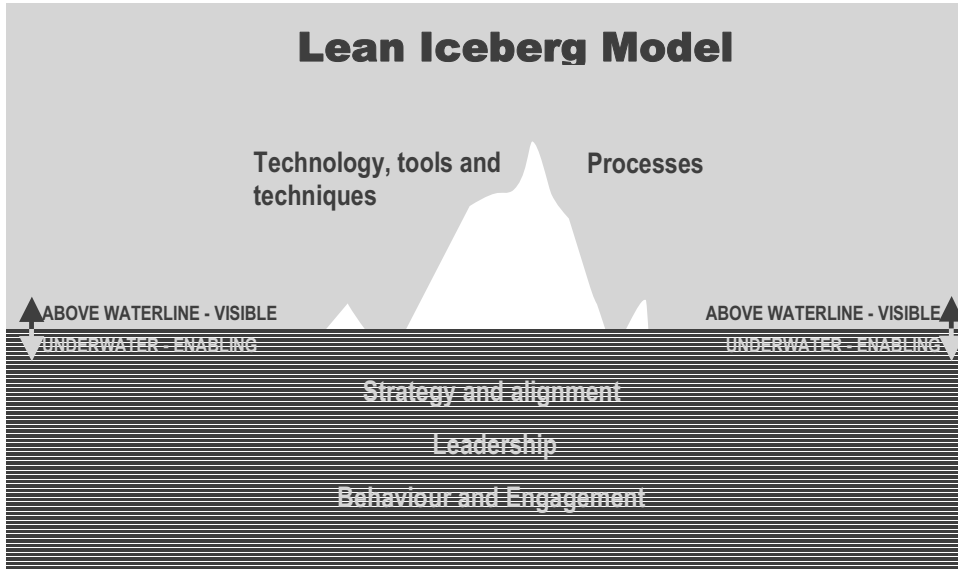


Figure 1 Lean Iceberg Model

The model is based on the theory that the visible portion of the iceberg is supported by a firm foundation that enables it to develop and that the visible part only represents about 30% of the whole. This is consistent with the Change Management Iceberg (Krüger, 2004). We believe that the foundations of a successful lean implementation are in the enabling elements of strategy and alignment, leadership and the human aspects of behaviour and engagement. However, these are often hidden from view, and it is the processes that are observed, together with the technology, tools and techniques that are used to improve them. Many organisations start with emulating the Toyota processes and applying lean tools to them to reduce waste; failing to recognise all the efforts that successful lean organisations put into the enabling features. Once deployed, the tools may not deliver all the expectations and employees regress once more to the old ways and revert to functional processes.

### CASE STUDY

The case study organisation embarked on a lean implementation in 2002 to help turnaround the organisation's financial performance and to improve competitiveness in the global marketplace. The company has three major sites that operate as semi-autonomous business units with their own management

structure, commercial and financial responsibilities. An internal supply chain exists where one of the units supplies another with some of the raw materials for further processing and conversion. To facilitate the turnaround, a new CEO was appointed. One of his first tasks was to announce that the company would start implementing lean. He engaged suitably experienced individuals at senior management levels to assist him. At the time, the factories were typical brown-field, heavy engineering plants with a high proportion of long-serving employees. The Canadian plant has subsequently relocated to a new site. A re-organisation of senior management, to support the new organisational model, was undertaken immediately, and some employees, who demonstrated a willingness to participate in the lean journey, were encouraged, and given responsibility for processes, value streams or projects. Before the lean programme started on the shop-floor, the senior management team met to define the company's critical success factors (CSFs) and to develop the strategy. Group level Key Performance Indicators (KPIs) were set and business level cockpits established to monitor progress. A comprehensive training programme was started to educate lean coaches that had been appointed at each site from volunteers across the organisation. They were given both theoretical, and hands-on, tools and techniques training. At this point, the executive board stepped back, and allowed each site to identify its own CSFs and KPIs to deliver the corporate strategy. Each site developed its own implementation roadmap that was contingent, not only on the product and process, but also on the organisational culture that reflected national differences. Although the focus of attention was mainly on the order fulfilment process, there was some early engagement with commercial departments to standardise the sales processes and to conduct a pilot activity using office 5S to reduce sales requisition through time.

This first phase of the implementation took about eighteen months and resulted in establishing lean experience within the organisation and involved, if not totally engaged, many people, which, in itself, could be seen as progress. There was also sound progression in the financial turnaround; however, the senior managers were concerned with the pace and the scope of change; some sites and areas were seemingly progressing better than others. As a result, a lean assessment was conducted and a number of issues were raised that justified these concerns.

These included a lack of consistent progress away from the shop-floor as the highest proportion of effort had been focussed there. In common with traditional businesses, customer value was perceived as merely quality, cost and delivery (QCD), and the business had not yet really captured the true voice of the customer. Another common theme across the sites was that, although KPI's had been reasonably well deployed during the first round of deployment, a second round was needed to ensure that process teams and individuals were aligned with a full "line of sight" to the business strategy.

Finally, and perhaps most significantly the coaches who had been deployed to help drive the programme had become the real leaders of lean and it was accepted that, in taking a top-down and bottom-up approach to the programme, the middle managers had been neglected. It was evident that they were not owning lean and therefore not "Living the Lean Lifestyle" which is so critical to sustainability.

As part of developing a lean order creation process, a voice of the customer survey was undertaken. The results of this, supported by the operational improvements that had been achieved, began to change the shape of the organisation. It was in a position to increase sales, utilising spare capacity in existing resources, and then looked to offer an extended product range at premium pricing. A further aspect was in the supply chain development programme, where key customers, and suppliers, participated in collaborative improvements utilising visual and technologically linked "pull systems". Some external partners approached the commercial managers for help to "lean" their own operations; resulting in strengthened relationships and further potential for sales growth. Internally, the office-based employees became more aware of their own roles in a lean enterprise and, as a result, became more involved and engaged.

The final part of this second phase paid particular attention to leadership and relied heavily on building capability around the seven lean skills (Howardell, 2004). These, were incorporated into the performance appraisal, training, development and recruitment processes. The result was that line managers and team leaders were given skills through a leadership development programme that emphasised the change in roles and responsibilities expected of the middle management community going forward.

These factors have helped to change the business, with the organisation becoming much more customer-focussed. The financial turnaround was accelerated by the exponential increase in sales that were achieved at controlled costs and the business is underpinned with the capability to "continuously improve the process of continuous improvement". The challenge now is to take the understanding and learning and to achieve similar performance benefits across selected global supply chains and to embed the changes for long-term sustainability.

### **MAJOR FINDINGS**

This case study demonstrates a maturity path that mirrors the progression through McGill and Slocum's (1993) classification of organisational learning. Stage one is the *knowing organisation* where single-loop learning takes place. This type of organisation believes that there is a best way of doing things and this can be likened to lean awareness (Hines *et al.*, 2006). At this stage the approach is reactive with little, or no, involvement and ad-hoc learning. From here the organisation progresses to an *understanding organisation* that is governed by a set of core values and management policies. The organisation has a more formal structure to implementing lean. Stage three is the *thinking organisation* where formative double-loop learning takes place (Senge, 1991). This is a pivotal stage in a lean implementation where the tools and techniques have been deployed. The approach, at this stage, is goal oriented and value stream thinking takes place. Many organisations consider that they have implemented lean but, in reality they have only tackled the visible, above the waterline, elements. A *learning organisation* would reflect at this point and take a contingency approach to actively implement the strategy and capture the voice of the customer. The focus at this point extends to the value system and encompasses other members of the supply chain. It is from here that organisations can strive to achieve much more than they knew was possible at the outset; and it is where the organisation realises true double-loop learning and management by fact. Stage four can be extended to a higher level where

lean becomes a way of life and there is full involvement by everyone in the organisation. These findings have allowed for the validation and minor modification of our existing working lean sustainability model and have contributed to the wider understanding of how to apply lean at a series of scales from individuals through to group companies.

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## SUPPLY CHAIN GOVERNANCE IN THE INTERNET AGE

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The paper provides data and insights on the nexus between the adoption of internet-based technologies to support supply chain relationships, the nature of such relationships and the coordination mechanisms at work<sup>1</sup>.

Results suggest that internet-based tools are particularly suitable to well-established relationships where the willingness of collaborating is high and common procedures are fixed.

### INTRODUCTION

"Supply chain management is the integration of key business processes from end user through original suppliers that provides products, services, and information that add value for customers" [Cooper *et al.*, 1997]. Most studies concerning the management of supply relationships underline the role of cooperation among customers and suppliers in achieving better cost, time and quality performances. In this context a relevant role is played by ICTs and, in particular, by the Internet. The Internet is considered as a communication standard used by inter-organisational information systems, such as Extranets and groupware [Ryssel *et al.*, 2004]. Brews and Tucci [2004] suggest that internetworking enhances business focalization and business scope specialization. The reorganisation enabled by the Internet could involve the whole supply chain, as it is possible to recombine players roles, reducing or increasing the steps in a supply chain. Further, internet-based systems make suppliers scouting and selection a more dynamic and easy process, thanks to communication facility

Definitively, it seems clear that internet-based technologies can affect inter-firm relationship characteristics and coordination mechanism by influencing knowledge coding, direct relationships, information sharing, mutual learning, process transparency, behavioural formalization and driving towards trust. This could bring to a real-partnership model based on common performance objectives and strategies.

The paper focuses on the impact of web-based tools on trust among supply chain partners and the use of information sharing and formalization within the relationship.

### THE GOVERNANCE OF SUPPLY CHAIN RELATIONSHIPS

Literature concerning the use of internet-based tools in SCM [García-Dastugue and Lambert, 2003; Brews and Tucci, 2004] states that the Internet influences both internal activities management and inter-firm relationships.

Internal resources are replaced by activities and functions carried out by third parties, inducing effects on inter-firm labour division and resource allocation [Boari *et al.*, 1989]. This trend implies that alternative mechanisms for transactions governance take place of traditional market spot relations [Malone *et al.*, 1987; Brews and Tucci, 2004].

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<sup>1</sup> The paper presents some results of the research "Internet and supply chain management: new organisational and managerial models" funded by Basic Research Funds of the Italian Ministry for University and Research (FIRB - MIUR 2001) and based on a survey carried out involving 1458 large firms operating in Italy with a response rate of 32% (463 firms answering).

In this context, "governance" is defined as a set of mechanisms to orient and guide inter-firm coordination. A non mechanist approach is used to link technologies to relationship features, being aware of the socio-technical nature of inter-firm relationships [Feldman and Pentland, 2003]. The main research assumption is that technology is an enabler of organisational change but it is continuously influenced by organisational decisions and choices.

In order to characterize supply chain governance, "relationship features" and "coordination mechanisms" are used as explanatory concepts. Even if it is very difficult to precisely define the boundary of these two concepts, previous studies are used to identify some of them.

The main idea is that relationships can be characterized with regards to different dimensions such as asset specificity, uncertainty and frequency [Garcia-Dastugue and Lambert, 2003], product complexity, routinization vs. flexibility [Powell, 1987, 1990, Becker, 2004], conflicts and trust [Nooteboom, 2002]. The relationship features are not alterable by the actors in a short-period and influence the relationship apart from strategic intentions of firms. On the contrary, coordination mechanisms - pricing [Bidault, *et al.*, 1998], formalization, information sharing [Dyer, 1997] and knowledge integration tools [Sethi, 2000] - can be chosen and settled by the actors.

In what follows three of the aforementioned issues - trust, formalization and information sharing among partners - are discussed.

**Trust:** Granovetter [1985] introduces relationship reputation as a basic element to set up effective relationships, where mutual trust is high and opportunistic behaviour risk is low. ICT systems and, in particular, the Internet favour information sharing and related process transparency, thus influencing mutual trust between supply partners. As to tracking and tracing activities, for example, a great amount of information used for internal management can be made available for the customer at zero costs, favouring visibility and enhancing the growth of trust among the parts.

**Formalization and standardization:** communication standards fix data transfer formats, reducing transfer times and costs but binding relationships. The use of ICTs favours repeatability and recognizability of tasks enhancing activities routinization. This allows each player to interiorize his own activities and to recognize the tasks of the other players [Becker, 2004], favouring coordination through standardization. The main consequences of routinization are better resource allocation and decision making and information processing rationalization. Routines reduce uncertainty, enhancing predictability, but can also induce some organisational inertia. Routines contain part of tacit knowledge of the organisation being able to seize operational knowledge. ICTs have an impact on this aspect of routinization as it influences know-how coding and languages sharing [Lomi, 1991].

**Information and knowledge sharing:** there is a general agreement in literature about improvements in information transferring enabled by the Internet. It is worth underlining that information and knowledge sharing is particularly critical in contexts characterized by complex activities. Free sharing of information in the network, enhancing process transparency [Colombo *et al.*, 1997], increases the degree of cooperation and the innovation level in products and services. Yet, as to inter-firm information sharing, it is not still clear whether new technologies enhance direct communication rather than new intermediation forms [Sarkar *et al.*, 1995].

## METHODOLOGY

A survey was carried out involving Italian firms having more than 50 million euros turnover: the firms, selected from MEDIOBANCA database, were 1458 and 463 answered with a 32% response rate. Questionnaires were sent to Supply Chain Manager or similar function. Data were collected May to October 2005.

This paper focuses on a specific section of the questionnaire used for the survey, analysing the relations among the use of internet-based tools to support a supply chain relationship and the governance of the relationship itself. It was asked the firm referent to focus on a single upward or downward relationship in order to have coherent answers; after the same perspective, a single product/service (or a single family of products/services) was chosen. The selected relation should be representative of the most part of the suppliers or customers with which the firm deals, in order to gather data concerning significant activities of the firm.

As some questionnaires were incomplete as to the section investigated the sample of this paper consists of 422 firms, resulting in 29% response rate.

## RESULTS

**Internet-based tools** supporting supply chain management here analysed belong to four classes: internet-based EDI, automatic data interchange systems such as XML systems and web services, Extranets integrated with internal MISs and stand-alone Extranets. Given that the four tools might be interchangeable, the total diffusion of internet-based tools for SCM is evaluated by choosing for each firm the most diffuse one<sup>2</sup>. About 54% of firms use such tools and 42% refer an intense use (rather + lot, see Table 1).

	frequency	percent	cumulative percent
not at all	160	37,9	37,9
little	50	11,8	49,7
rather	86	20,4	70,2
lot	93	22,0	92,2
total answers	389	92,2	
missing answers	33	7,8	
total	422	100,0	

Table 1 - diffusion of internet-based tools with selected partner

**Trust** is measured through the belief the firm has in opportunistic behaviour of the partner - as a proxy of mistrust (Table 2) - the declaration that the chosen relationship is collaborative and the willingness in confirming the cooperation (Table 3). The level of trust is quite high: the sample is bipartite into firms trusting "rather" and those trusting "lot" in their partners and 60% of them think the partner will hardly behave opportunistically with them.

	frequency	percent	cumulative percent
not at all	92	21,8	21,8
little	163	38,6	60,4
rather	109	25,8	86,3
lot	25	5,9	92,2
total answers	389	92,2	
missing answers	33	7,8	
total	422	100,0	

Table 2 - mistrust with selected partner: the partner would behave opportunistically

<sup>2</sup> A new variable is built from the four original ones, assigning it value 4 if any of the four tools is used "a lot", 3 if any of them is used "rather" and none is used "a lot", 2 if any of them is used "a little" and none is used "rather" or "a lot", 1 if none of them is used at all.

	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>
not at all	3	0,7	0,7	6	1,4	1,4
little	32	7,6	8,3	12	2,8	4,3
rather	254	60,2	68,5	221	52,4	56,6
lot	113	26,8	95,3	156	37,0	93,6
total answers	402	95,3		395	93,6	
missing answers	20	4,7		27	6,4	
total	422	100,0		422	100,0	

Table 3 - trust: (a) the relation is collaborative and (b) willingness in confirming the cooperation

Further, main relevant motivations in deciding to confirm the cooperation are investigated: the most quoted motivation is that they trust each other, past experience and respected contractual terms follow (Table 4).

	<i>count</i>
mutual trust among the part	161
past experience	151
kept contractual terms	147
strength and weakness known	82

Table 4 - main motivations for confirming the relationship with the selected partner<sup>3</sup>

**Formalization** is measured through the use of common standard procedures by the employees of both firms and the joint organisational structures - such as team and task forces - used by the two firms (Table 5). About 66% of firms regularly use common procedures, while joint organisational structures are established for about 38% of them. Further, about 33% of firms regularly use both common procedures and joint structures, resulting in a very high level of standardization within the selected relationship.

	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>
not at all	58	13,7	13,7	139	32,9	32,9
little	72	17,1	30,8	103	24,4	57,3
rather	162	38,4	69,2	116	27,5	84,8
lot	118	28,0	97,2	45	10,7	95,5
total answers	410	97,2		403	95,5	
missing answers	12	2,8		19	4,5	
total	422	100,0		422	100,0	

Table 5 - formalization: use of (a) common procedures (a) and (b) joint organizational structures

**Information and knowledge sharing** is measured with respect to production capacity and costs information sharing, mutual technical assistance and co-joint problem solving. Further, the lack of quality in information sharing is considered as a proxy of misinformation.

	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>
not at all	83	19,7	19,7	99	23,5	23,5
little	93	22,0	41,7	159	37,7	61,1
rather	179	42,4	84,1	110	26,1	87,2
lot	37	8,8	92,9	23	5,5	92,7
total answers	392	92,9		391	92,7	
missing answers	30	7,1		31	7,3	
total	422	100,0		422	100,0	

Table 6 - information sharing with partner on (a) assets and production capacity and (b) costs

The level of information sharing is quite high, mainly as to production capacity and assets (216 firms, equal to 51% of the sample, state they share such information "rather" or "lot") while information on costs are less shared (133

<sup>3</sup> More than one answer was allowed for each firm.

firms, 32% see Table 6). Mutual technical assistance is diffused between the firm and the selected partner (221 firms, 52%) and co-joint problem solving is very often carried out (292 firms, 69%, see Table 7). Finally, the quality of information sharing is quite good, as only 97 firms - equal to 23% of the sample - state that the partner does not give them the necessary information (Table 8).

	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>	<i>freq.</i>	<i>perc.</i>	<i>cum. perc.</i>
not at all	59	14,0	14,0	34	8,1	8,1
little	110	26,1	40,0	65	15,4	23,5
rather	195	46,2	86,3	206	48,8	72,3
lot	26	6,2	92,4	86	20,4	92,7
total answers	390	92,4		391	92,7	
missing answers	32	7,6		31	7,3	
total	422	100,0		422	100,0	

Table 7 - knowledge sharing: (a) mutual technical assistance and (b) co-joint problem solving

	<i>frequency</i>	<i>percent</i>	<i>cumulative percent</i>
not at all	94	22,3	22,3
little	197	46,7	69,0
rather	82	19,4	88,4
lot	15	3,6	91,9
total answers	388	91,9	
missing answers	34	8,1	
total	422	100,0	

Table 8 - misinformation with selected partner: bad quality of information sharing

In order to verify the **links between the use of internet-based tools and the three governance dimensions**, a correlation analysis is performed (Table 9).

	<i>kendall's tau</i>	
trust	opportunistic behaviour	-0,024
	collaborative relationship	0,103 (*)
	cooperation renewing	0,091
	strength/weakness known	0,11 (*)
	previous experience	0,055
	kept terms	0,089
	mutual trust	0,101 (*)
formalization	common standard procedures	0,1 (*)
	co-joint organisational structures	0,115 (**)
information & knowledge sharing	assets and product capability info sharing	0,121 (**)
	mutual technical assistance	0,196 (**)
	cost info sharing	0,094 (*)
	co-joint problem solving	0,125 (**)
	bad quality of information	-0,054

Table 9 - correlation of governance dimensions with the use of the Internet<sup>4</sup>

Most of the proxies used for each governance dimension investigated show statistical significance in the association with the use of the Internet.

## DISCUSSION AND CONCLUSIONS

From the results achieved some considerations can be done.

The tools here investigated are linked to the execution and automation of supply chain processes such as order cycle, billing and logistics, but also to strategic activities such as collaborative supply chain planning and control, co-joint new product development and marketing. The nature itself of such tools implies that

<sup>4</sup> Significance at (\*) 0,05 and (\*\*) 0,01 level (2-tailed).

they are more likely to be used within well-established relationships with suppliers and customers, even if they are based on open technologies and standards.

This is confirmed by the fact that, among all the governance dimensions investigated, statistical significance is found only for trust, formalization and information and knowledge sharing among supply chain partners, while the main "market" issue, i.e. price, is not relevant. The willingness of collaborating and sharing information with the partner and the degree of standardization reached within the relation characterize the most internet-based relationships.

"Richness" seems to be more relevant than "reach" in the Internet adoption strategies implemented by Italian large firms. Thus, critical issues will be data standards and systems interoperability, as confirmed by the fact that, among the four kind of tools considered, stand-alone Extranets are the least used.

Some limitations of the study will be the starting point for further research. First, the influence of context is here neglected: an industry deepening will give more insights and differences in adoption modalities can be pointed out. Second, not all the tools considered have similar features and further investigation can be addressed to how the technical differences among them can be linked to different governance dimensions. Third, some case studies will help to deeply analyse the phenomena under investigation.

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# **SUPPLY CHAIN UNCERTAINTY**





## **THE POWER OF FLEXIBILITY FOR MITIGATING SUPPLY CHAIN RISKS**

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### **ABSTRACT**

Many firms acknowledge that their supply chains are facing rare-but-severe disruption risks and routine risks (e.g., frequently-occurring problems that cause mismatches in supply and demand or higher-than-expected procurement costs), but few firms are investing in risk reduction programs. While the exact reasons for this are not known, it is conceivable that the lack of exact cost/benefit analyses can be one of the key reasons. In the absence of exact analysis to justify various risk reduction programs, firms are unwilling to invest unless there are other compelling reasons. In this paper, we examine four different types of risk mitigation strategies that call for different types of flexibility. While it is clear that flexibility can reduce the negative impacts associated with different types of risks, we show that firms can obtain most of the benefits at low levels of flexibility. The fact that a relatively low level of flexibility is often sufficient may enable managers to justify flexibility investments more readily, even if precise estimates of impacts and likelihoods of different types of risks are not available.

### **INTRODUCTION**

Despite the fact that many firms are instituting risk assessment programs to systematically uncover and estimate supply chain risks, very few firms are making concomitant investments to reduce risk. While the exact reasons for this are not known, Rice and Caniato (2004), Zsidisin et al. (2001) and Zsidisin et al. (2004) suspected that the lack of precise cost/benefit or return on investment (ROI) analyses can be one of the key reasons. To garner support for implementing certain risk reduction programs without exact analyses of certain risk reduction programs, Tang (2006) argued that risk reduction programs must provide strategic value to the firms regardless of the occurrence of major disruptions that rarely occur. Indeed, in addition to disruption risks, firms should be concerned about routine risks: frequently-occurring problems that cause mismatches in supply and demand or higher-than-expected procurement costs. Specifically, Tang (2006) highlighted the strategic value of 9 different supply chain risk reduction programs that would enable a firm to reduce these routine risks and those rare-but-severe supply disruption risks.

Risks are often measured on two dimensions – the “likelihood” of occurrence and the “impact” if the event occurs. In this paper, we focus on examining the power of flexibility for reducing the impact of certain routine supply chain risks (e.g., uncertain supply cost, uncertain supply capacity, uncertain demands, etc.). While it is clear that flexibility provides strategic value to a firm and it enhances the supply chain resiliency, it is unclear how much flexibility is needed to mitigate supply chain risk. Without a clear understanding of the value associated with different levels of flexibility, firms are reluctant to invest in risk-reducing flexibility strategies, especially when precise cost/benefit analysis is unavailable. In this paper, we present a framework for examining the value of flexibility.

Based on our analysis, it appears that firms can obtain significant value by implementing a risk reduction program that calls for a relatively low level of flexibility. Our findings highlight the power of flexibility, and provide convincing arguments for deploying flexibility to mitigate supply chain risks.

This paper is organized as follows. We first present 4 different flexibility strategies for mitigating different types of supply chain risks. Then we introduce a flexibility measure and review some stylized models that are intended to illustrate the value of flexibility. Based on our models, we show that only a small amount of flexibility is required to mitigate risk. We note that this paper is a summary of the research presented in Tang and Tomlin (2007).

### **FLEXIBILITY STRATEGIES FOR MITIGATING SUPPLY CHAIN RISKS**

We focus on four types of flexibility strategies for mitigating various types of routine supply chain risks (See Table). (For discussion of other types of risks and flexibility strategies, please see Tang and Tomlin (2007) for details.) Although these four types of strategies are listed separately, firms can implement some of these strategies jointly. Since our focus is on the value of flexibility, we do not consider the cost for implementing flexibility in our models. Clearly, one can combine the cost and the benefit associated with different levels of flexibility to determine the optimal level of flexibility. However, the determination of the optimal level of flexibility is beyond the scope of this paper.

<b>Supply Chain Risk</b>	<b>Measure of Risk</b>	<b>Flexibility Strategy</b>	<b>Measure of Flexibility</b>	<b>Underlying Mechanism</b>
<b>Supply cost risk</b>	Uncertain supplier costs	Multiple Suppliers	The number of active suppliers	Shift orders quantities across suppliers
<b>Supply commitment risk</b>	Uncertain product demand over time	Flexible Supply Contracts	The percentage of allowable changes in order quantities	Shift order quantities across time
<b>Process risk</b>	Uncertain process capacities	Flexible Manufacturing Processes	The number of products that a plant is capable of producing	Shift production quantities across plants
<b>Demand risk</b>	Uncertain end-product demands	Postponement	The time at which a generic semi-finished product is customized into end products	Shift production quantities across different products

**Flexibility Strategies for Reducing Supply Chain Risks**

### **THE POWER OF FLEXIBILITY: HOW MUCH FLEXIBILITY DO YOU NEED?**

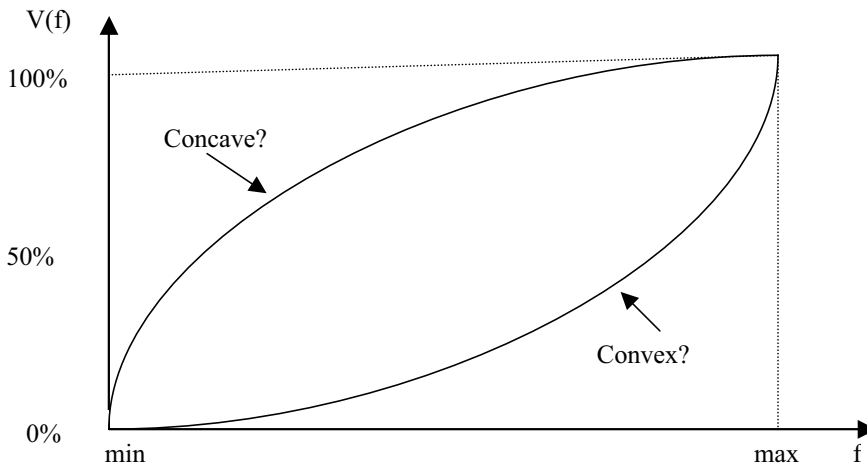
Before we examine how much flexibility is needed to mitigate supply chain risks, let us introduce a general flexibility measure that can be used for each of the flexible strategies. Let  $f$  denotes the level of flexibility for a particular flexible strategy such that a higher  $f$  refers to a more flexible supply chain. For example, in the multiple-supplier strategy,  $f$  would refer to the number of suppliers. Each of the 4 flexibility strategies has a minimum and maximum level of possible flexibility. The minimum level, denoted by  $f_{\min}$ , corresponds to a supply chain with no flexibility. For example,  $f=1$  when the firm sources from a single supplier

in the multiple-supplier strategy. Similarly,  $f_{\max}$  corresponds to a supply chain with the maximum level of flexibility theoretically possible.

Let  $P(f)$  be a performance metric for a supply chain with flexibility level  $f$ . Depending on the context, the performance metric  $P(f)$  might be measured in terms of cost or profit. For example, in the case of the multiple-supplier strategy that aims to mitigate the impact of uncertain supplier costs,  $P(f)$  might be the expected per-unit cost. We can measure the "relative value" of flexibility by using the following term:

$$V(f) = \frac{\frac{P(f) - P(f_{\min})}{P(f_{\min})}}{\frac{P(f_{\max}) - P(f_{\min})}{P(f_{\min})}} = \frac{P(f) - P(f_{\min})}{P(f_{\max}) - P(f_{\min})}$$

Notice that  $V(f)$  measures the percentage of benefit obtained by a supply chain with flexibility level  $f$  as compared to one with the maximum possible level of flexibility. Specifically,  $V(f_{\min}) = 0\%$  and  $V(f_{\max}) = 100\%$ . Given the performance metric  $V(f)$  associated with a flexibility level  $f$ , we can evaluate the impact of flexibility associated with each of the 4 flexibility strategies. The measure  $V(f)$  is increasing in  $f$  because a more flexible supply chain performs better than a less flexible supply chain. However, what is less clear is whether  $V(f)$  is concave or convex in  $f$ . (See Figure.) If  $V(f)$  is concave, then significant benefits associated with a flexibility strategy can be obtained with a low level of flexibility; i.e., when  $f$  is small. On the other hand, if  $V(f)$  is convex, then a firm needs to invest in a high level of flexibility in order to obtain significant benefit.



### The relative value of flexibility.

We now show that the flexibility measure  $V(f)$  associated with each of the 4 flexibility strategies is indeed concave. (See Tang and Tomlin (2007) for the technical details.) Therefore, firms can obtain most of the benefits at low levels of flexibility. This is of great practical importance. The higher the degree of flexibility required the more costly the investment and, therefore, the more likely it is that a precise ROI analysis will be required to justify the investment. The fact that a relatively low degree of flexibility is often sufficient may enable

managers to justify flexibility investments more readily, even if precise estimates of costs, impacts, and likelihoods are not available.

### **THE VALUE OF FLEXIBILITY VIA MULTIPLE SUPPLIERS**

Firms faced with uncertain supplier costs may choose to maintain an active set of suppliers so that, at any given time, it can place orders with those suppliers who currently offer the lowest cost. Consider the following stylized example in which a manufacturer has an unlimited number of pre-qualified suppliers with uncertain supply costs. Let the unit cost of supplier  $j=1,2,\dots, \infty$ , denoted by  $C_j$ , be \$5, \$10, or \$15 with equal probability  $1/3$ . To satisfy the demand in each period, we assume that the manufacturer always orders from the supplier who offers the lowest unit cost. In this case, the flexibility level  $f$  can be defined in terms of the number of active suppliers and the performance metric  $P(f)$  can be defined as the expected unit cost associated with sourcing from  $f$  suppliers.

Suppose that the manufacturer is committed to sourcing from one exclusive supplier, i.e., it chooses an inflexible sourcing strategy. Then the expected unit cost, denoted by  $P(f_{\min}) = P(1)$ , is given as:  $P(1) = 1/3 (5 + 10 + 15) = \$10$ . Next, consider the case in which the manufacturer can source from 2 suppliers, and so it has some flexibility. Because the manufacturer selects the supplier with a lower unit cost, the corresponding expected unit cost associated with sourcing from 2 potential suppliers, denoted by  $P(2)$ , can be expressed as  $P(2) = E(\text{Min}\{C_1, C_2\})$ , i.e., the expected value of the minimum of the two supplier costs. By enumerating all possible scenarios, it can be shown that  $P(2) = \$7.8$ . Similarly, one can show that  $P(3) = \$6.6$ ,  $P(4) = \$5.9$ ,  $P(5) = \$5.6$ , and so on. Finally, if the manufacturer sources from  $f_{\max}=\infty$  suppliers, then  $P(f_{\max}) = \$5$ . In this case, it is easy to check that  $V(2) = 44\%$ ,  $V(3) = 68\%$ ,  $V(4) = 82\%$ ,  $V(5) = 88\%$ , and that  $V(f)$  is concave. (As shown in Tang and Tomlin (2007),  $V(f)$  is concave regardless of the specific costs and probabilities used.) Notice that 44% of the benefit associated with an infinite number of suppliers can be achieved when a firm orders from just 2 suppliers. Therefore, limited flexibility is very effective at managing supply-cost risk.

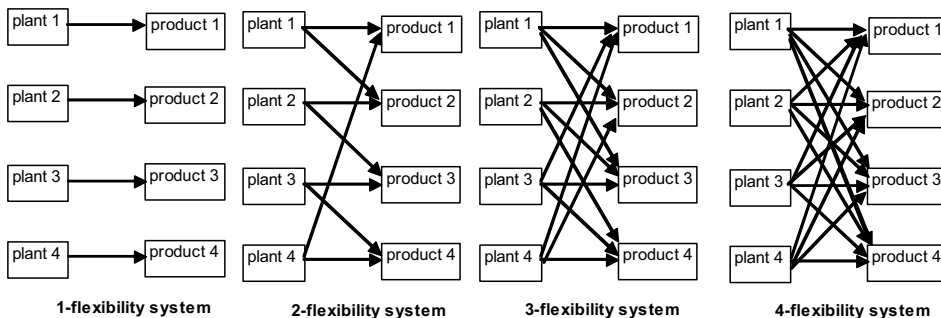
### **THE VALUE OF FLEXIBILITY VIA A FLEXIBLE SUPPLY CONTRACT**

In many supply chains, contracts with suppliers limit the ability of a manufacturer to alter a previously placed order. A contract might specify an upper bound on the percentage by which the manufacturer can revise, upwards or downwards, a previous order. In this case, the flexibility level  $f$  can be defined in terms of the percentage bound placed on quantity revisions. Consider the following stylized supply chain comprising a supplier, a manufacturer and a retailer. The supply cost is  $\$c$  per unit, the wholesale price is  $\$p$  per unit, and all unsold units have \$0 salvage value. We consider a 2-period model in which the retailer places his order only at the end of period 1. (Tsay and Lovejoy (1999) analyzed this type of supply contracts previously. However, due to the multi-period nature of their model, an analytical characterization of the value of flexibility is not feasible.) However, due to the supply lead time, the manufacturer needs to place an order with the supplier at the beginning of period 1, which occurs prior to the actual order to be placed by the retailer. At the beginning of period 1, the manufacturer estimates that the retailer will order a quantity  $D = a + \epsilon$  at the end of period 1, where  $\epsilon$  corresponds to the uncertain market condition to be realized in period 1. Based on the information about  $c$ ,  $p$ ,

and  $D$ , the manufacturer orders  $x$  units at the beginning of period 1. Under a flexible supply contract, the manufacturer is allowed to modify this order from  $x$  units to  $y$  units after receiving the actual order from the retailer at the end of period 1. Consider the case when the retailer orders  $d = a + \epsilon$  at the end of period 1, where  $\epsilon$  is the realized value of  $\epsilon$ . Under the  $f$ -flexible contract, the modified order  $y$  must satisfy:  $x(1-f) \leq y \leq x(1+f)$ , where  $f \geq 0$  represents the allowable percentage adjustment as specified in the contract. Let  $P(f)$  be the manufacturer's expected profit under the  $f$ -flexible contract based on the optimal initial order  $x^*$  and the optimal adjusted order  $y^*$ . When  $\epsilon$  is uniformly distributed, Tang and Tomlin (2007) showed that the benefit associated with the  $f$ -flexible supply contract is increasing and concave in  $f$ . Therefore, significant benefits associated with the  $f$ -flexible contract can be obtained when  $f$  is relatively small, say 5%.

### THE VALUE OF FLEXIBILITY VIA FLEXIBLE MANUFACTURING PROCESSES

Process risks, resulting from yield or quality issues for example, cause fluctuations in the effective capacity of plants. Firms that produce multiple products can mitigate this capacity variability by building plants that have the ability to produce more than one product. Consider the following stylized example in which a firm sells 4 different products (1, 2, 3, and 4), each with a demand of  $D_1 = D_2 = D_3 = D_4 = 100$  units. The firm owns 4 different plants; the capacity of each plant  $j = 1, 2, 3, 4$ , denoted by  $C_j$ , is equal to 50, 100, or 150 units with equal probability  $1/3$ . In this setting, there is no redundant capacity in the sense that the average total aggregate capacity of all 4 plants is 400 units, which is equal to the total aggregate demand of all 4 products. To illustrate the value of process flexibility, we focus on the following system configurations: a system is considered to possess " $f$ -flexibility" when each plant has the capability of producing exactly  $f$  products and when the system is configured as illustrate in the figure below, which depicts the  $f$ -flexibility system for  $f = 1, 2, 3, 4$ . When  $f = 1$ , each plant  $j$  is capable of producing product  $j$  only, where  $j = 1, 2, 3, 4$ . Hence, 1-flexibility system corresponds to the system with no flexibility, and so  $f_{\min} = 1$ . The 4-flexibility system corresponds to a system with total flexibility, and so  $f_{\max} = 4$ . (To simplify our exposition, we restrict attention to this particular type of system configurations. The reader is referred to Jordan and Graves (1995) for an in-depth analysis of a model in which different plants are capable of producing different number of products.)

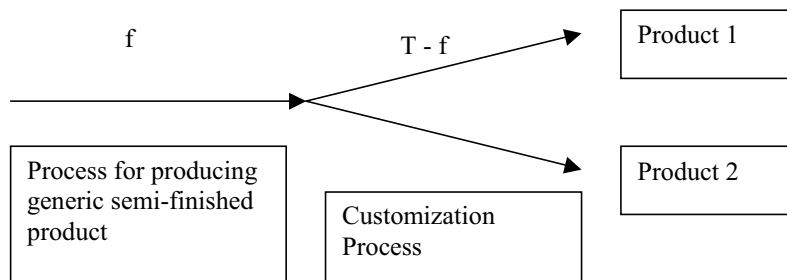


**f-flexibility manufacturing systems.**

Since each plant has 3 capacity scenarios, there are 81 possible plant-capacity scenarios for each of the f-flexibility manufacturing systems. By considering the probability of each of the 81 possible plant-capacity scenarios, Tang and Tomlin (2007) showed that the expected sales associated with the f-flexibility system, denoted by  $P(f)$ , is given as follows:  $P(1) = 333.33$ ,  $P(2) = 367.9$ ,  $P(3) = 367.9$ ,  $P(4) = 367.9$ . By noting that  $V(2) = 100\%$ , we can conclude that significant benefits associated with process flexibility can be obtained with limited flexibility, i.e., the 2-flexibility system. (See Tang and Tomlin (2007) for a more general version of managing process risks with limited process flexibility.)

### THE VALUE OF FLEXIBILITY VIA POSTPONEMENT

Postponement, or delayed differentiation, is an increasingly popular strategy for managing demand risk. By postponing the point of differentiation, a firm has increased flexibility in matching its production mix to the demand mix. It can, therefore, reduce the amount of inventory required to provide a high customer service. The following description is a simplified version of the postponement model presented in Lee and Whang (1998). A firm produces 2 end-products by using a 2-stage production process. The firm adopts an "f-postponement" strategy when it takes  $f$  time periods to produce a generic semi-finished product at the first stage and  $(T - f)$  time periods to customize these generic products into two different end-products. Since the generic product is flexible, the production process is more flexible as  $f$  increases. We note that  $f_{\min} = 0$  and  $f_{\max} = T$ . For any f-postponement strategy, define the performance metric  $P(f)$  be optimal average inventory level of the two end-products.



#### A manufacturing process associated with the f-postponement strategy

Let  $D_i(t)$  denote the demand for product  $i$  to be realized  $t$  periods in the future, where  $i = 1, 2$ . Let the demand follows a Random Walk (RW) model; i.e.,  $D_i(t) = \mu_i + \varepsilon_{i1} + \varepsilon_{i2} + \dots + \varepsilon_{i,t-1} + \varepsilon_{it}$ , where  $i = 1, 2$ ,  $t = 1, \dots, T$ , and the  $\varepsilon_{it}$  are independently and identically (i.i.d.) normally distributed random variables with mean 0 and standard deviation  $\sigma$ . Lee and Whang (1998) proved that  $V(f)$  is increasing and concave in  $f$ . Therefore, significant benefits associated with postponement can be obtained even if the point of differentiation is placed at an early stage of the production process, i.e., when  $f$  is small.

### CONCLUDING REMARKS

We have examined the benefits of different flexibility strategies in the context of supply chain risk management. By considering 4 different flexibility strategies, and reviewing the stylized models presented in Tang and Tomlin (2007), we have shown that a firm does not need to invest in a high degree of flexibility to

mitigate supply, process and demand risks; most of the benefits are obtained at low levels of flexibility. Even though we have focused our attention on "defensive" flexibility strategies, that is, strategies that mitigate the negative impact of undesirable events, it is important to realize that flexibility can also be used as an "offensive" mechanism that enables firms to compete more effectively in the marketplace. The reader is referred to Tang and Tomlin (2007) for details.

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## **THE IMPACT OF SUPPLY CHAIN UNCERTAINTY ON SUPPLY CHAIN STRATEGY, STRUCTURE, AND PERFORMANCE (SSP)**

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### **ABSTRACT**

The purpose of this paper is to empirically explore the impact of supply chain uncertainty on strategy, structure and performance. Increasingly from time-to-time supply chains are vulnerable to various kinds of unpredictable disruptions which cause huge uncertainties to supply chains. These uncertainties are at times natural e.g., tsunami, hurricanes, volcanic disruptions, or earthquakes and at times man-made e.g., terrorism, strikes. Unfortunately, despite these threats of various types of uncertainties so far there were no systematic studies carried out to understand the impact of supply chain uncertainty on supply chain strategy, structure and performance. Hence, the current study will contribute by addressing that gap in the extant literature.

### **INTRODUCTION**

The relationship between supply chain strategy, structure, and performance was proved to be significant based on the studies; especially from Chandler (1962) and Bowersox et al. (1999) work. Hence, firms' performance significantly impacted by the alignment between the strategy and structure as it is considered a baseline requirement for the operational performance. Therefore, current study aims to investigate and study the effects of relationship between strategy and structure leading to their impact on operational performance. In line with extant literature current study addresses the research question: "Does fit between supply chain strategy and structure lead to the greater level of Operational Performance?"

### **LITERATURE REVIEW**

#### **Supply Chain Uncertainty**

Supply chain uncertainty refers to, decision making for situations in the supply chain in which the decision maker does not know definitely what to decide due to the uncertainty of outcome, lacks information about supply chain or its environment; lack of information processing capabilities; inability to accurately predict the impact of possible control action on supply chain behavior; or, lacks effective control mechanisms (Van der Vorst and Beulens 2002). Sources of supply chain uncertainty are: Demand Uncertainty and Supply Uncertainty.

#### **Supply Chain Strategies**

Supply Chain Strategy refers to, coordination and commitment of multiple firms to implement company strategic objectives. It utilizes inter-firm coordination as the capability that facilitates achievement of objectives (Christopher and Ryals 1999). According to Lee (2002), supply chain strategies can be classified into four types: 1. *efficient supply chain*, 2. *risk-hedging supply chain*, 3. *responsive supply chain* and 4. *Agile supply chain*.

## Supply Chain Structure

Supply chain structure refers to, the integration, both within the firm and across supply chain members is a central theme required for effective coordination of activities across multiple firms, entailing the common use of materials and systems to create timely, high quality product and information flow that drive enhanced performance. Thus, supply chain structure implies the integration of the organization governing the network of supply chain members and the links between members through which the enterprise is administered (Lambert, et al. 1998).

According to Bowersox, et al. (1999) found integrated structural elements have direct impact on the operational performance and could create the sustainable competitive advantage for the firms, which lead to four types of operational performance. They are: 1. *Supply Chain Relationship*, 2. *Technology and Planning Integration*, 3. *Measurement System*, and 4. *Integrated Operations*.

## Operational Performance

Operational performance refers to; the performance that deals with the time required delivering a customer's order. Operational performance classified into: speed and flexibility (Bowersox, et al. 2002). *Speed* is the elapsed time from when a customer establishes a need to order until the product is delivered and is ready for customer use. And, *flexibility* is the ability to accommodate unusual or unexpected customer requests. Therefore, the improvement and assessment of operational performance is important because it will enhance efficiency across supply chain.

## RESEARCH FRAMEWORK AND HYPOTHESES

Lee (2002) expanded Fisher's (1994) work to include not only demand uncertainty but also supply uncertainty. Lee's model identified four types of supply chain strategies called: efficient supply chain, responsive supply chain, risk hedging supply chain and agile supply chain. A match between 'low' demand and supply uncertainty leads to an 'efficient supply chain'. A match between 'low' demand and 'high' supply uncertainty leads to a 'risk-hedging supply chain'. The match between 'high' demand uncertainty and 'low' supply uncertainty leads to 'responsive supply chain'. Hence, the first focus of this research is to answer, does Supply Chain Uncertainty impact Supply Chain Strategy? This has been tested by the following hypothesis:

**H<sub>1</sub>:** *Firms with the different levels of supply chain uncertainty emphasise different types of supply chain strategies.*

Watts, et al. (1992) claimed that buyer-seller relationships need to be consistent with the deployed strategies. The second research focus proposes that under different supply chain environments taking into account supply and demand uncertainty, firms emphasize different types of supply chain relationship. Relationship integration requires willingness on the part of supply chain partners to create structure that encourages cross-organizational behavioral (Bowersox, et al. (1999). Hence, the next research question: Does the Supply Chain Strategies are associated with supply chain relationship? This has been tested by the following hypothesis:

**H<sub>2</sub>:** *A firm that adopts a supply chain strategy will demonstrate a high level of supply chain relationship.*

Technology integration is the coordination of systems and relevant data (Choy et al. 2003). Systems coordination entails the capability to exchange information

with internal and external firm supply chain members in a timely, responsive, and usable format. Hence, the next research question: Does the Supply Chain Strategies lead to development of Technology and Planning Integration? This has been tested by the following hypothesis:

**H<sub>3</sub>:** *A firm that adopts a supply chain strategy will demonstrate a high level of Technology and Planning Integration across supply chain entities.*

Structural measurement systems represent another key structural element of coordinated logistical operations. Integrated measurement systems form the basis for calibrating the many parts of the supply chain by providing timely feedback on strategic initiatives so that management can take corrective action to ensure that goals and objectives are met (The Global Logistics Research Team at Michigan State University 1995). Hence, the third research question: Does the Supply Chain Strategies lead to development of Measurement System? This has been tested by the following hypothesis:

**H<sub>4</sub>:** *A firm that adopts a supply chain strategy will demonstrate a high level of development of measurement systems across supply chain entities.*

Integrated internal operation is achieved by linking operations into a seamless, synchronized operational flow, encouraging front-line managers and employees to use their own discretion, within policy guidelines, to make timely decisions. Having strong information and measurement systems in place facilitate the initiatives that drive integrated operations (Bowersox, et al. 2002; Stank, et al. 2001). Hence, the fourth research question: Does the Supply Chain Strategies lead to development of Organizational Structure? This has been tested by the following hypothesis:

**H<sub>5</sub>:** *A firm that adopts a supply chain strategy will demonstrate a high level of development of organizational structure.*

SSP portrays performance as resulting outcome of the fit of structure to the chosen strategy. This fit ultimately drives adjustments to goals and strategies. Performance, therefore, is the measurable outcome of strategy execution and structural implementation. Hence, the next research question: Do the types of Supply Chain Structure impact on Firm's Performance? This has been tested by the following hypotheses:

**H<sub>6</sub>:** *A firm that adopts supply chain relationship structure will demonstrate a high level of operational performance.*

**H<sub>7</sub>:** *A firm that adopts technology and planning integration structure will demonstrate a high level of operational performance.*

**H<sub>8</sub>:** *A firm that adopts measurement system structure will demonstrate a high level of operational performance.*

**H<sub>9</sub>:** *A firm that adopts organizational structure will demonstrate a high level of operational performance.*

According to Lee (2002), Technology involvement, i.e. internet and connection can help to regain control of supply chain efficiency in reduction of both demand and supply uncertainties. Developing technology framework for sharing of information and tight collaboration can help to control supply chain efficiency. Hence, the final research question: Does the Supply Chain Uncertainties impact on the Technology and Planning Integration? This has been tested by the following hypothesis:

**H<sub>10</sub>:** *A firm that adopts the higher level of supply chain uncertainty reduction will demonstrate the higher level of technology and planning integration structure.*

In the next section, the research methodology is discussed. In addition, the

constructs utilized in this study are further explained. Lastly, the key respondents utilized in the study are determined.

## **RESEARCH METHODOLOGY**

Consumer Packaged Goods Industry has been selected as the target industry for analysis. Due to an increasing number of precuts offered from manufacturers at retail stores and the narrow retail margins are making it more and more difficult for retailers in the consumer goods industry to manage their operations effectively. For this reason, firms in these industries are selected as the population base of this study. Thus, the supervisors to managers for each selected firm will be selected.

Based on the recommendation of Hair et al. (1998), the sample size is determined for Structural Equation Modeling should have a minimum of 15 to 20 samples for each parameter. Hence, the sample size will be 23 parameters\*15 samples per parameter = 345 samples.

### **Research Instrument and Survey Design**

The survey instrument was adopted from the initially designed questionnaire based on previous studies. The questionnaire was designed in English and was revised after the pre-test has been done with 30 respondents. It was then translated into Thai through back translation process. Respondents were asked to indicate agreement with statements related to the relationship between strategy and structure based on a five-point scale where 1 = Strongly Disagree and 5 = Strongly Agree for some of the predictors and also "Extremely High" and "Extremely Low" were also used; and for operational performance "Very Low Performance" and "Very High Performance" were used. Item purification of the original measurement items was conducted through a qualitative assessment of nomological validity, that is, the scale expresses the relationships shown to exist based upon previous research (Hair et al. 1998). This was followed by quantitative analysis consisting of correlation analysis, reliability evaluation (using item-to-total correlations as well as Cronbach's alpha), and principal component and confirmatory factor analysis. The implications of the findings will be discussed in the next section.

## **FINDINGS**

The survey responses were obtained from the multinational firms within Consumer Packaged Goods industry in Thailand. The key informants included: supervisors to managers, who are typically the decision makers of their firms on supply chain functions including: marketing, logistics, supply chain, and finance. A total of 307 questionnaires were sent out, and only 155 completed surveys were returned, of which 146 surveys were usable. The overall response rate was 47.56%.

### **Reliability Assessment**

Cronbach Alpha tests were performed on the eleven constructs and the full model (see Table 1). Cronbach's  $\alpha$  range from 0 to 1 with  $\alpha$  - values greater than 0.70 is considered acceptable (Nunnally and Bernstein 1994). All the latent constructs achieved acceptable range of reliability. Latent variables and their associated reliability are: Supply Chain Uncertainty (*Cronbach's Alpha=0.74*) Demand Uncertainty (*Alpha=0.80*), Supply Uncertainty (*Alpha=0.86*), Supply Chain Strategies (*Cronbach's Alpha=0.79*) [*Efficient Supply chain (Alpha = 0.71)*,

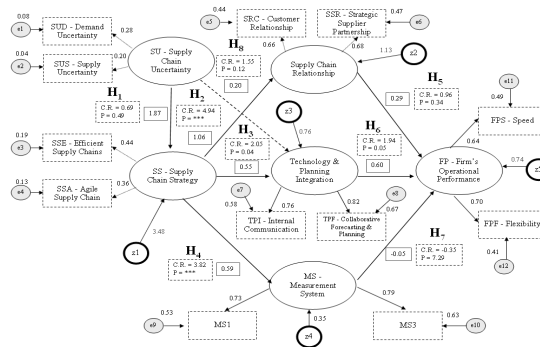
*Agile Supply Chain* (Alpha = 0.83)]. Supply Chain Relationship (Cronbach's Alpha=0.84) [*Customer Relationship* (Alpha = 0.78), *Strategic Supplier Partnership* (Alpha = 0.85)]. Technology and Planning Integration (Cronbach's Alpha=0.91) [*Internal Communication* (Alpha=0.85), *Collaborative Forecasting and Planning* (Alpha = 0.91), *Measurement System* (Alpha= 0.73)]. Firm's Operational Performance (Cronbach's Alpha=0.81) [*Speed* (Alpha = 0.77), *Flexibility* (Alpha = 0.78)]

**Analysis of Measurement Model (Confirmatory Factor Analysis)**

Confirmatory factor analyses (CFA) were conducted to address the validity, reliability, and unidimensionality of the constructs in the study (Anderson and Gerbing, 1988).

**Analysis of Structural Model**

Structural equation modeling approach was applied to test the proposed hypotheses using AMOS 6.0. The structural model is presented in Figure 1 along with the parameters estimates and fit statistics.



**FIGURE 1: STRUCTURAL MODEL**

The fitness indices in the table below suggesting the model fits the sample data well.

**TABLE 2: SUMMARY OF FIT INDICES IN STRUCTURAL MODEL**

Fit Measures	Recommended threshold values	Construct
		SSP
$\chi^2 / df$	$\leq 3.00$ Chau (1997)	1.97
RMSEA	$\leq 0.10$ Chau (1997)	0.08
RMR	$\leq 0.03$ Bentler and Chou (1987), Bollen (1989)	0.03
GFI	$\geq 0.90$ Byrne (1998)	0.91
NFI	$\geq 0.90$ Byrne (1998)	0.84
CFI	$\geq 0.90$ Byrne (1998)	0.91
IFI	$\geq 0.90$ Byrne (1998)	0.91

**Hypotheses Testing**

To test the hypothesized relationship between supply chain uncertainty, supply chain strategy, supply chain structure, and firm's operational performance, the researcher used the estimates of the path coefficients, i.e. Critical Ratio (C.R)

and Probability (P-Value), as shown in Figure 1. Based on the results (shown in Figure 1), a summation is shown below in Table 3, followed by explanation:

**TABLE 3: SUMMARY OF HYPOTHESES RESULTS**

Hypotheses		Estimated Regression Weight	Standard Error	Critical Ratio	P-Value	Result
H1	Supply Chain Uncertainty → Supply Chain Strategy	4.447	6.449	0.69	0.49	Not Support
H2	Supply Chain Strategy → Supply Chain Relationship	1.670	0.338	4.94	***	Support at P<.001
H3	Supply Chain Strategy → Technology and Planning Integration	1.216	0.594	2.05	0.04	Support at P<.05
H4	Supply Chain Strategy → Measurement System	1.144	0.300	3.82	***	Support at P<.001
H5	Supply Chain Relationship → Firms Operational Performance	0.200	0.209	0.96	0.34	Not Support
H6	Technology and Planning Integration → Firms Operational Performance	0.293	0.151	1.94	0.05	Support at P<.05 (marginally supported)
H7	Measurement System → Firms Operational Performance	(0.026)	0.075	-0.35	7.39	Not Support
H8	Supply Chain Uncertainty → Technology and Planning Integration	1.073	0.695	1.55	0.12	Not Support

## IMPLICATIONS

### Theoretical Implications

This research validated and provides empirical support for the studies on SSP paradigm in supply chain context by Stank and Defee (2005) and Rodrigues, Stank, and Lynch (2004). Based on the findings, it can be inferred that supply chain strategy can stimulate the well established supply chain structures.

### Managerial Implications

The findings of the research will have several meaningful implications for managers in the marketplace. Practitioners may utilize this knowledge to as the guideline to ensure that 'strategic fit' between firm and supply chain partners is created, and to support the improvement of decision-making to ensure the right strategic approach to customer and supplier to best influence firm's operational performance. Specifically, they support the importance of well collaborative working and knowing the supply chain partners. Therefore, managers should ensure the right alignment and strategic 'fit' to enhance the greater level of firm's operational performance; especially when considering the new supply chain members. The researcher also highlighted the importance of adopting the higher level of technology in the company; it will certainly support the company to cope with supply chain uncertainties, though there's no direct support found in this study. Relationship is highlighted for the selected industry of which the relationship is very important in achieving the shared goals. It also highlights the well structuring of measurement system will create the right alignment across supply chain entities to achieve business objectives and goals.

## LIMITATIONS AND DIRECTIONS FOR FUTURE RESEARCH

There are several limitations of this study, which may be overcome by incorporating some of the issues in future, research on SSP: First, the empirical model needs to be tested across other industries to verify the stability of the findings. Second, sample size of the study was not large enough, which may be an issue for future study with longitudinal data. Third, since the empirical data were provided by single informants, the existence of possible biases cannot be discounted. Fourth, the majority of the samples were collected within Thailand. Hence, the findings are indicative of the global consumer goods supply chain only but not representative. Fifth, initially the relationship between supply chain uncertainty and supply chain strategy in the current model was insignificant. The researcher would suggest that the future research should investigate other factors that might have a better impact on supply chain strategy. Sixth, the modification of current model needs to be examined in order to clarify the 'fit' between strategy and structure enhanced firm's operational performance as the present results showed the indirect relationship that was opposed to the prior study of Rodrigues, et al. (2004), except technology and planning integration which marginally supported. Finally, the certain structures to reduce supply chain uncertainties need to be revealed. Finally, research on how SSP model fit across different industries or across different strategies and structures that might enhance firm's operational performance across global supply chains may offer another fruitful avenue for future studies.

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## **AUTONOMOUS COOPERATION – A CAPABLE WAY TO COPE WITH EXTERNAL RISKS IN INTERNATIONAL SUPPLY NETWORKS?\***

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### **ABSTRACT**

This paper intends to show possible contributions of the concept of autonomous cooperation (AC) to enable logistics management of International Supply Networks (ISN) to improve dealing with external risks caused by environmental complexity and dynamics. The concept of AC as one possible approach to cope with external risks of ISN will be analysed either from a theoretical and an empirical point of view.

### **IDENTIFICATION OF MANAGEMENT PROBLEMS IN ISN**

In the course of globalization, a trend towards the development of ISN can be recognized. This trend can be detected by the tendency of different supply chains to interlink themselves (Hülsmann and Grapp 2005, p. 244) and is associated with the phenomenon of "hyper-linking". For organizations, hyper-linking connotes that they are interlinked not only with their direct business partners but as well indirectly with other logistic actors (Tapscott 1999) (e.g. its logistic service providers). From the perspective of strategic management, these multiple linkages represent the relevant environment of an organization (e.g. ISN) (Welge and Al-Laham 2003, p. 189). However, besides positive effects of cooperation in ISN (e.g. providing/exchanging logistic services) the relevant environment of ISN additionally holds negative effects such as potential external risks (e.g. non-predictable increasing quantity of logistic process data). Such external risks result from the characteristic complexity and dynamics of ISN induced by the cited phenomenon of hyper-linking. Its complexity originates from the large amount of involved organizations and relations between these organizations. Dynamics is caused by changes in involved organizations and relationships between organizations (Hülsmann and Wycisk 2005, pp. 4-5). Increasing complexity and dynamics simultaneously enlarge the amount of external risks ISN-Management is confronted with. Risk in an entrepreneurial view can be described as the impossibility to forecast the repercussions of decisions and the inherited uncertainty of future developments (e.g. order situation). The impossibility to forecast future developments results from a lack of information that is necessary to undertake a secure decision-making (Rosenkranz and Missler-Behr 2005, p. 20). Furthermore, it is difficult to manage external risks because of their volatility (e.g. fast changes of supplier-relationships and therefore permanently altering relevant

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environments). Volatility in an economic perspective is the fluctuation of an indicator around its trend or average value (Bruns and Meyer-Bullerdiek 2003).

It can be concluded that ISN-Management has to face uncertainty regarding its decision-making because it has to process an increasing quantity of fluctuating information in its logistic processes (Hülsmann and Grapp 2005, p. 244). If the capacity of ISN-Management to process information is not sufficient to cope with all relevant information, problems in decision-making might occur (e.g. ineffective or inefficient management solutions). The informational basis for decision-making deteriorates with a rising amount of complexity and dynamics if the capacity of the system to handle information does not increase (Hülsmann and Wycisk 2005, pp. 4-9). This means, for every single logistic actor embedded in ISN, external risks connote challenges they have to cope with for ensuring their (logistic) goal achievement (e.g. right quantity, quality, time, space, costs) (Mikus 2003, p. 48). Finally, this signifies the necessity for ISN-Management to deal with external risks that result from complexity and dynamics. Is there a capable way to deal with external risks? The main research question of this paper is to answer if and how far a management approach (e.g. AC) could contribute to cope with external risks of ISN. Firstly, it will be analysed if and how far AC might contribute to cope with the identified problems of ISN. The concept of AC will be introduced and its characteristics will be applied to the ISN-context (**Aim no. 1**). Secondly, it will be evaluated empirically which method of AC is able to cope with external risks in ISN. A simulation and measurement model will be used to simulate the impacts of different methods of AC on the management of external risks in ISN (**Aim no. 2**).

### **MANAGING EXTERNAL RISKS OF ISN BY AUTONOMOUS COOPERATION**

One approach that has been discussed in the context of managing complexity and dynamics -here understood as causes for external risks- is the concept of AC (Hülsmann et. al. 2006). AC is based on the concept of self-organization which has its scientific roots in multiple fields of research (e.g. biology, physics, and chemistry). It belongs to the academic field of complexity science (Hülsmann and Wycisk 2005). AC aims at explaining how complex systems create ordered structures autonomously (Hülsmann and Wycisk 2005). According to Windt and Hülsmann AC "describes processes of decentralized decision-making in heterarchical structures. It presumes interacting elements in non-deterministic systems, which possess the capability and possibility to render decisions independently. The objective of Autonomous Control is the achievement of increased robustness and positive emergence of the total system due to distributed and flexible coping with dynamics and complexity (Windt and Hülsmann 2007, p. 8). According to this general understanding the main characteristic attributes of AC are decentralized decision-making, autonomy, interaction, heterarchy and non-determinism (Windt and Hülsmann 2007, pp. 8-10). The impacts of these attributes on logistics management of ISN shall be outlined in the following.

In the context of AC **decentralized decision-making** connotes the delegation of decision power from a centralized entity to individual elements of the system (e.g. packages, industrial trucks) (Windt and Hülsmann 2007, pp. 8-9). From an ISN-perspective, more elements that are enabled to undertake decision-making signify an increasing decision-making capacity because they contribute to the organization's decision-making capability. For ISN-Management this implies that the thread of external risks could be reduced, because the total ability to manage external risks increases. **Autonomy** is the result of processes of decentralization

and delegation (Kappler 1992). It connotes that an element is responsible for its own system design, development and direction (Probst 1987). For logistics management of ISN autonomy implies that a suitable degree of autonomy can enable the system to develop itself and therefore develop suitable structures for given and for changing situations. This emergent behaviour may lead to structures that are superior in processing complexity and dynamics and therefore reduce external risks (e.g. new channels of informational exchange). **Interaction** in systems that cooperate autonomously is assumed if the elements are able to communicate directly with each other and therefore are able to exchange information that is needed for decision-making of the individual elements (Windt and Hülsmann 2007, p. 9). Interaction of the elements (e.g. either persons, logistic actors or AC-technologies) in ISN might imply a more target-oriented exchange of information. Because the single elements (e.g. RFID tags) might be -e.g. from a technical point of view- capable to absorb and process information they need for an upcoming decision. Therefore the overall amount of information an organization has to process might be reduced because only the needed portion of information is exchanged. This reduced amount and the more target-oriented exchange of information may reduce the uncertainty in decision-making and therefore the problems if external risks in ISN occur. A **heterarchic** system is a system that does not feature a permanently dominant control entity. The system can be characterized by growing interdependencies between single elements and a central logistic co-ordination entity (Windt and Hülsmann 2007, p. 9). For logistic management heterarchic structures imply that the structure of the organization itself might become more complex and dynamic due to more elements that have to be taken into account. This might lead to redundancy of decisions different elements undertake, but it might also enlarge the capacity of decision-making. Therefore heterarchy in general might lead to more internal complexity and dynamics but in turn might enlarge the capacity to handle external risks. **Non-determinism** is a further AC-characteristic. Non-determinism implies that the behaviour of a system can not be predicted over a longer period of time (Fläming 1998). With the characteristic of non-determinism, AC aims at higher efficiency for dealing with complexity and uncertainty within processes (Windt and Hülsmann 2007, p. 10). For the management of ISN non-determinism might imply that the processing of information and therefore processes can be handled more flexible. It enables the system to react to changes in the structure of ISN and the resulting problems. Accordingly, non-determinism might increase the ability of logistics management of ISN to cope with external risks, especially risks that result from dynamics (e.g. changing of supplier-relationships). Generally, implementing AC-technologies or concepts in ISN might advance the ability to cope with an increasing quantity of information, because it might enlarge its ability to process information. In turn, this might lead to an improved decision-making and reduced uncertainty. Therefore, AC seems to be able to improve the ability of logistics management to deal with external risks of ISN.

### **EMPIRICAL ANALYSIS OF EXTERNAL RISKS OF ISN**

To measure the effects of AC on a systems ability to cope with complexity and dynamics a simulation and measurement system has been developed (Hülsmann et. al. 2006). A similar approach will be used to simulate the impact of AC in ISN. Figure 1 shows the developed simulation model of an ISN in order to show different levels of complexity and dynamics. The complexity can be varied by different

numbers of processing units within the ISN and different numbers of sources (e.g. for information, resources and orders) as shown before complexity and dynamics of an ISN may represent external risks for logistics management in ISN. In this scenario, AC is implemented by autonomous orders that render decisions about their processing autonomously. The orders enter the system at the sources. Each order has a specific processing plan i.e. a list of processing steps that have to be undertaken to produce goods or services. The finalised goods or services leave the system at the drain. Depending on different autonomous control methods (Queue length estimator, Pheromone method and Due Date method), the overall system shows altered behaviour and dynamics. The first AC method called Queue Length Estimator compares the actual buffer level at all parallel processing units that are able to perform the next production steps, i.e. the direct successor referring to the production plan (Scholz-Reiter et al. 2006). The second method, the Pheromone method, is inspired by the behaviour of foraging ants that leave a pheromone trail on their way to the food. Following ants use the pheromone trail with the highest concentration of pheromone to find the shortest path to the food. In the simulation this behaviour is imitated in a way that whenever a part leaves a processing unit the part leaves information about the duration of processing and waiting time at the respective processing unit. The following parts use the data stored at the machine to render the decision about the next production step (Scholz-Reiter et al. 2006). The due date method is a two-step method. When the parts leave a processing unit they use the queue length estimator to choose the subsequent processing unit with the lowest buffer level. The second step is performed by the processing units. The due dates of the parts within the buffer are compared and the part with the most urgent due date is chosen to be the next product to be processed (Scholz-Reiter et al. 2007).

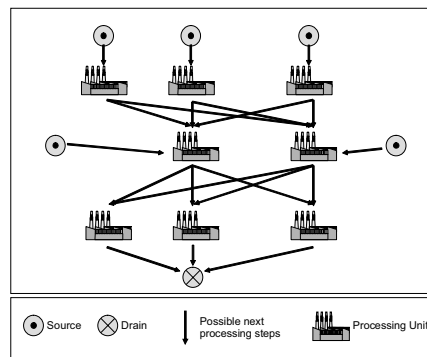


Fig. 1. Simulation Model of an ISN.

The following simulation analyses the overall systems ability to cope with rising structural complexity and rising dynamics using different autonomous control methods. At each source the arrival rate of the orders is set as a periodically fluctuating function. Therefore, the external risks rise with increasing complexity of the ISN. The logistical goal achievement is measured using the key figure throughput time for different levels of complexity and different AC methods. Figure 2 shows the results i.e. the mean throughput times for the three different autonomous control methods in dependence of the systems complexity and the minimal throughput time. The systems complexity is increased by enlarging the amount of processing units as well as the number of sources. It has been found that the Due Date method and the Queue Length Estimator show almost the same

results. The Due Date method shows a slightly worse performance because of sequence reordering, while the Pheromone method shows inferior goal achievement. The first two curves are almost parallel to the minimal throughput time. This means that a constant logistical goal achievement is accomplished all through rising complexity and rising dynamics. Therefore it seems that an organization might be able to deal with increasing external risks by using AC methods. The pheromone method shows an inferior behaviour. In this scenario, the dynamics is too high and the boundary conditions change faster than the pheromones are updated.

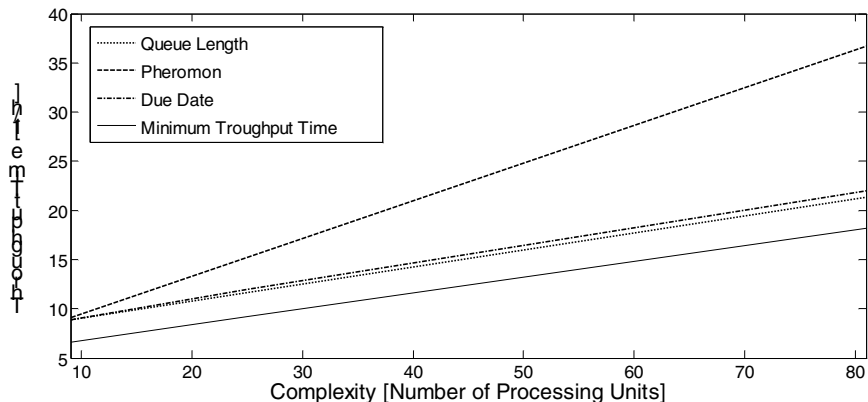


Fig. 2. Logistical goal achievement for different organisational level of complexity and multiple autonomous control methods.

It has been shown that for this kind of scenario, representing rising levels of external risks, the queue length estimator is an appropriate autonomous control method and represents the adequate degree of AC. Because of high dynamics, the pheromone method has not been able to adapt to the changing boundary conditions. The empirical findings imply that a suitable degree of AC might enable logistics management in ISN to handle external risks and therefore ensure logistical goal achievement.

## CONCLUSION & FUTURE RESEARCH TASKS

On the one hand, it has been outlined that AC might enable logistics management of ISN to cope with external risks by enlarging the capacity to process information. Especially interaction and communication activities among ISN-actors in logistic processes might be optimized (e.g. information accessible when needed for achieving a specific logistical goal) and correspondingly possible external risks could be anticipated early enough (e.g. adequate package of data is available). Further research should focus on setting up a consistent system of hypotheses regarding the management of risks in ISN through AC. Moreover, this has to be reflected and considered for an optimization of existing AC-measurement concepts (Hülsmann and Grapp 2006). On the other hand, the empirical findings have shown that a suitable degree of AC can enable an organization to deal with external risks in ISN. However, future research needs a more detailed analysis of the impacts of AC on the handling of risks in ISN. For example, empirically other degrees and therefore other methods of AC should be analysed.

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## **ASPECTS OF RISK REDUCTION CONCERNING FORECAST DATA IN CUSTOMER-SUPPLIER RELATIONSHIPS**

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### **ABSTRACT**

In supply chains, customers usually provide information about their required materials to their suppliers. But what forecast data should a customer report to his suppliers when the future demand of his outlet isn't exactly known? Without any restrictions, the customer will report those forecast data that correspond to the possible maximum demand of his outlet to keep flexibility. This information won't be useful to the supplier. Therefore, the customer usually is obliged to purchase, within certain limitation periods, that quantity of parts he reported. Otherwise he has to do an adjustment payment. This paper will analyse what forecast data the customer should report, which quantity the supplier should take into consideration in light of the customer's intentions and what release order quantity the customer should realise having previously reported the forecast data.

### **INTRODUCTION**

Supply networks are "loose" conjunctions of legally independent enterprises linked by the relationships between customers and suppliers. (cf. Cooper/Ellram 1993, p. 13 et sqq.; Brueckner et al. 2005, p. 316; Harrison 2005, p. 4) The aim of those networks is to improve the material flow in the value chain and to achieve synergetic effects by coordinated activities. (cf. McGovern/Hicks/Earl 1999, p. 152 et sqq.) This can be done by systematically sharing data and by a closer cooperation of the network participants in order to eliminate information asymmetries and uncertainties. (cf. Fiala 2005, p. 419; Simon 1989, p. 457 et sqq.; Zäpfel/Piekarz 1996, p. 21) Such an activity consists in providing forecast data to the suppliers concerning the estimated quantity of materials that is required within the following periods. (cf. Grünewald 1991, p. 218 et sqq.)

The following analysis bases on a simple network structure with two enterprises, a supplier S and a customer C, the latter of which has to face uncertainties in his outlet. S delivers one product to C. The sales forecast of C's outlet is one parameter of his production plan. From this, he quantifies the future release orders of the preliminary product. He reports these forecast data to the supplier, who uses them to plan his production and supply activities. (cf. Lackes 1998, p. 293 et sqq.) The forecast covers a planning horizon T, separated in subperiods 1, 2, ..., T. In line with revolving planning, C's sales forecast, which is getting more precise in shorter forecasting horizons, may cause modifications in the corresponding forecast data for specific periods in the later planning. (cf. Zäpfel/Piekarz 1996, p. 22) For simplicity we assume w.l.o.g. that the (possibly accumulated) production coefficient between the preliminary product and C's end product is 1.



Within the planning horizon, there are two concerted points in time  $T_M$  and  $T_P$  with  $1 \leq T_P < T_M \leq T$ , where modifications to forecast data are limited and cause adjustment payments. Typically these are the point of go-ahead for purchase of input materials  $T_M$  and the point of production go-ahead  $T_P$ . (cf. Grünewald 1991, p. 218 et sqq.) Thus C has to bear the risk of reporting forecast data to S based on an uncertain sales forecast of his outlet. Because L is geared to C's sales forecast, his risk is minor. However, for S the risk of (possibly short term) modifications to the forecast data remains (cf. Meyer/Schneider/Stübel 1988, p. 41; Simon 1989, p. 456) and even the customer takes one part of the commercial risk through compensation agreements.

Below the following problems shall be discussed:

1. Which forecast data should customer C report to supplier S in order to gain maximum flexibility with regard to his uncertain outlet?
2. Which quantity should supplier S consider in his primary requirements planning, if he knows from experience that the forecast data reported by C tend to be too high, that they can be revised and that the effectively required quantity can differ from the reported forecast data?
3. Which released quantity should customer C effectively order when the time of ordering is reached, bearing in mind his previously reported forecast data and the fact that his sales forecast has become more precise in the meantime?

### DETERMINATION OF FORECAST DATA

C has to deal with the question of which quantity  $x_F$  of the preliminary product he should report to his supplier as forecast data. On the one hand, he wishes to gain certainty of supply concerning his preliminary product. On the other hand, he wants to avoid an adjustment payment. Aggregatively C doesn't precisely know the exact end customer demand. His expectations are more vague the more the sales period lies in the future. (cf. Lackes 2004, p. 408) Let  $x_{EP,t}$  be the end product demand on C's outlet in a period  $t = 1, \dots, T$ . Then for  $x_{EP,t}$ , which is a random variable with expectation  $\mu_{EP,t}$  and standard deviation  $\sigma_{EP,t}$ , holds:

1. The random variables  $x_{EP,t}$  are each independent.
2.  $\frac{\sigma_{EP,t}}{\mu_{EP,t}} < \frac{\sigma_{EP,t+1}}{\mu_{EP,t+1}}$  i.e. the distribution of density function decreases in time.

Following categories of cost matter for the determination of forecast data for any period  $t = 1, \dots, T$ : (cf. Kilger 1986, p. 352)

- Adjustment payment  $p_A^C$  to supplier S due to released quantities of the preliminary product less than the reported forecast data, so for  $x_{EP} < x_F$ .
- Additional costs  $c_A^C$  for released quantities greater than the forecast data. Up to a certain maximum  $x_{RQmax}$ , this may be possible, so for  $x_F \leq x_{EP} < x_{RQmax}$ .
- Out-of-stock costs  $c_0^C$ , in consequence of underestimated end customer demand and not accommodating demand, so for  $x_{RQmax} \leq x_{EP}$ .

If C's release order quantity is lower than the quantity of his forecast  $x_F$ , he has to do an adjustment payment to L. We assume this payment  $p_A^C$  to be lower than C's storage costs for the preliminary product. Thus there is no inducement for C to do a release order that exceeds his demand just because of his prior forecast data. More over we assume C's out-of-stock costs  $c_0^C$  to be greater than the adjustment payment  $p_A^C$ , otherwise release orders greater than  $x_F$  wouldn't make

any economic sense. The maximum released quantity  $x_{RQmax}$  is supposed to be dependent on  $x_F$ , which can be exceeded by the released quantity up to a certain percentage  $\chi$ . This means  $x_{RQmax} = (1 + \chi) \cdot x_F$ . Every additional end product demand cannot be satisfied and therefore leads to out-of-stock costs. If C orientates the decision risk neutrally to the expectation of these costs (cf. Dinkelbach 1982, p. 74 et sqq.), we get (for simplicity the period index  $t$  is left out):

$$(1) \quad C^C(x_F) = \int_0^{x_F} p_A^C \cdot (x_F - x_{EP}) \cdot p(x_{EP}) \cdot dx_{EP} + \int_{x_F}^{x_{RQmax}} c_O^C \cdot (x_{EP} - x_F) \cdot p(x_{EP}) \cdot dx_{EP} \\ + \int_{x_{RQmax}}^{\infty} c_O^C \cdot (x_{EP} - x_{RQmax}) \cdot p(x_{EP}) \cdot dx_{EP}$$

This cost expectation has to be minimised and leads to the following conditional equation with density function  $p(x)$  and distribution function  $P(x)$ :

$$(2) \quad 0 = p_A^C \cdot (P(x_F) - P(0)) + c_A^C \cdot (P(x_F) - P((1 + \chi) \cdot x_F)) + p((1 + \chi) \cdot x_F) \cdot \chi \cdot (1 + \chi) \cdot x_F \\ + c_O^C \cdot ((1 + \chi) \cdot P((1 + \chi) \cdot x_F) - (1 + \chi))$$

The greater the out-of-stock costs  $c_O^C$  are the greater the difference between the expected sales volume  $E(x_{EP})$  and the optimal forecast quantity. This means that C reports forecast data too high compared to the sales forecast of his outlet. (cf. Grünwald 1991, p. 219) If we assume C to avoid risk, which is very realistic, this effect is enhanced. Then the minimum of the cost expectation is no longer the only decision criteria but additionally the standard deviation or rather the variance of the costs. (cf. Dinkelbach 1982, p. 84 et sqq.) Adjustment payments act oppositely to out-of-stock costs. The lower the payment is in relation to the out-of-stock costs, the greater the forecast data are. This effect can be observed in sensitive outlets where sales orders will be lost if a fast delivery is impossible. In this case, C safeguards himself by reporting very high forecast data (compared to the expectation). The possibility of obtaining more preliminary products than those reported provides some *a posteriori* room for manoeuvre to C. This leads to more "realistic" forecast data because C won't have to build a safety stock a priori by reporting relatively high forecast data.

### SUPPLIER'S USE OF FORECAST DATA

From practical experience, S knows that most times the forecast data are too high. Hence he has to think about a "subjective" correction factor concerning C's forecast data. In analogy to our considerations about C's sales forecast, the released quantity  $x_{RQ}$  is a random variable whose probability distribution has the expectation  $\mu_{RQ}$  and the standard deviation  $\sigma_{RQ}$ . Because the forecast data  $x_{F,t}$ , with  $t = 1, \dots, T$ , build a time-dependent data vector, we can assume:

1. Every  $x_{F,t}$  is a value of the random variable  $x_{RQ,t}$  from the estimated distribution with expectation  $\mu_{RQ,t}$  and standard deviation  $\sigma_{RQ,t}$ .
2.  $x_{F,t} = \mu_{RQ,t} + \alpha \cdot \sigma_{RQ,t}$
3.  $\alpha_t < \alpha_{t+1}$  i.e. the forecast data differ not so much from the expectation if the planning period is short.
4.  $\frac{\sigma_{RQ,t}}{\mu_{RQ,t}} < \frac{\sigma_{RQ,t+1}}{\mu_{RQ,t+1}}$  i.e. distribution of density function decreases in time.
5. The random variables  $x_{RQ,t}$  are each independent.

Now S has to deal with the problem of how to handle these forecast data within his material requirements planning and job order planning. Concretely he has to decide which quantity  $x_{p,t}$  he should provide to C because of the reported forecast data. This equals the customer independent requirements in the material requirements planning. The concrete quantity to be produced is calculated later in consideration of disposable inventory using methods and data (storage costs etc.) of lot-sizing. (cf. Fandel/François/Gubitz 1994, p. 115) Taking into account the reported forecast data and a probability distribution about the future released quantity the following cost and revenue components are relevant (cf. Kilger 1986, p. 352) to optimising S's primary requirements quantity  $x_{p,t}$  (for simplicity, the period index  $t$  is again left out):

- Storage costs  $c_s^S$  for quantities not purchased by C, so for  $x_p > x_{RQ}$ .
- Out-of-stock costs  $c_o^S$  occurring in case C wants to purchase more than S had planned, so for  $x_p \leq x_{RQ} \leq x_F$ .
- Adjustment payment  $p_A^C$  C has to pay in case the released quantity is lower than the forecast quantity resp. the primary requirements quantity, so for  $x_F \geq x_{RQ}$  resp.  $x_p > x_{RQ}$ .
- Additional revenue  $c_A^C$  generated for released quantities greater than  $x_F$ , so for  $x_F < x_{RQ} \leq (1+\chi) \cdot x_{RQ}$ .

Additional revenue only occurs in case C is able to purchase more than he reported before. This is only relevant when S can provide this quantity. As an incentive for C to purchase a quantity  $x_{RQ} > x_F$  the additional revenue  $c_A^C$  has to be lower than the out-of-stock costs  $c_o^C$ , which C has to bear in mind. However, even if the released quantity is greater than the primary requirements quantity, it may be covered under certain circumstances. This may happen because, due to S's lot-sizing (cf. Fandel/François/Gubitz 1994, p. 156), a greater released quantity may be provided than the primary requirements quantity suggests. But within successive planning – as we have here – the lot-sizing and job order planning is done after the primary requirements planning (cf. Lackes 2004, p. 407; Zäpfel/Piekarz 1996, p. 33 et sqq.). To determine the cost optimal primary requirements quantity we have to distinguish whether the primary requirement quantity is lower or greater than  $x_F$ . In case  $x_p \leq x_F$ , no additional revenue can be generated. Storage costs and adjustment payments can be summarised such that the latter seem to be a reduction of the storage costs, so effectively  $c_s^S - p_A^C$ . In case  $x_p > x_F$ , additional revenue can be generated. Out-of-stock costs do not appear and adjustment payments only occur up to  $x_F$ , not up to  $x_p$  as in the first case. If we are again geared to the expectation of costs, as a risk neutral decision maker would do, we get the following cost functions:

$$(3a) \quad x_p \leq x_F: \quad C_F^S(x_p) = \int_0^{x_p} (x_p - x_{RQ}) \cdot (c_s^S - p_A^C) \cdot p(x_{RQ}) \cdot dx_{RQ} + \int_{x_p}^{x_F} (x_{RQ} - x_p) \cdot c_o^S \cdot p(x_{RQ}) \cdot dx_{RQ}$$

$$(3b) \quad x_p > x_F: \quad C_F^S(x_p) = \int_0^{x_p} (x_p - x_{RQ}) \cdot c_s^S \cdot p(x_{RQ}) \cdot dx_{RQ} - \int_0^{x_F} (x_F - x_{RQ}) \cdot p_A^C \cdot p(x_{RQ}) \cdot dx_{RQ} \\ - \int_{x_F}^{x_p} (x_{RQ} - x_F) \cdot c_A^C \cdot p(x_{RQ}) \cdot dx_{RQ}$$

At this we suppose that S only gets adjustment payments in case the released quantity is lower than the primary requirements quantity and it does not extend

this difference. This implies that S doesn't hide information about his scheduled primary requirements quantity  $x_p$ , otherwise he may possibly get greater adjustment payments at an altitude of  $x_F - x_{RQ}$ . But in the sense of a trustful cooperation in a supply network, we assume that hiding this information won't take place. The minimisation of the cost function  $C_F^S(x_p)$  results in:

$$(4a) P(x_p) = \frac{P(0) \cdot (c_S^S - p_A^C) + P(x_F) \cdot c_0^S}{c_S^S + c_0^S - p_A^C}$$

$$(4b) 0 = c_S^S \cdot (P(x_p) - P(0)) - c_A^C \cdot (p(x_p) \cdot (x_p - x_F))$$

C and S have to negotiate the adjustment payments  $p_A^C$  for lower released quantities. The greater they are, the more cautious C will calculate his forecast data to avoid them. The intention is to guarantee S a kind of indemnity for additional costs caused because he relied on the forecast data and provided according quantities of the preliminary product. Hence it is reasonable to orientate the adjustment payments to S's additional storage costs. If S succeeds in completely shifting the storage costs to C ( $c_S^S - p_A^C = 0$ ), then this affects that he doesn't schedule less than the forecast data. Thus, S eliminates the risk of shortfalls and according out-of-stock costs, as the customer has to bear storage costs if he purchases less than the forecast data. But it is also conceivable that because of his market power, C enforces very low adjustment payments (0 in the extreme) in comparison to S's storage costs. Then, C doesn't have to fear any consequences and will tend to report forecast data near his maximum distribution expectation. Further on, S beholds this forecast data as very invalid and amends them down. In the extreme, this information is completely useless to him.

### DETERMINATION OF THE RELEASED QUANTITY

When reaching the preliminary product's release point, C has to ask himself which quantity of the preliminary product he should really purchase. From his point of view, the situation is characterised as follows: On the one hand, he has already reported forecast data to the supplier and on the other hand, he meanwhile gained more precise information about his real end product demand. In the following, we assume that the end product demand of C's outlet isn't completely known, otherwise a simple decision rule can be derived which released quantity C should choose because all needed parameters are known and ascertained. Therefore, the demand quantity  $x_{EP}$  is subject to a probability distribution, which in general spreads less than the distribution used earlier to specify  $x_F$ . We need the following four cost components to determine – the assumptions made above may still hold – the cost optimal released quantity of the preliminary product:

- Storage costs  $c_S^C$  for the end product in case the released quantity  $x_{RQ}$  of the preliminary product and thus (because of the assumed cumulated production coefficient of 1) the quantity of the manufactured units of the end product is greater than the demand, thus for  $x_{EP} \leq x_{RQ}$ .
- Out-of-stock costs  $c_0^C$  for the demand of the end product not supplied on the outlet, thus for  $x_{RQ} \leq x_{EP}$ .
- Adjustment payment  $p_A^C$  for quantities of the preliminary product, not purchased although the reported forecast quantity was greater, thus for  $x_{RQ} < x_F$ .
- Additional payment  $c_A^C$  for quantities of the preliminary product, purchased although the reported forecast data were lower, thus for  $x_F < x_{RQ}$ .

When optimising, the released quantity adjustment payment and additional payment exclude each other. Adjustment payment only appears if the released quantity  $x_{RQ}$  is lower than the forecast data. Additional payment instead only occurs if the released quantity is greater than the forecast data. So we first have to calculate the cost optimum for both cases and afterwards determine the general optimum from this. Due to the assumptions made above, adjustment payment only accrues for released quantities lower than  $x_{Ff}$ , but never above S's scheduled quantity  $x_p$ . This means that it results from the difference between the minimum of  $x_p$  and  $x_F$  and the chosen released quantity  $x_{RQ}$ . Instead the additional payment is only based on the forecast data. Depending on the released quantity  $x_{RQ}$  of the preliminary product we get the following functions of the cost expectation:

$$(6a) \quad x_{RQ} \leq x_F: \quad C_{RQ}^C(x_{RQ}) = \int_0^{x_{RQ}} (x_{RQ} - x_{EP}) \cdot c_S^C \cdot p(x_{EP}) \cdot dx_{EP} + \int_{x_{RQ}}^{\min(x_p, x_F)} (\min(x_p, x_F) - x_{EP}) \cdot p_A^C \cdot p(x_{EP}) \cdot dx_{EP} \\ + \int_{x_{RQ}}^{\infty} (x_{EP} - x_{RQ}) \cdot c_O^C \cdot p(x_{EP}) \cdot dx_{EP}$$

$$(6b) \quad x_{RQ} > x_F: \quad C_{RQ}^C(x_{RQ}) = \int_0^{x_{RQ}} (x_{RQ} - x_{EP}) \cdot c_S^C \cdot p(x_{EP}) \cdot dx_{EP} + \int_{x_F}^{x_{RQ}} (x_{RQ} - x_{EP}) \cdot c_A^C \cdot p(x_{EP}) \cdot dx_{EP} \\ + \int_{x_{RQ}}^{\infty} (x_{EP} - x_{RQ}) \cdot c_O^C \cdot p(x_{EP}) \cdot dx_{EP}$$

These two functions have to be minimised according to the released quantity  $x_{RQ}$  such that we get the following conditional equations:

$$(7a) \quad x_{RQ} \leq x_F: \quad 0 = c_S^C \cdot (P(x_{RQ}) - P(0)) + p_A^C \cdot (-\min(x_p, x_F) \cdot p(x_{RQ}) + x_{RQ} \cdot p(x_{RQ})) + c_O^C \cdot (-1 + P(x_{RQ}))$$

$$(7b) \quad x_{RQ} > x_F: \quad 0 = c_S^C \cdot (P(x_{RQ}) - P(0)) + c_A^C \cdot (P(x_{RQ}) - P(x_F)) + c_O^C \cdot (-1 + P(x_{RQ}))$$

For each of the two values of  $x_{RQ}$  we have to determine the costs afterwards. That  $x_{RQ}$  that leads to lower estimated costs is the cost optimal released quantity.

## RESULTS

From all this, it follows that additional information between the supply network participants about their dispositions reduces uncertainty. (see Lackes 2004, p. 410 et sqq.) We have pointed out that providing forecast data is useful to the supplier and therefore benefits the whole supply network. Without forecast data the supplier would have to face similar uncertainties as the customer on his outlet and therefore build his own risk-absorbing stock. Because the supplier does not take the forecast data as deterministic values but modifies them from his experience, the situation in the whole supply network improves again. The supplier's modifications act risk-reducing as the supplier's specific situation is included into his consideration of the forecast data. If not, the uncertainties on the customer's outlet would uncontrollable take effect on the supplier.

Room for improvement results from the fact that the customer reports not only forecast data, but also the whole estimating of his outlet, i.e. the distribution function of the end customer demand. In this case the supplier doesn't need to speculate which value of the distribution function the customer has chosen as forecast data. Instead he can orientate to the risk information on the end cus-

tomer outlet. A further risk reduction and further potential of economisation can be achieved by not only reporting data about the estimated demand – against the direction of material flow – but also reporting data about possible supply shortfalls in upstream areas of production – corresponding to the material flow (similar to the concept of message-based production planning). (see Lackes 1995, p. 442 et sqq.) Through this, we could achieve that the follow-up costs evoked by one's own decisions but arising externally among other participants of the network, can be included into one's own disposition.

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## **RISK ASSESMENT OF COLLABORATIVE PRODUCT DEVELOPMENT IN A SUPPLY CHAIN**

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### **ABSTRACT**

Increased global competition has forced companies to involve their suppliers and customers during the product development in order to develop competitive products. Although faster product design, development and delivery are the intended outcomes of this collaboration, one of the undesirable by-products is an increase in risks as a consequence of uncertainties between interdependent processes such as supply chain collaborative relationships. This paper discusses the challenges of the product development process in manufacturing industries which expose them to several risks in supply chain networks. The dynamic nature of manufacturing environments was captured by establishing a framework followed by mapping and assessing risks in product development process. Such an approach would support developing further knowledge about the role of supply chain networks in product development process and help minimize risks.

### **INTRODUCTION**

Designing the complete product development process approaches customers as an important stakeholder and consider suppliers as partners. This is intended to extend manufacturing capability while focusing on core competencies of each. The paradigm then is to view design as teamwork and achieve collaborative effort through effective communication among geographically distributed partners. The dilemma then is information sharing, collaborative decision-making, compatibility of processes and resource sharing, leading to enhanced effectiveness and efficiency of the product design and development on one hand, while introducing new risks on the other. Each risk in itself and/or combination of other risks can directly affect the deadline, cost and quality of the collaborative product development process. Within the context of global manufacturing, the design style must be changed from the "Design OF" in the past, through the "Design FOR" at present, to the "Design WITH" in the future. The key feature of "Design WITH" approach is that designers continuously and collaboratively negotiate their decisions with their supply chain around the globe (Tseng et al,2003). This approach requires communication, consideration and collaboration and supports beyond those traditional design approaches, which relied on several

iterations to be carried out by supply chain network. In today's collaborative design environment, the number of project participants have been increased and the nature and means of collaboration has been changed with different participant backgrounds, interests, expertise, behaviours, cultural features, etc.

The full scale involvement of manufacturers at operational levels have not been achieved yet due to a lack of complete understanding of the project life cycle. This is mainly because every aspect of engineering design and/or manufacturing capabilities have not been linked with customers and suppliers proactively throughout the product development process and collaborating across boundaries (Tseng et al, 2003, Barry, 2004, Chopra et al, 2004, Omar et al, 2006). The management of risks in multi-site, multi-partner (MSMP) new product development engineering projects attract interest from both academia and practitioners.

This paper discusses the challenges of the PD<sup>3</sup> process in manufacturing industries which expose them to several risks in supply chain networks followed by a framework proposed for supply chain risk management.

### **SUPPLY CHAIN RISK MANAGEMENT**

Risk management is perceived in the current literature as an approach to identify and assess the supply chain vulnerabilities, and define mitigation strategies accordingly (Kiser and Cantrell, 2006, Omar et al, 2006), rather than a process to identify the uncertainties faced by supply chain partners and the resulting trade-offs between the potential benefits and losses. The risk management process provided by ISO requires adaptations according to the specific environment and circumstances of its application. These adaptations are not only related to the tools and techniques used but also to the implementation process. Indeed, the supply chain is a set of various companies and as such the management process should not be the responsibility of each firm individually but rather should be defined and decided at a network level by involving every firm in the process (Hauser, 2003). The risk awareness should be established across the organization and the supply chain and should be recognized and understood that risks exist and that consequently risk management is not a response to a major disruption, thus risk management is not a reactive approach to risk, but definitely a proactive process (Hauser, 2003, Deleris et al., 2004). Supply chain dynamics and implementation of a common risk management strategy are further reviewed as well (Kleindorfer and Saad, 2005). Finally, although risks should be managed globally, i.e. at a supply chain level, and not individually (Deleris et al., 2004), each firm should nonetheless needs to implement a risk management process and the appropriate strategies before the supply chain risk management can take place. As a result of this process as well as constantly changing business environments, the risk profile of the network needs to be modified, reviewed and re-assessed on a continuous basis. Besides three different types of classification such as types of risk, supply chain's and organization's viewpoint, other frameworks that may not fall into one of these categories have also been identified (Smallman, 1996). Svensson (2003). Cousins et al. (2004) tackle the exposure of the firm rather than the sources and



divide them into technological and strategic, considering environmental as part of the other two.

In conclusion, majority of the classifications presented in literature are designed with the objective of classifying risk and not the sources of risk. However, as mentioned above, risk is a multidimensional concept, and a classification that proves suitable for the causes may not be adequate for the consequences. Moreover, in some cases, the criterion according to which the differentiation has been made is not clearly stated which renders the taxonomies difficult to use by a third person. This is emphasised by the lack of clear definition of the categories and their boundaries, most of the classifications being defined through examples. Furthermore, while some classifications tend to be very specific (eg, type of risk) others are much more general (eg, internal versus external). It is believed that in order to make a comprehensive and directive framework that will enable to identify and understand as many risks as possible, a mix of broad categories and more specific one should be used. Additionally, majority of the authors only consider downsides of risks and this is reflected in their typologies through the use of terms such as vulnerabilities or other negative terms. A very thorough literature review on the topic was covered in Gomez (2007).

### **RESEARCH FRAMEWORK**

Several risk types are encountered in product development process (Tseng et al, 2003). Each risk in itself and/or combination of other risks can directly affect the deadline, cost and quality of the PD<sup>3</sup> process mainly due to the interdependency between tasks (Kayis et al, 2006, Kara and Kayis, 2007). An example of few tasks and risk items and their links to the others are shown in Figure 1 for the Requirements phase of PD<sup>3</sup> process. The dynamic nature of manufacturing environments was captured by developing an Intelligent Risk Mapping and Assessment System (IRMAS<sup>TM</sup>) through mapping and assessing risks in product development process (Kayis et al, 2007). Different risk types and their combined effects are evaluated in a unique way through systematically integrating an organisation's culture with project, product and process related risks (Savci and Kayis, 2006). Whereas, the risks in supply chain networks are not covered in depth. Accordingly, a framework is built to identify, categorize and assess the supply chain related risks as shown in Figure 2 (Gomez, 2007).

### **CONCLUSION**

The incorporation of the framework presented in this paper into the Intelligent Risk Mapping and Assessment System (IRMAS<sup>TM</sup>) which aims to identify, assess and mitigate potential risk items at all stages of the project life cycle would be beneficial. The system was successfully tested in industry and is currently being used as a decision support tool to accomplish effective risk management in "Design WITH" project environments.

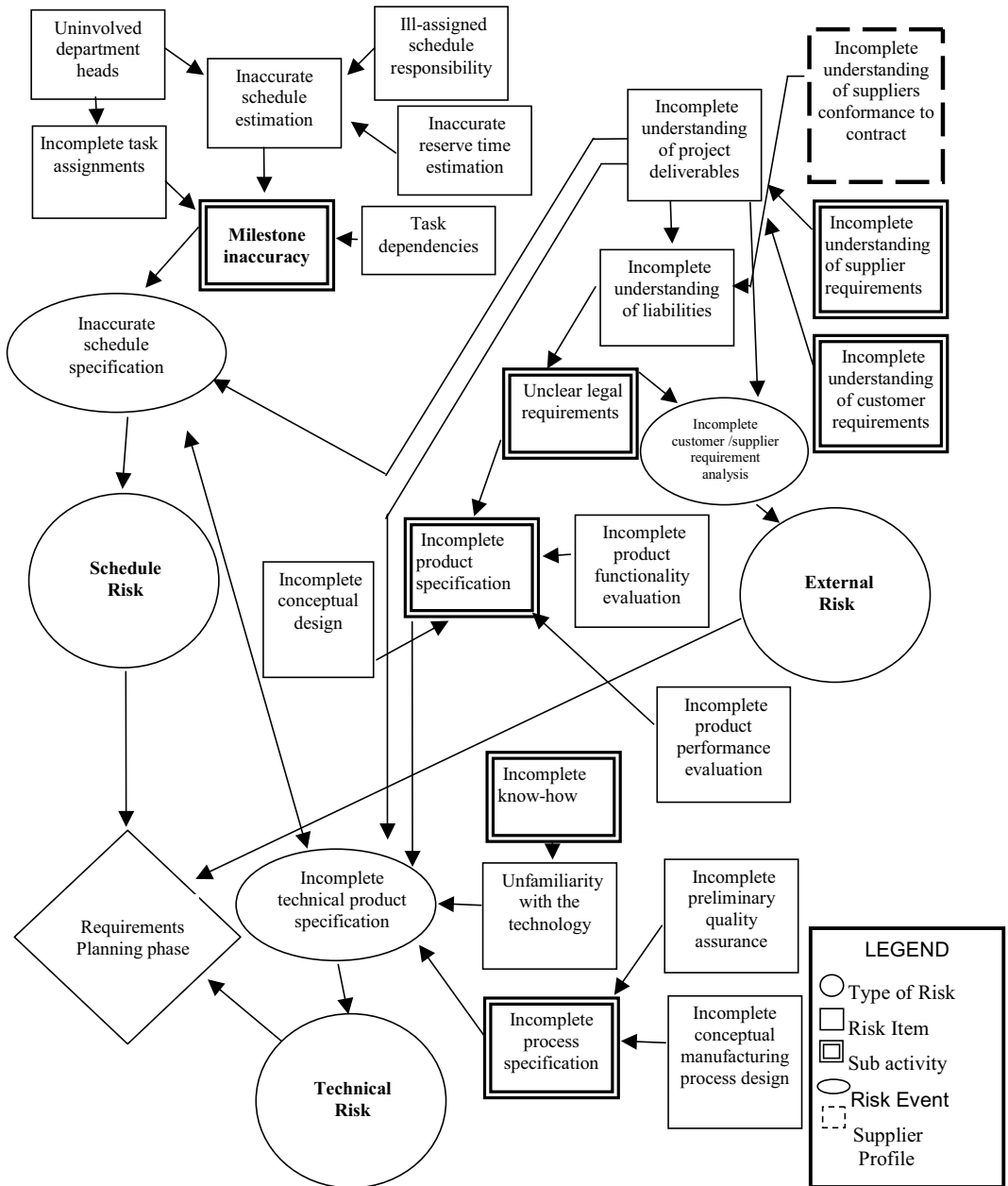


Figure 1: An example of interrelationships of tasks and risks in PD<sup>3</sup> process (Kayis et al, 2007)

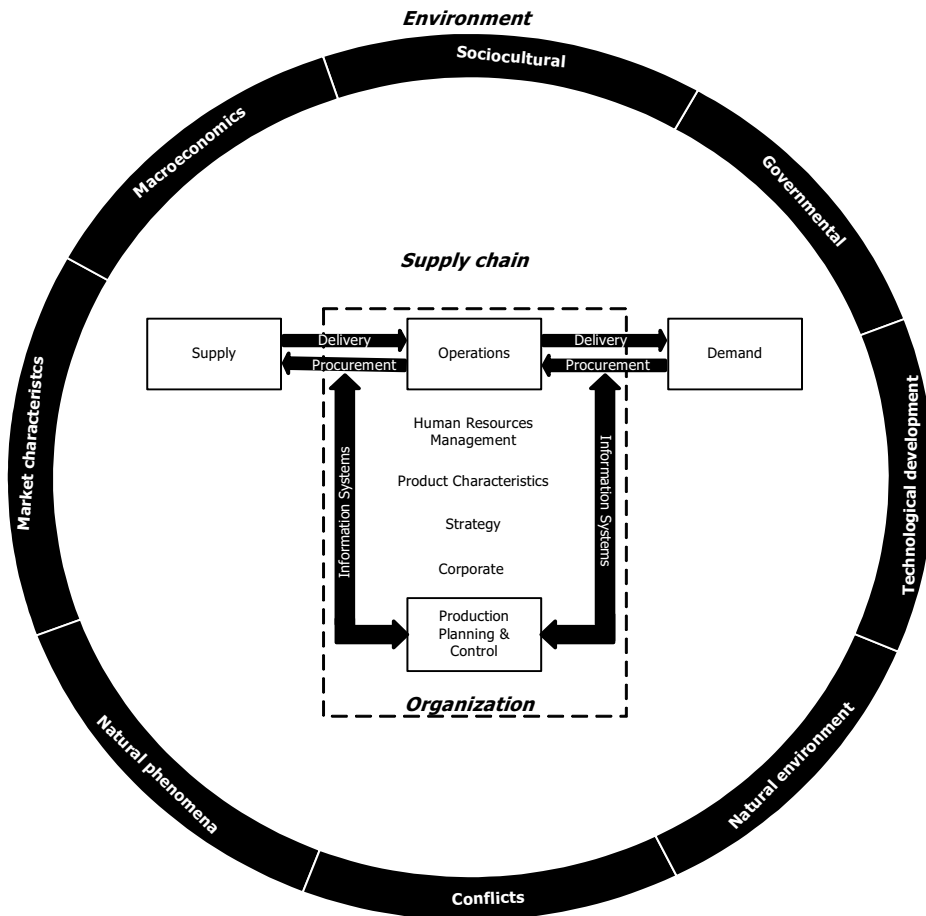


Figure 2 – The supply chain risk identification framework

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# **SUPPLY CHAIN DIAGNOSTICS**



## **THE QUICK SCAN AUDIT METHODOLOGY: A SUPPLY CHAIN DIAGNOSTIC APPROACH**

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### **ABSTRACT**

There are many paradigms proposed in the literature as the means whereby the performance of supply chains may be improved. Often such principles are accompanied by waves of publicity aimed at convincing busy executives that this is the singular and indispensable route forward. Consequently, small differences between approaches may be amplified by the consultant in an effort to gain business. In contrast, there is a perceived shortage of objective methodologies for the reliable and consistent auditing of value stream performance, and that build confidence regarding any claims for causality. The objective of this research paper is to fill this gap by detailing a rigorous supply chain diagnostic.

### **INTRODUCTION**

The need for more case-based logistics research to supplement the more popular survey and analytical modelling methods forms the basis for this research (Frankel et al., 2005; Naslund, 2002; New and Payne, 1995; Solem, 2003). In 1998, Cardiff University's Logistics Systems Dynamics Group developed a supply chain diagnostic approach named the Quick Scan Audit Methodology (QSAM). Since being first presented at the Florence International Symposium on Logistics in 1999 (Childerhouse et al., 1999), the method has been continually updated, revised, and applied in a wide variety of settings.

The approach described herein is anchored in both Action Learning (Revans, 1976) and Action Research (Coughlan and Coghlan, 2002; Westbrook, 1995). The QSAM is positioned within the established spectrum of logistics research and shown to produce rich empirical research data. Consequently, QSAM is demonstrated to produce effective delivery pipeline assessments and generic guidelines on the key enablers for enhancing supply chain performance.

The purpose of this paper is to argue the merits of QSAM, which will be achieved through the following means: Firstly, a detailed description of the methodology (Naim et al., 2002) will be provided to highlight the rigorous nature of the audit approach. This will identify the three forms of triangulation utilised (Mentzer and Flint, 1997; Denzin, 1989) that make the QSAM superior for obtaining reliable evaluations of real world supply chains. The methodology will then be compared and contrasted with Action Learning (AL) and Action Research (AR) to show where it fits in the spectrum of generic research approaches.

The QSAM has two primary outputs; guidance for the target organisation and rich research data (Naim et al., 2002). The value of this data is evidenced by the quality of research outputs and the resultant original contributions (Childerhouse and Towill, 2002; 2003; 2004; 2007; Potter et al; 2005). Finally, the generic applicability of the QSAM will be demonstrated through global



applications (Barker et al., 2000; Basnet and Childerhouse, 2003; Banomyong et al., 2005) and the wide variety of supply chains examined to date.

### THE QUICK SCAN PROCESS

The QSAM is a diagnostic approach designed to perform a health check of a supply chain (Naim et al., 2002). It has been specifically developed to minimise the disturbance to the target organisation(s) whilst still acquiring an accurate performance and operations assessment. Typically, in total, it takes four researchers one week to fully audit the supply chain of a medium-sized organisation; during this period only half of the time is spent on-site disrupting managers. It is important to note that the QSAM is team based and the team contains 'players' from the host organisation; both sides contribute considerable inputs to the audit programme. The six major process steps involved in conducting the QSAM, associated key objectives and the reasoning for each are provided in Table 1.

QS Process	Loc./ Dur.	Key Objectives	Reasoning
Preliminary Presentation	On-site 2 hours	Identify a value stream	The selection of one or two representative value streams allows focus & detailed investigation within the limited QS duration.
		Issue data requests	Pre-emptive requests for archival data & the issuing of questionnaires minimises wasted time during intensive on-site data collection.
		Obtain buy-in	Successful buy-in is key for access to data & to avoid political game-playing via the distortion and with holding of information.
Evaluate Supply Chain Status	On-site 1 day	Collect questionnaires	Methodological triangulation significantly reduces the errors of each individual data collection approach.
		Conduct Interviews	Different researchers collect each of the data types hence reducing bias via investigator triangulation.
		Process map	
Brainstorm Supply Chain Inhibitors	Off-line 1 day	Identify good & bad practices	Initial impressions are first discussed between the team members.
		Develop hypotheses	The inter-relationships & possible causes of the bad practices are hypothesised and the data required to validate each identified.
		Identify further data req.s	
Hypotheses Investigation	On-site 1 day	Collect archival data	Specific historical data such as time series inventory levels are collected to test each hypothesis.
		Conduct probing interviews	Further interviews are conducted that delve into why current practices are indifferent.
		Observe current practise	The material flow process is observed and documented, especially when there is a lack of archival data.
Analyse the Findings	Off-line 1 day	Identify major pain(s)	The over-riding problem(s) is first identified.
		Cause and effect analysis	The heart of the analysis is the development of a cause and effect diagram based around the major pain that inter-relates all the bad practices and identifies the root causes.
		Develop improvement opportunities	Improvement opportunities for the root causes are identified and rank by benefit, time and cost to implement.
Feedback Presentation	On-site 3 hours	Present findings to management Initiate a round table discussion Agree upon an action plan	This is the most important stage for the target company, as the objectives is a group understanding of the key shortcomings of the supply chain and the agreement of an action plan to rectify the most significant poor practices.

Table 1. Overview of the Quick Scan Process

To summarise, the key QSAM elements that result in a successful supply chain audit are:

- A team of four researchers ensures investigator triangulation
- The use of four data collection methods provides methodology triangulation
- The application of a refined, systematic and hence holistic methodology
- The considerable skills and knowledge of the QSAM team
- The buy-in obtained during the preliminary presentation, based around the win-win situation of the identification of improvement opportunities and the gathering of research data.

### THE USE OF ACTION LEARNING AND ACTION RESEARCH IN THE QSAM

A prime requirement during the early phase of the Supply Chain 2001+ Research Project was the development of an audit methodology for the rating of a value stream, or “health check” (Naim et al. 2002). The QSAM was piloted and subsequently evaluated in depth within the European automotive sector (Childerhouse, 2002). Having described the QSAM procedure in detail, it is considered helpful to see how it utilises and exploits elements of both AL and AR.

It is our experience that industry-based research requires certain pre-requisites. Firstly, the sponsoring company must be made fully aware of the substantial time and effort contributions that will be necessary on its part, in the form of availability of relevant “players” in the supply chain, and also of an experienced staff liaison to ensure reliable on-site access to personnel, data, and plant. Secondly, academic researchers must have industrial credibility if the right doors are to remain open. Finally, as well as being party to long-term research programmes, companies expect some immediate payback for their considerable inputs, via the identification of problems amenable to immediate solution. If due regard is paid to these expectations it is clear that both Action Research and Action Learning have roles to play in effective supply chain audit. Thus, the ambitions of the researchers are arguably best met in the AR mode, but enabling a good level of industrial collaboration necessitates the AL mode. Hence the QASM is engineered so as to combine them in a DNA-type format as shown in Figure 1.

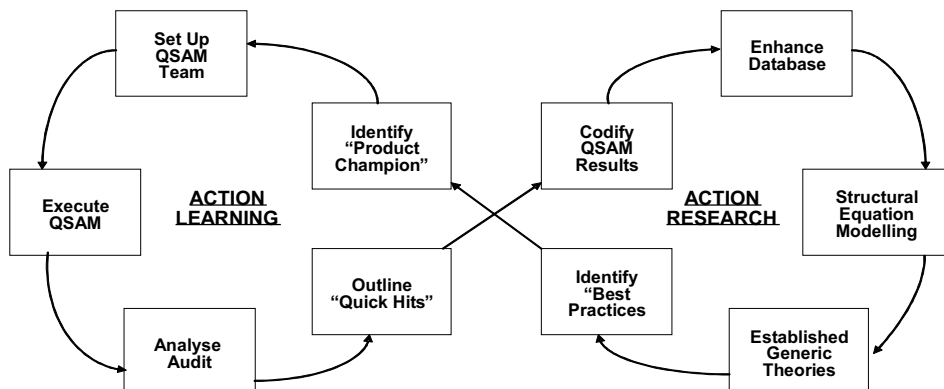


Figure 1. Double Helical Representation of QSAM DNA

In the AL mode on the left-hand side of the helix, a 'product champion' having appropriate vision and power to make things happen, must first be identified in the industrial partner. This is followed by the setting up and training of that particular QSAM team. Then the QSAM is executed, the audit results analysed, and any 'Quick Hits' relevant to that particular value stream identified and discussed with company executives for their immediate in-house implementation. Hence, from this perspective an individual QSAM audit is very similar to the Revans (1976) model AL process.

The company-specific aspects of Figure 1 conclude with the performance benchmark of the focal organisation. While these results are interesting, in the absence of comparisons with other value streams the gap with 'best in class' cannot be meaningfully estimated; nor do we necessarily know why one company performs better than another. Hence, there must be an AR output from QSAM as shown in the DNA representation of Figure 1, which is directly analogous to the evolved model of AR as developed by Westbrook (1995). Thus, there is a procedure for codifying results, creating and enhancing a data base, statistical analysis, and thence establishing generic theories. The statistical analysis also enables us to rank the codified scores and attach the necessary significance level to any hypotheses. Identification of clusters of similarly rated value streams can lead to selection of exemplar supply chains. Finally, the exemplars can be further studied to establish why these enterprises are 'good' and to cross-check for any statistical equivalences.

### **GENERIC NATURE OF THE QSAM**

As previously mentioned, the QSAM was first developed in 1987 by a team of researchers working on the Supply Chain 2001+ project; this team included such experts as Professors Parnaby, Towill and Naim. The QSAM was then prototyped in a UK automotive engine system supplier and further refined. The method was then once more tested in practice, this time on a UK automotive electronics system supplier. Final glitches were removed and the QSAM was then re-applied to the first target supply chain. These three applications concluded the prototyping. During 1998 and 1999 the QSAM was applied twelve more times to examine the supply chain practices of the highly regarded European automotive sector.

In 2000 the QSAM had been shown to be an effective tool in the automotive sector and it was decided that other industrial sectors needed to be examined to increase the generic nature of the method. To date, it has been applied in 33 real-world scenarios from a wide range of settings. It has been successful in different industrial sectors including; dairy, timber, automotive, utility, and retail enterprises. The QSAM has also been shown to be applicable in different countries with applications in the UK, Germany, New Zealand, and Thailand. The QSAM has been successfully applied in global, medium, SME and family-run businesses, highlighting the important fact that organisational size is no barrier to its application. Furthermore, the method has been used on a 'zoom and focus' basis with audits, ranging from a single focal organisation to the examination of three echelons in series.

Much of the follow up research from Quick Scan audits is based around the use of an uncertainty metric taken directly from process control engineering, which

measures the overall integration level of a supply chain-as highlighted in Figure 2. The solid boundary contains the elements that constitute one particular Quick Scan audit. A large volume of the data collected during an audit is subsequently used to codify the process, supply, control and demand sources of uncertainty. Childerhouse (2002) contains more details of how this is performed. This standard measurement tool has facilitated cross-industry and cross-nationality comparisons of supply chain performance. This is often almost impossible for more quantitative-type surveys due to there regularly being questionable external validity (attempting to compare 'apples with oranges').

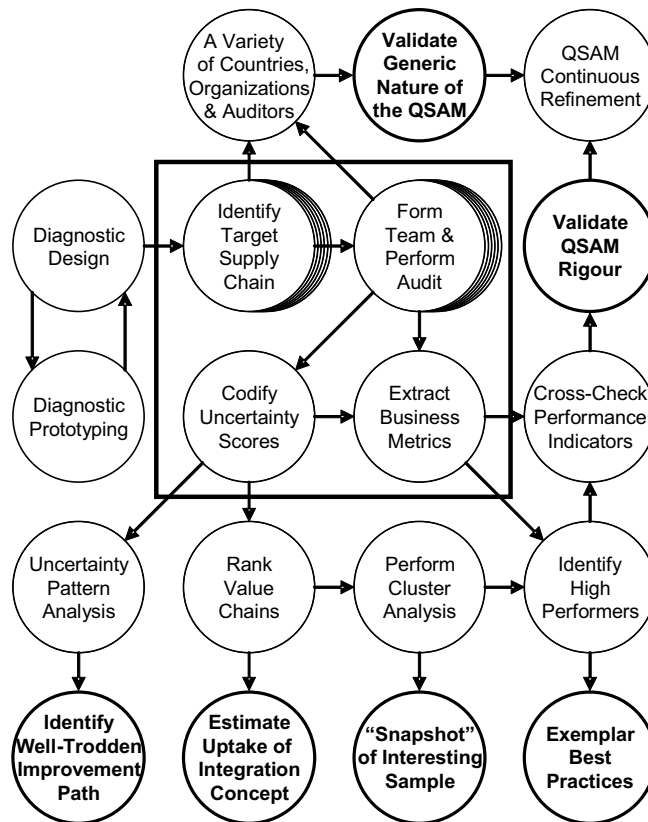


Figure 2. Refinement, Validation and Original Contribution of the QSAM

A specific aim of the research is to develop a generic tool that can be used by multiple investigators in a range of settings. Currently, three institutions from Europe, Asia, and Australasia are applying the QSAM on a regular basis and there are plans for further training and application by others. To-date over thirty researchers have participated in Quick Scans around the globe, ranging from Masters Students to Associate Professors.

## DISCUSSION

If the 'proof of the pudding is in the eating' then the QSAM is very successful. The feedback from the target supply chains is certainly encouraging and shows real value to business:

- *"Quick Scan was a worthwhile investment giving us actionable results. Totally win/win."* Keith Cooke - Managing Director - Metso Minerals.
- *"For Heinz Wattie's Ltd the Supply Chain Quick Scan Audit had tremendous value for us. The formal review process followed by executive summary and documented detailed findings from the review was the perfect route map for us to change our behaviour and address major shortcomings. We are confident that from what we have seen of our performance in a relatively short time we will continue to deliver the desired improvements in our end to end supply chain"*, Max Birt – Supply Chain Manager – Heinz Wattie's Ltd.

Likewise the QSAM has yielded a very valuable and varied pool of empirical data to test and further investigate leading academic theories on supply chain integration, time compression, the bullwhip effect and simplified material flow, among others. The understanding gained from the multiple Quick Scans has manifestly enabled the development of new management theory, and validation and further refinement of research ideas.

## CONCLUSIONS

There is a significant need for more investigator-involved, qualitative research on supply chains. However, there is a significant gap with regard to proven methodologies to conduct such research in the context of supply chain management. The research described herein fills this gap with a tried and tested method to diagnose a supply chain's performance, while also collecting rich empirical data. Over the past nine years this method has been applied by multiple researchers in a multitude of settings, resulting in a refined generic research method capable of auditing almost any type of supply chain. However, this avenue of research is far from exhausted. Further uptake of the QSAM and applications in more industrial sectors and countries will facilitate continuous refinement and improvement of the diagnostic tool. To this end we offer our assistance to potential industrial and academic partners who may be interested in adopting the QSAM. A great deal of further information including handbooks, questionnaires and interview questions are available on request.

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## **THE DEVELOPMENT OF A GENERIC SUPPLY CHAIN INTEGRATION MODEL USING THE QUICK SCAN DIAGNOSTIC METHODOLOGY**

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### **ABSTRACT**

Theoretical research suggests that supply chain integration provides a significant competitive advantage; however the literature falls short of proposing any particular specific implementation path. The integration model developed in this paper enables the level of supply chain integration to be assessed and provides researchers with a tool to identify routes that companies have taken to further integrate their supply chain. Its application is illustrated via longitudinal studies involving a NZ Dairy Food company and a UK Steel company.

### **INTRODUCTION**

One of the main themes in supply chain management is integration along the supply chain in order to improve performance and competitiveness by facing less uncertainty, reduced inventory buffers and better customer service, and with more flexible responses to customer demand (Bagchi & Skjott-Larse, 2002; Childerhouse & Towill, 2003). This paper presents a generic supply chain integration model that was developed with the aid of the Quick Scan Audit Methodology (e.g., Childerhouse *et al.*, 2001) and the supply chain integration literature. The paper contributes to supply chain integration theory by providing a tool that enables identification of routes companies have taken to further integrate their supply chain. The paper begins with a review of the theoretical foundations of supply chain integration and presents the proposed research model. A methodology section specifies the research design. Results are then presented illustrating the application of the developed research model. The paper concludes with a discussion of results, their implications for researchers/practitioners, and directions for future research.

### **LITERATURE REVIEW**

The relevance of supply chain integration has been widely discussed and supported. Many studies confirm that the higher the level of integration the higher the operational and business performance of the firm (Frohlich & Westbrook, 2001; Gimenez & Ventura, 2005). The goal of integrated supply chains is to remove barriers so as to ease the flow of materials and information, thereby creating profits, increasing market share, strengthening competitive position, and enhancing the value of the company (Lee, 2000). Figure 1, which has been adapted from Bowersox, Closs, & Cooper, (2007), presents an integrated supply chain model highlighting the four key areas of supply chain integration.

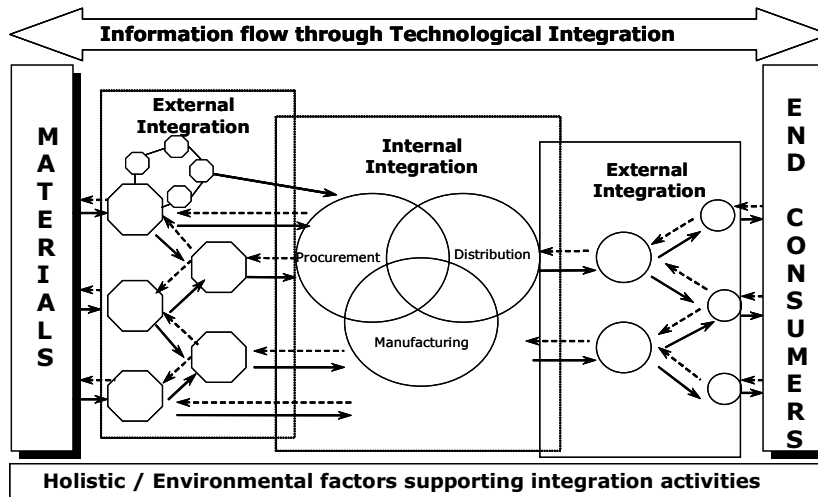


Figure 1. Integrated supply chain model

Four different elements of integration have been identified:

- internal integration;
- external integration;
- technological integration; and
- holistic and environmental factors supporting integration activities.

Internal integration focuses on divisions and boundaries within the organisation and seeks to eliminate the traditional functional 'silo approaches' (Gimenez & Ventura, 2005). External integration focuses on an organisation's interfaces with its customers and suppliers. While internal integration and external integration are two key integration areas within the organisation, two key supporting areas are highly relevant to their success-integration of information systems and holistic and environmental factors. Information technologies increase the flow of information between process participants to facilitate the integration of processes (Vickery, Jayaram, Droge, & Calantone, 2003). Vickery *et al.* showed that the greater the investment in integrated information technology infrastructure, the more likely it is that the company will achieve integration-both internally and externally. Holistic and environmental factors support integration via factors that include organisational structure, culture, and strategy, and communication along the supply chain (Bagchi & Skjott-Larse, 2002).

It has been shown that even similar companies may progress through quite different stages to achieve a fully integrated and seamless supply chain (Childerhouse, Naim, Towill, & Disney, 2001; Lambert, Cooper, & Pagh, 1998; Lee, 2000; Stevens, 1989). Possibly the most influential work on supply chain integration is by Stevens (1989), who proposed a four stage evolutionary model of supply chain integration: baseline integration, functional integration, internal integration, and external integration. Many researchers have identified a lack of understanding/knowledge regarding the path to further integrate the supply chain (e.g., Fawcett & Magnan, 2002; Frohlich & Westbrook, 2001). For example, Gimenez and Ventura (2005) and Potter *et al.*



(2004) recently reported that internal integration and external integration influence each other, indicating that Stevens' stepwise approach does not always reflect reality. This paper aims to close this gap in understanding by providing researchers and practitioners with a tool that identifies the paths companies take to further integrate their supply chain. To this end the factors contained within the following four tables were devised with the aid of the Quick Scan Methodology (Naim *et al.*, 2002) backed by an in-depth literature review.

Table 1. Key Area: Internal Supply Chain Integration

Characteristics	0	Baseline	Functional SC	Reactive SC	Seamless SC
Physical flow (Stevens, 1989)		Functional; uncoordinated	Fragment of coordination within company	Excessive coordination within company	Integration across company boundaries
Inventory (Stevens, 1989)		High levels; multiple stock holding between echelons	Each company function buffered	No intermediate inventory except at organisational boundaries	Minimal, strategic inventory
Lead times (t) (Stevens, 1989)		Long storage, process and distribution (t)	Few reduction in storage, process and distribution t	Excessive reduction in storage, process, and distribution	Minimised throughout Supply Chain
Decision points (DP) (Towill, 1997)		Multiple DPs	Single DP for each process	Single DP within organisation boundary	Coordinated control from single point
Performance Measurement (Bagchi & Skjott-Larse, 2002)		None	Measurement of delivery performance and inventory levels	Excessive measurement within company	Performance measurement across supply chain processes
Operational Data (Mouritsen, Skjott-Larsen, & Kotzab, 2003)		Not Shared	Shared within functions	Shared within Organisation	Shared throughout Supply Chain

Table 2. Key Area: External Supply Chain Integration

Characteristics	0	Baseline	Functional SC	Reactive SC	Seamless SC
Supplier Relationship (Ellram, 1991)		Open Market Bargaining – large supplier base	A few partnerships with selected suppliers –local focus-	Strong relationships – minimised supplier base	Multiple tiers. Lasting relationships with suppliers of choice
VMI, CPFR, (Bagchi & Skjott-Larse, 2002)		Not used	Used only in an experimental stage	Implementation stage with a few suppliers/customer	CPFR/VMI with key suppliers/ customers
Customer Relationship (CR) (Stevens, 1989)		Poor customer service	Reactive customer service	Some few major customer integration	Multiple tiers. Lasting CR with customer of choice
Procurement		Pure buying	Decentralised procurement	Exception management	Federal organisation
Relationship Management		Parochial management, ad hoc contractual arrangements	Broader management partnership	Management and operational partnership	Multi-level relationship management; open book; strong R&D

Table 3. Supporting Area: Technology Integration

Characteristics	0	Baseline	Functional SC	Reactive SC	Seamless SC
Identification and Track-and-trace Systems (Bagchi & Skjott-Larse, 2002)		No IT system being used	Bar Coding of products	More extensive bar-coding, automated e-mail updates with key players	Bar-coding from entry to dispatch, Track-and trace throughout the supply chain
Visibility (Fawcett & Magnan, 2002)		No visibility	Small amount of cross-functional visibility	Complete visibility within organisation	Full pipeline visibility in supply chain (incl. 2 <sup>nd</sup> tier customer/supplier)

Data transfer and Communication Systems (Bagchi & Skjott-Larse, 2002)		Manual – facsimile or telephone	PC based IS (E-Mail, Internet, Extranet used for limited purposes)	Few EDI/Internet links to customers / suppliers Extranet	Extensive use of EDI/Internet/XML links within supply chain
Transaction systems (Bagchi & Skjott-Larse, 2002)		Separate independent incompatible	MRP/MRP II Legacy System	ERP/DRP with MRP II - Intra company - Rigid interface	ERP and Supply Chain Planning - Inter-company - Flexible Interface

Table 4. Supporting Area: Holistic Factors

Characteristics	0	Baseline	Functional SC	Reactive SC	Seamless SC
Supply Chain Focus (Stevens, 1989)		Asset focussed Quick fix	Inbound or outbound flow/ cost focus	Process flow/ cost focus	Customer focus
Communication across the SC (Bagchi & Skjott-Larse, 2002)		Within the organisation only	Few contact points between companies in the SC	Regular contact at top/senior levels – rare operational level contact	Multiple contact points at all management levels
Formal Lateral Organisation (Bagchi & Skjott-Larse, 2002)		None	Functional teams only	Cross-functional teams key account managers	Teams across the supply chain – regular interaction
Organisational structure (Harrington, 1995)		Separate almost independent departments	Discrete business functions	Less hierarchical, flat organisational structure	Process orientated organisational structure
SC Strategy (Mejias-Sacaluga & Prado-Prado, 2002)		None	Each function individual	Company aligned	Supply Chain aligned
Human Resources KPI (Lee, 2000)		None	Functional	Organisational	Supply Chain
Organisational Culture (Harrington, 1995)		Defensive, chief/boss watching our backs	Internal team focus, us vs them. Prepared for internal trade offs	Willingness to improve. Prepared for internal trade-offs	Embrace change, team, ownership, understanding of external violence

## METHODOLOGY

Two longitudinal studies were undertaken to illustrate the application of the developed model, involving a New Zealand Dairy Food company and a UK Steel company. The New Zealand Dairy Food company study covered a timeframe of almost three years and the UK Steel study a timeframe of some nine months. The preliminary data sets were collected using the Quick Scan Audit Methodology (QSAM) and the final data sets were collected via in-depth case studies. The QSAM can be defined as a robust diagnostic tool developed to assess the current performance of an organisation's supply chain. Further information can be found in Naim *et al.* (2002).

## FINDINGS

This section provides summary data for both organisations, briefly explains the nature of the organisation initiatives conducted between the collection of the data sets, and with the aid of the proposed model highlights the paths each firm has taken to further integrate its supply chain. Figure 2a presents longitudinal data for the New Zealand Dairy Food organisation and Figure 2b the corresponding data for the UK Steel company. In each case, the continuous line represents the data collected by a QSAM and the dashed line shows the data collected during the later follow up case study. Please note that the average score for each identified area of supply chain integration has been calculated using the factors contained in Tables 1-4 (Using a scale of 0 = N/A, 1 = Baseline,

2 = Functional SC integration, 3 = Reactive SC integration and 4 = Seamless SC integration).

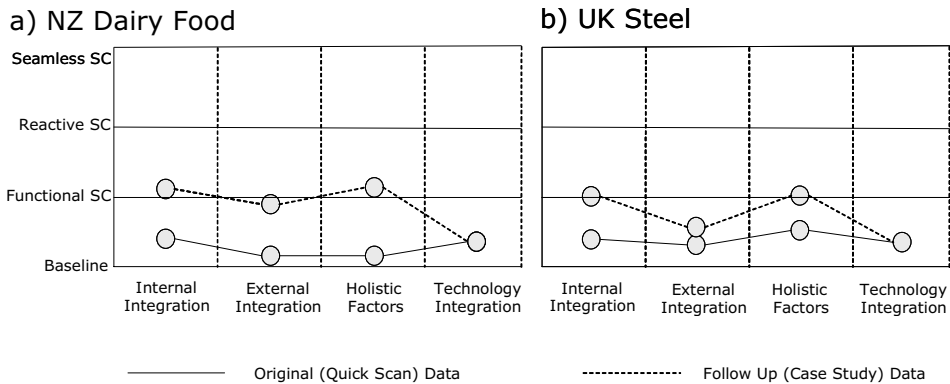


Figure 2. Level of Integration within Two Case Studies

### New Zealand Dairy Food

Figure 2a shows that, over the three-year period covered by the longitudinal study, New Zealand Dairy Food moved predominantly from Baseline to Functional SC (integration). As an initial step the company was restructured and cross functional teams were formed to overcome the existing functional silo mentality. These changes resulted (collectively) in a marked increase in the value of the supporting area *Holistic Factors*. Further, the company hired a Procurement Manager, enabling the company to centralise its procurement activities and to manage a portfolio of different buyer/supplier relationships, positively impacting the value of the key area *External Integration*. Internal visibility was greatly enhanced so that employees had better access to needed data, which positively impacted the value of the key area *Internal Integration* by improving material control. Finally, no discernable changes to the firm's information technology resulted in an unchanged value of the supporting area *Technology Integration*.

### UK Steel

Figure 2b indicates that, while some improvements in supply chain integration are evident, the UK Steel supply chain predominantly continues to demonstrate functional integration in all the key integration areas. This positioning reflects the changes that occurred within the company aimed at streamlining internal processes, over the nine-month period covered by the longitudinal study. Such changes did not strongly extend across the organisation boundary to the wider supply chain. Over the nine-month period the UK Steel company implemented changes but despite the streamlining initiative a number of functional silos remain. However, there is now evidence of better coordination and operational data sharing via a revised performance measurement system, which favourably impacts the value of the key area *Internal Integration*. Modest improvements in collaboration between supply chain partners have resulted in a small increase in the value of the key area *External Integration*. Similarly, changes to performance measurement resulted in issues with deliveries being addressed, and increase the value of the supporting area *Holistic Factors*. However, similar to the New Zealand Dairy Food case, there has been no change in *Technology Integration*.

Overall it is evident that these two organisations, in seeking to improve their level of supply chain integration, have taken the path of focusing on people, communication, and the environment before investing in expensive IT systems. Thus far, both have struggled to cross over the functional integration hurdle.

## **CONCLUSION**

The study supports the literature with evidence that different levels of integration exist in organisations. The original contribution made by this paper lies in the factors tentatively identified from the literature and from the well-recognised Quick Scan Audit Methodology (contained in Tables 1-4), which provide researchers and practitioners with measures that enable them to identify routes that companies have taken to integrate their supply chain. Future research will involve more longitudinal studies to seek further support that the identified factors capture all of the key characteristics of supply chain integration.

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## **CUSTOMER DATA MANAGEMENT – A KEY PRE-REQUISITE IN IMPROVING SUPPLY CHAIN EFFICIENCY**

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### **ABSTRACT**

Influence of excellence in quality and low cost as differentiators over competition is stretching thin. Organizations now, are striving for excellence in 'Customer Oriented Operations' in the supply chain, with an objective to provide their customer, a uniform and consistent experience in their interactions with the organization. 'Customer Intelligence' supported by robust and accurate customer and related data enables organizations in making the right strategic and operational decisions to serve the customers better and quicker. However, most companies struggle to leverage 'Customer Intelligence' because of unreliable data in their organization.

This paper highlights the key reasons leading to customer data quality issues and outlines an approach that can enable organizations recognize and address the issues in their customer data quality improvement journey.

### **INTRODUCTION**

#### **Wading through the competition**

**The conventional approach:** Competitive pressures have been driving the businesses differentiate through exceeding quality expectations at a lower cost. This differentiation lever primarily targeted on excelling in cost efficient supply management and manufacturing activities – strict quality assurance, value engineering and continuous improvement to attain the 'price & quality efficiency' targets.

**With the turns:** With cost and quality differentiation stretching thin, companies are looking at greater opportunities in defending their market share and enhancing the customer base by excelling in 'Customer Oriented Operations' - through providing a unified and consistent quality experience, the key aspect being responding to customers quicker and better.

One of the enablers of 'Excellence in Customer Oriented Operations', is 'Customer Intelligence' that can be leveraged strategically to identify, acquire, rightly serve and retain those 'high value' customers. Good quality customer data forms the backbone of an efficient Customer Intelligence System. However, most companies struggle with enormous but unreliable customer data, few reasons being non-standardized way of capturing the data, proliferation of disintegrated systems capturing the data resulting into isolated data pockets, lack of coherence between multiple channels used to transact with the same customer and disjoint processes of maintaining the data. While, few organizations fail to recognize the issues of poor data quality and their impact on their business metrics, most resonate, but fail to institutionalize adequate measures to address the issues

around managing this. In a primary research<sup>1</sup> conducted by the authors jointly with 'Electronics Research and Survey Association' (ESCA), USA in 2006 with 30 companies in the high technology industry in USA, around 59% mentioned that they faced severe challenges because of poor data quality with 'data inaccuracy', 'data incompleteness' and 'poor integration of customer data' being the major issues.

Most organizations feel complacent after implementation of Customer Relationship Management (CRM) systems, assuming that success of the CRM system would fulfill their mandates in the customer orientation journey. Often, there is a preference of aligning the customer data with the CRM Systems need and not adequately with the supply chain need, thus leading to tangible impacts in supply chain operations metrics e.g. number of consignments returned because of incorrect 'Ship-To' address, wrong deliveries of invoices because of incorrect 'Bill-To' addresses, etc. Fig. 1<sup>2</sup> illustrates the impact of poor quality customer data on business operations and business metrics:

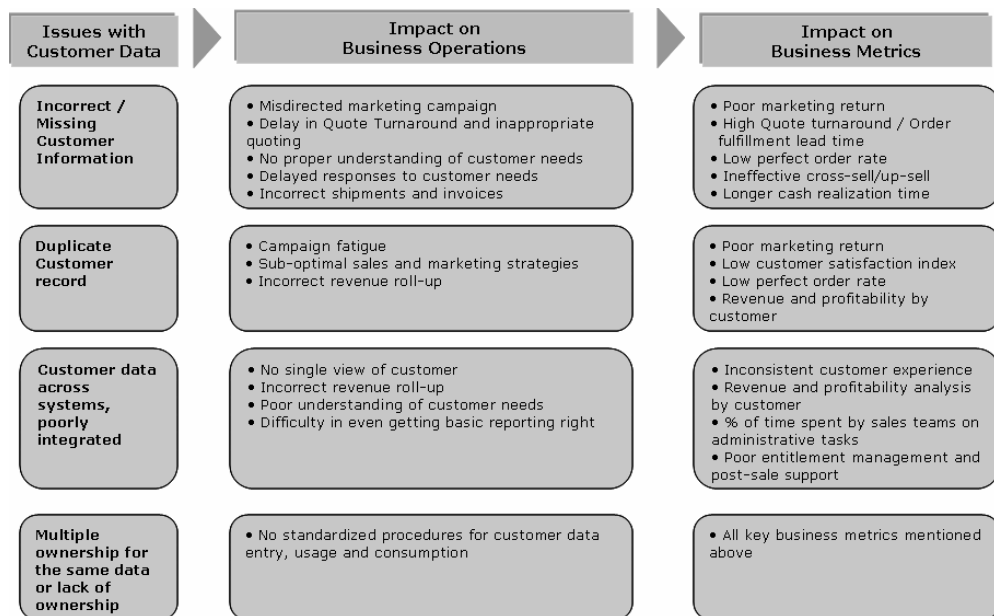


Fig.1: Illustrative list of impact of customer data issues on business operations and business metrics

### The Holistic Approach in Enhancing Quality of Customer Data

Quality customer data is a result of a systematic approach that requires a balanced emphasis on the three aspects<sup>2</sup> (Fig 2):

1. **Preventive:** Prevent erroneous, incomplete and redundant data entering the organization.
2. **Corrective:** Profile, validate, correct and consolidate existing erroneous, incomplete and redundant data.

3. **Sustaining:** Establish governance of processes, infrastructure and resources in maintenance and continuous enhancement of customer data quality.

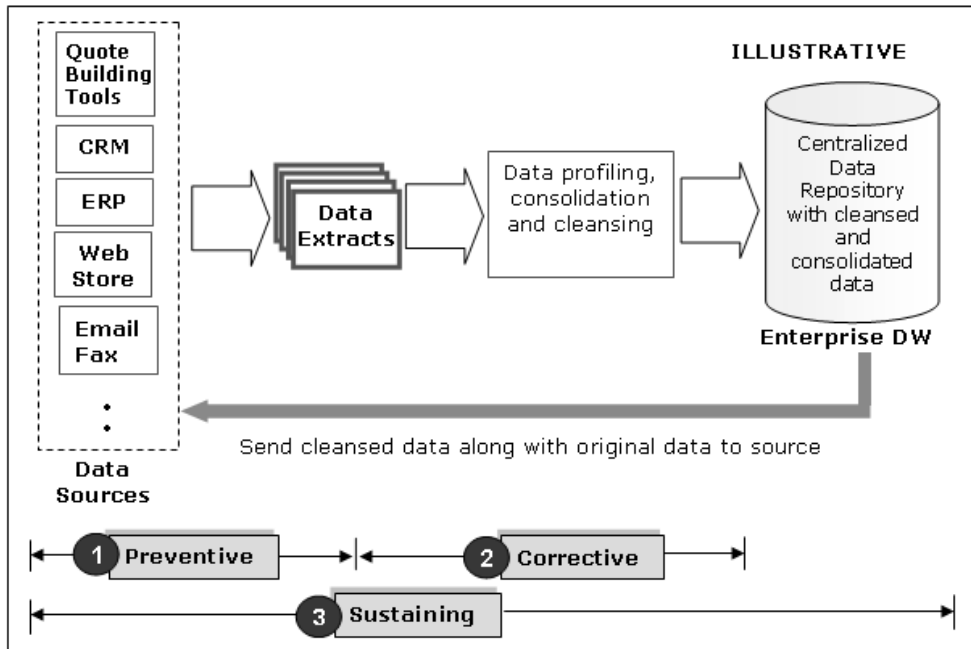


Fig.2: The three pronged approach of managing customer data quality

These three aspects are required to be looked at in tandem, with the approach being aligned with the business objectives of the organization. As an approach, few of the key steps, although not essentially sequential, are outlined as follows:

### Step 1: Scoping

- Identify the sources of customer data and customer data repositories.
- Understand at a high level, the need and usage of customer data by various business processes in the organization. Few of the key processes include campaign management, lead management, quote management, fulfillment, after sales services etc.
- At a high level, identify and prioritize the key issues faced by various functions in usage of customer data.

A well defined scope based on prioritization of data quality objectives of the organization ensures a focused direction in the data quality improvement journey.



### **Step 2: As-Is Assessment**

- Perform 'Data Health Check' based on systematic sampling of customer data from various systems/repositories and assessing the quality of data against a set of key parameters, few of which include:
  - o Duplicate customer records
  - o Incomplete customer records, incompleteness being further bucketed based on the key attributes of the customer
  - o Degree of inconsistency in the values of certain attributes
  - o Level of consistency in data definitions and interpretations
  - o Discrepancy between the actual data and data type definition
  - o Unique constraint violation – different representation of the same value of an attribute across customers

Initial health check of the existing data provides a quantitative estimate of the issues that could be considered as one of the bases in prioritization of the activities in the analysis phase.

### **Step 3: Analysis and Solution**

This is a crucial phase that focuses on:

- Information gap – identify missing information and recommend new processes or systems to capture additional information.
- Process gap – recommend new process or systems or customization / configuration of existing systems to fully leverage customer information.
- Potential data redundancies – minimize redundancy in the data and emerge with a single source of truth about the customer.

Few of the key areas for analyses include:

#### **Data Requirements vs. Availability**

- Identify the processes and sub-processes in the organization that potentially use customer data.
- Analyze the current usage of various customer attributes by these processes and sub-processes.
- Compare type of information captured about the customer vis-à-vis information required to run the business operations. One of the key pitfalls is gathering customer information based on customer facing processes alone without adequate focus on the fulfillment processes such as 'Delivery of Products and Services', 'Invoicing', 'After Sales Service' etc.
- Identify the attributes that are not captured now, but that could be useful with respect to future direction of the organization.

#### **Data Generation**

- Map the processes that are linked to generation of customer data in the organization. Identify and prioritize the issues to be addressed. For example, a prominent issue could be disparate information about contacts and transactions with customers because of proliferation of disintegrated sales channels and/or lead management/transaction systems.
- Evaluate accuracy targets in data entered/created. Not all attributes require the same level of accuracy.

- Assess ease of data entry, possibilities of standardization and automation in the data entry processes. Few of the standardization measures include providing drop down list of values to choose from for certain attributes, judicious definition of mandatory vs. non-mandatory fields etc.

### **Data Infrastructure**

The following are some key assessments that need to be made:

- Definition of data model for optimization.
- Robustness and scalability of existing data models.
- Optimization of databases from a technical perspective.
- Technical architecture of storing the data – centralized vs. decentralized, decoupling of master data and transaction data.
- Data Architecture, existing level of integration between the systems vis-à-vis the integration requirements.

### **Data Consolidation Processes**

- Evaluate possible alternatives for validation, de-duplication, cleansing, consolidation and publishing of cleansed data to various systems. If 3<sup>rd</sup> party tools are to be used for validation/de-duplication/filtering of data, identify fitment of 3<sup>rd</sup> party tools and their usage in the process.

It is a misconception if data consolidation is considered as a fully automated process. While organizations plan to leverage third party tools to consolidate customer data, it is important to understand the capabilities of such tools and plan their data consolidation exercise including the manual inputs and intervention that may be required to consolidate the data.

### **Data Ownership & Organization**

Assess the data governance processes in terms of:

- *Data Ownership*: Establish owner of customer data – the entity responsible for data should have the authority to manage it, and hence be accountable for it
- *Data Organization*: Data governance requires both the business and technology understanding and hence the data governance team should have adequate representation from both Business and Information Technology Management teams. For example, few of the key responsibilities of business include defining and documenting regional business rules and policies, periodic review and cleansing of data, defining data quality metrics, measuring and reporting data quality, periodic interaction with data users and identify scope for continuous improvement. On the other hand, few of the key responsibilities of technical team include design and implementation of the data architecture, optimizing the data model, maintain integration between systems as the IT infrastructure proliferates and archiving of data.
- Data governance team should have the full authority and responsibility to define the standards, processes, business rules for data management and data quality audit.

### **Data Performance Management**

- Identify the key metrics for data quality and establish linkages of these metrics to business metrics. Few of the data quality metrics include 'percentage of duplicate records', 'percentage of customers with values of certain attributes missing', 'percentage of customers that have incorrect values of attributes' etc. Few of the business metrics include 'quote turnaround time', 'perfect order rate', 'number of returns because of wrong 'Ship-To' etc.
- Prioritize the metrics. In certain cases, the metrics can be co-related and a metrics hierarchy can be established.
- Define plan for monitoring data quality on a continuous basis, analyze the results and plan for incremental improvement.

### **CONCLUSION**

Changing business scenarios, forays into newer markets, competition, changes in identity of the customers and several other reasons make customer data, a dynamic master data mandating its management through an ongoing process with a systematic approach. Good quality customer data might have an initial connotation of 'nice to have', since the organizations could still manage their business for years with existing data. However, establishing the data quality metrics and relating them to business metrics can help provide quantitative estimate of the impact that could convince the organization that 'data quality' is a 'must have' necessity. While organizations embark on the data quality improvement journey, a phased approach with achievable targets set in each phase could form the foundation of transforming 'Data' to 'Information' to 'Intelligence'. An organization that succeeds in monetizing 'intelligence' has a definite competitive advantage.

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1. Primary Research: The Primary Research was conducted in 2006, by the authors representing Infosys Technologies Limited jointly with Electronics Supply Chain Association (ESCA). The research involved structured interviews with 30 players in the high-tech industry in the United States. Few of the areas for exploration included Demand Sensing, Demand Shaping, Demand Fulfillment practices and the Usage of IT tools in their business and future investment priorities.
2. Artifacts on 'Data Quality Services/Customer Information Management Solution', Infosys Technologies Limited, 2006.

## **USING "QUICK SCAN" AT A MEDIUM-SIZED FOOD COMPANY: A CHANGE MANAGEMENT PERSPECTIVE**

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### **ABSTRACT**

The QS methodology is adapted to take a more human-centred approach, and applied to a medium sized food manufacturing business. Quick hits on forecasting, raw material shortages and schedule adherence are identified and implemented using a team-based approach

### **INTRODUCTION**

Company A is a rapidly growing food manufacturing company supplying major retailers and coffee shop chains in the UK. The company uses natural and additive-free ingredients to supply short self-life products to a market with significant demand uncertainty. The company has grown organically to its present size of 500 employees from a home based start-up company in only 17 years. The company is currently seeking to improve the planning and control of its supply chain, and has embarked upon a joint project with the University of Brighton to identify problems and next steps using the proven Quick Scan (QS) methodology (Towill et al., 2002). The QS methodology is to understand, document, simplify and improve the material and information flows of the subject supply chain. It has been employed in 20 automotive supply chains and in other manufacturing companies. The generic input-output, feedback and control model which underpins QS has proved to be transferable to food manufacturing.

### **METHODOLOGY**

The QS process was carried out by the writers with the help of a business champion, and was planned to take place over a 3 month period; i.e. with fewer resources and taking longer than recommended by the originators Childerhouse et al. (1999). Archival data collection and semi-structured interviews formed the investigation phase, which was analysed using the uncertainty circle model, dividing supply chain uncertainties into four areas; supply, demand, control and the value-adding process (Mason-Jones and Towill, 1998). In this way, problem areas can be recognised and solutions developed, with improvement efforts initially focused on 'Quick hits'. Key archival data sources are illustrated in Table 1 below. Findings from the archival investigation were used to develop the questions employed in semi-structured interviews with 16 people drawn from planning, sales and from different levels in the production organisation. Pareto analysis, process mapping and cause and effect analysis were applied to the archival data and interview findings.

### **CHANGE MANAGEMENT**

Reis and Pena (2001, cited in Mullins, 2005, p. 971) suggest that in order to overcome change barriers, the improvement project should focus on recognition of the human element; including the resistance to and fear of change. Following

this suggestion, during the 16 interviews with employees from different departments, the aim of the QS process and its expected benefits was explained. According to Balogun and Hope-Hailey (2004), early communication gives enough time to absorb, understand and adjust to the change. Interviews are used to collect data *and* to prepare employees for a potential change and to reduce resistance.

<b>Uncertainty Area</b>	<b>Subject Measured</b>	<b>Source</b>
Demand Side	Forecast accuracy	Customer dating sheet and forecasts
Process Side	Production target and output Sources of problems in production	End of Shift Reports
Supply side	Average ingredient stock holding days	Stock Report
Control Side	Shortage reasons	Shortage Reports

Table 1: Company A's QS Data Sources

### **Findings and Analysis**

Forecasting is an essential approach to reduce the demand uncertainty in the supply chain. In Company A, the Planning Manager forecasted demand according to his experience. None of the conventional mathematical models had been applied into company's forecasting process, and the Mean Absolute Percentage Error (MAPE) was found to vary from 16 % to 26% for nine typical products.

The Process side of the company converts customer demand into finished goods as directed by the daily manufacturing plan. However, on average, the company only achieved 96% of its daily production plan and 92% of its daily packaging plan. The difference between production and packaging efficiency caused high work-in-progress in manufacturing. Raw material shortages, lack of labour and machinery breakdowns were found to be the main problems, which contributed 70% of the production variances. The remaining 30% was caused by technical problems and by changes to the daily schedules.

Company A has an average 40 days stock of packaging materials and 15 days of ingredients. Defining, measuring and managing customer service is important for supply chain management as customer satisfaction has become a prime objective (Christopher, 1992). Company A's shortage of delivered product to customers represented 0.16% of its sales. Reasons were investigated using the uncertainty circle, and 50% were due to stock control errors, raw material shortages and delays in the packaging process.

Weaknesses in the uncertainty areas are summarised in Table 2 below.

<b>Uncertainty areas</b>	<b>Weaknesses observed during the QS</b>
Demand Side	Forecast errors Sales process
Process Side	Bottleneck in packaging Long lead times

Supply Side	High packaging and raw material stocks
Control Side	Managing resources Double handling of information Stock Control System Manufacturing Planning System

Table 2: Uncertainty areas and weaknesses at Company A

### Feedback Presentation

The aim of the feedback presentation is to illustrate the findings to the business champion, to discuss improvement opportunities and to agree an action plan. McCalman and Paton (2000) argue that effective communication is key to reducing resistance to change. In this improvement project the feedback presentation was used as a communication tool between board of the company and the employees to reduce potential resistance. The QS Analyst made 6 presentations to 40 employees from different departments including production shift managers, production and packaging supervisors, sales, commercial, accounting, technical, product development and human resources departments. Employees were agreed that the QS feedback presentations gave a brief view of the current situation of the business to the employees and showed the way forward to better supply chain operations.

### Implementation

Empowerment and team-working are the main aspects of the human-centred approach to change (Mullins, 2005). In the implementation stage of the QS, there was a focus on giving responsibility to people for their work and encouragement to work in teams. Watson (1994) argues that teamwork is a tool of change and produces more effective results than individuals working alone. 'Quick hits' were implemented through a series of small projects teams. To reduce the demand uncertainty, mathematical forecasting techniques were applied, and sales and planning departments started to work more closely together to improve forecast accuracy. Due to the complexity of the raw material stock problems, a new stock project was established to address supply uncertainty. Manufacturing schedule adherence was partly addressed through implementation of a new key performance indicator (KPI).

Although the project focused on reducing resistance to change through increasing communication and empowerment in the company, there were still some barriers to implementation. Childerhouse et al's (2003) Business Process Change Model identifies barriers to implementation in organisation, technology, finance and culture. In addition to these barriers the "previous experience" of the company was found to constitute a barrier to change for one of the longer term proposals arising from the QS.

### CONCLUSION

The QS process employed at Company A was adapted through more extensive use of interviews, and by prefacing the interviews with an explanation of the purpose of the project. In addition, 6 feedback presentations were made to people at all levels within the company, and a team work approach was taken to the implementation of the 'quick hits' identified. The authors believe that the human-centred approach adopted to the QS at Company A represents an improvement to this tried and tested methodology.

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# **SUPPLIER INVOLVEMENT IN PRODUCT DEVELOPMENT**





## **NEW PRODUCT NOVELTY AND SUCCESS RATES IN THE UK FMCG INDUSTRY**

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### **ABSTRACT**

Apocryphical new product failure rates of 90-95% are suggested to exist in the fast moving consumer goods (FMCG) industry, although little rigorous research exists on this topic. This paper presents the findings from a structured data collection exercise conducted as part of an applied research project to validate private-label success/failure rates in the UK FMCG industry. This project involved Asda and six of its leading private-label suppliers. After presenting a new innovation typology for the UK fast moving consumer goods industry, it draws on data provided on 283 individual product development projects undertaken by these suppliers to establish the innovation project and associated success profiles. A 21% failure rate was found (with a further 14% of projects dropped during the development process). It was concluded that (a) 90-95% failure rates are folklore (b) private-label success rates are generally better than those for manufacturer branded products and/or (c) retailer aspiration of private-label success is generally lower than that for branded products, as reflected in the measurement criteria.

### **INTRODUCTION**

Despite the strategic importance of an effective product development programme, evidence indicates that firms are generally poor at the process of designing and launching commercially successful new products. Whilst often taking on the status of apocryphical folklore rather than rigorous research, product development failure rates as high as 90% have appeared in the popular and consultancy press (Cooper, 1994). However, citing Crawford's (1979) study Cooper (1988) suggests that a more accurate marketplace failure rate of the new product launches of industrial-product [manufacturing] firms lies between 35-50%, with this figure varying depending upon how 'new product' (newness or novelty) and 'failure' are defined.

Little has been written specifically about new product [and packaging] development (NPD) within the fast moving consumer goods (FMCG) industry, and less about private-label development performance (Francis, 2006; Grunert *et al.*, 1997); the topic of this paper. These FMCGs are low-priced items that are used with a single or limited number of consumptions (Baron *et al.*, 1991). Unlike durable goods, there have been few studies that have attempted to address the classification of relative novelty and associated commercial success/failure rates in the FMCG context. In a parody of the folklore mentioned earlier, the consultancy firm Ernst & Young LLB cite "[*historical*] *conventional industry wisdom ...*" (Ernst & Young LLB/ Progressive Grocer, 1997, p.10) as evidence for a 95% failure rate for the 20,000 new products introduced in American supermarkets every year. Commenting upon the European grocery and FMCG market, Ernst & Young/ ACNielsen (1999, p.4) similarly state that "... *it is said*

*that around 90% [of all products launched] fail within two years".* From the existing evidence it would seem that the FMCG industry is particularly poor at launching successful new products; with such failure rates representing enormous development and opportunity costs for all the firms involved.

## **LITERATURE**

The only attempt to quantify NPD performance in the UK FMCG industry is the Efficient Product Introductions (EPI) project (*op cit.*). This set out to ascertain the NPD success/ failure rates for all types of project within the European FMCG sector, and contained a stream of research on the UK. 7,682 European Article Numbering code records from the UK were extracted from the database of new European FMCG product registrations maintained by ACNielsen. The sample encompassed all the new products launched between 1<sup>st</sup> June 1996 to 30<sup>th</sup> June 1997 from 32 representative food, beverage and non-food product categories.

Each code was first classified into its relative type of innovation project by reference to a bespoke typology called the Innovation Based Clustering (IBC) model. This recognised six types of development project; two classified into each of high, medium and low innovation level categories. 'Level' of innovation referred to perceived newness of the end-product, with 'high' equating to radical and 'low' equating to incremental' projects. 1.6% were of higher innovation project types, 85.8% medium and 12.6% of low innovation levels. EPI found that nearly 82% (6,285) of the UK sample were of the medium innovation, Me-too type (copies of existing products). All [retailer] private-label products were classified as Me-toos; constituting 49% (3,091) of this category. The relative commercial success of each of these project types was then plotted. The failure rate for the Me-too category as a whole was between 90-95% whilst failure rates for the other types of innovation project varied between 70-95%. A correlation was established between level of innovation and success, with the study concluding that high innovation is a critical success factor (Ernst & Young/ ACNielsen, 1999, p.50).

## **PURPOSE**

The purpose of this paper is to detail the findings from a parallel study of EPI designed to validate the actual new *private-label* product failure rate within this world class UK industry. This was designated the Supplier Association New Product Development (SANPD) project, which was initiated by the newly launched Asda Supplier Association (SA) in July 2005 and lasted six months. The paper addresses the four key questions to answer when considering this topic area: What classifies a product as new (degrees of 'newness')? How many new products are introduced? What constitutes success and how successful are these new products? (Ernst & Young LLB/ Progressive Grocer, 1997, p.44).

## RESEARCH METHODOLOGY

The SANPD project adopted an applied, case study-based research strategy with the researcher acting as a facilitator in return for research access. The project involved Asda and six of its leading private-label product suppliers that were all drawn from the SA (Table 1). These six SANPD firms exemplify the SA and wider private-label supply base. They represent £0.8 billion cost of goods sold (COGS), supply 22 (ambient and fresh/ chilled) product categories and have Asda-related turnover ranging from 16-100%. Their individual number of Asda stock keeping units range from 15-297 and their NPD activity with Asda in the year preceding the project (2004) ranged from 10-189 new product lines launched. The SANPD project also involved the Asda single-source reprographic agency that was responsible for coordinating all private-label packaging development, along with a representative packaging design agency.

Company	Category
Supplier A	Household, Health & Beauty
Supplier B	Primary Poultry, Rotisserie
Supplier C	Rice, Pasta, Foreign Foods, Condiments & Cooking (sauces, pickles etc)
Supplier D	Produce-Bagged Leaf, Prepared Salads
Supplier E	Milk, Cream
Supplier F	Cooked Meats, Bacon, Sausage, Fresh & Frozen Coated Poultry, Fresh Chicken, Frozen Chicken, Lamb, Pork, Pies, Deli, Meals Made Easy, Deli

**Table 1.** *The Suppliers Involved in the SANPD Project*

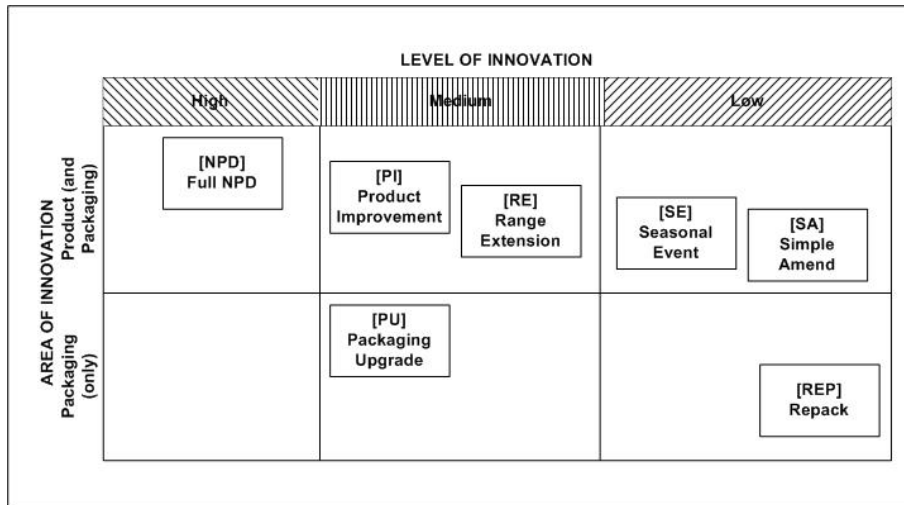
Having previously mapped and validated the current-state of the standard Asda private-label NPD process called *Bullseye* (Francis *et al.*, 2006), the findings in this paper are derived from a structured data collection exercise conducted as part of the case. This was designed to establish the quantitative baseline operational performance level of the Bullseye process for each of the six suppliers.

## FINDINGS

The IBC typology was rejected by the SANPD team because it inadequately accommodated private-label and packaging development projects. The team consequently developed a new typology to classify their innovation project types (Figure 1). The first, 'Level' of innovation axis indeed reflects the IBC framework. The second axis recognises that all FMCG product development requires concomitant packaging development, and the fact that packaging development alone can also form a project. There are seven recognised project types. Their acronyms are used for the remainder of this paper.

Addressing the project types in what was considered their descending level of innovation; an NPD project is a new or unique product idea or launch of a new brand of product/s. A PI involves a significant improvement applied to an existing product, such as a recipe or formula upgrade. Next comes a PU, which is a packing (only) project and involves the introduction of a new or more highly innovative type of packaging for an existing product/s. The fourth most highly innovative type is an RE. This involves introducing a new secondary characteristic such as flavour, size or format to an existing product range. Next comes the SE project for seasonal or event-driven developments (eg Easter eggs). The sixth type is the SA project that involves a minor product change

such as a cost reduction or new pack size. The least innovative project type is the REP, which involves a simple change to an existing packaging format. For example, a new illustration to 'refresh' the packaging.



**Figure 1.** *Typology of UK FMCG Innovation Projects*

The above typology was subsequently used in a questionnaire sent to all six SANPD suppliers to establish a baseline for their respective NPD performance. This was designed to provide a company-specific micro-analysis of each of the [283] new product lines they had collectively developed in the period 2004/5. Table 2 details the findings. In marked contrast to the findings of the EPI project (Ernst & Young/ ACNielsen, 1999) the table illustrates that 46% of the development projects were categorised as highly innovative, 33% as of medium innovation and 21% of low innovation. It also illustrates very significant intra-firm variations in innovation profile; including their focus on and distribution of project types. Clearly there is a need for such companies to develop an innovation portfolio management capability and to consider where they should seek to be the innovator as opposed to [fast] follower.

A uni-dimensional metric of 'success' was used in the Bullseye NPD process. This was the new product still being listed (on shelf) 12+ weeks after its launch. If a product was launched but de-listed within 12 weeks it was considered a 'failure'. Surprisingly, a product could be fully developed but not launched (due to shelf-space constraints or an event-specific product missing its launch window); also classifying it as a failure. Table 3 illustrates the success/ failure rate findings by project type.

Company	NPD	PI	RE	PU	SA	SE	REP	Total by Co.
Supplier A	15 (13%)	4 (3%)	32 (27%)	17 (14%)	16 (13%)	14 (12%)	22 (18%)	<b>120</b>
Supplier B	13 (65%)	0	7 (35%)	0	0	0	0	<b>20</b>
Supplier C	24 (49%)	0	21 (43%)	0	4 (8%)	0	0	<b>49</b>
Supplier D	27 (68%)	2 (5%)	2 (5%)	8 (20%)	1 (2%)	0	0	<b>40</b>
Supplier E	7 (70%)	0	3 (30%)	0	0	0	0	<b>10</b>
Supplier F	45 (96%)	0	0	0	0	2 (4%)	0	<b>47</b>
<b>TOTAL by Type</b>	<b>131</b>	<b>6</b>	<b>65</b>	<b>22</b>	<b>21</b>	<b>16</b>	<b>22</b>	<b>283</b>
<b>AVG. by Type</b>	<b>46%</b>	<b>2%</b>	<b>23%</b>	<b>8%</b>	<b>7%</b>	<b>6%</b>	<b>8%</b>	
<b>AVG. by Level</b>	<b>46%</b>	<b>33%</b>			<b>21%</b>			

**Table 2.** Number of New Product Lines by Company/ Project Type (2004/5)

Perform. Category	NPD	PI	RE	PU	SA	SE	REP	Total by Cat.
DROPPED Prior to Full Devt.	36 (28%)	0	3 (5%)	0	0	0	0	<b>39</b>
FAILED: Not Launched	24 (18%)	2 (33%)	10 (15%)	0	0	0	0	<b>36</b>
FAILED: Delisted <= 12 wks	16 (12%)	0	0	3 (14%)	0	4 (25%)	0	<b>23</b>
SUCCESS: Listed 12+ wks	55 (43%)	4 (66%)	52 (80%)	19 (86%)	21 (100%)	12 (75%)	22 (100%)	<b>185</b>
<b>TOTAL by Proj. Type</b>	<b>131</b>	<b>6</b>	<b>65</b>	<b>22</b>	<b>21</b>	<b>16</b>	<b>22</b>	<b>283</b>
<b>DROPPED by Level</b>	<b>28%</b>	<b>3%</b>			<b>0%</b>			<b>14% *</b>
<b>FAILED by Level</b>	<b>30%</b>	<b>16%</b>			<b>7%</b>			<b>21% *</b>
<b>SUCCESS by Level</b>	<b>43%</b>	<b>81%</b>			<b>93%</b>			<b>65% *</b>

**Table 3.** Commercial Performance (Success Profile) by Project Type

Note: \* Percentages for total development projects.

Significantly different success profiles between the project types are revealed. Success rates also seem to be *inversely* correlated with the innovation level of the project that was undertaken; the lower the innovation level, the more generally successful the project (and also the less likely that project is to be dropped during the development process). This last finding is in *direct contrast* to that of the EPI (*op cit.*) study, which recommended the highest possible innovation level project to maximise the probability of success. Lastly, but not illustrated in the table; a very high variation in success rates was also found by

company, with a positive correlation established with a larger distribution of project types (ie the more diverse the portfolio, the more successful the firm).

## CONCLUSIONS AND FUTURE RESEARCH

This research set out to validate actual new private-label product success/ failure rates in the world class UK FMCG industry. This paper presents a new typology of innovation for this industry and indicates the magnitude of development activity and profile of innovation project types undertaken by each of the six supplier firms involved in the study of the Asda Bullseye NPD process. It also explains the measures of success/ failure used by these firms and provides a detailed profile of this performance for each type of development project.

No equivalent to the Bullseye 12-week survival measurement of commercial success has been detailed elsewhere in the NPD literature, making a comparison of these findings difficult. However, this 12-week listing period is a meaningful success/ failure measure to Asda and its development supply base and should therefore not be regarded lightly. Whilst acknowledging this caveat, the resultant 21% Bullseye private-label failure rate recorded in Table 3 is in marked contrast to the apocryphical 90-95% FMCG failure rates reported by Cooper (1994) and prophesied in Ernst & Young LLB/ Progressive Grocer (1997). It also contravenes the findings and conclusions of the EPI project (Ernst & Young/ ACNielsen, 1999a) because either the Bullseye failure rate is significantly lower than EPI and/or the Bullseye portfolio was composed of more highly innovative product concepts than attributed to private-label by that study. It is therefore possible to conclude that (a) 90-95% failure rates in the FMCG industry are indeed folklore (b) private-label success rates are generally better than those for manufacturer branded products and/or (c) retailer aspiration of private-label success is generally lower than manufacturer aspiration of success for its branded products, as reflected in their measurement criteria. There is clearly a need to conduct future research to clarify these points.

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## POTENTIAL CHANGES IN A NON-TIMBER FOREST PRODUCT LOCAL CHAIN

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### ABSTRACT

Many recent development projects tried to promote the development of Amazonian communities and forest conservation by adding value to forest products. Though, most of them faced several difficulties associated to the complex relations among the traditional chain actors and to diverse infrastructure aspects. This paper presents the analysis of a non-timber forest product (NTFP) chain in a Brazilian Amazonian state. After an exploratory study within 3 groups of gatherers, a concise literature review concerning the aspects related to NTFP marketing is presented. Finally, a research-action and its potential impacts in the arrangement of another group of gatherers are commented.

**Keywords:** Non-Timber Forest Products Trading, Sustainable Local Development, Logistics

### INTRODUCTION

Brazil-nut (*Bertholletia excelsa*) is an important non-timber forest product (NTFP) for some countries in the Amazon region. Bolivia, Brazil and Peru are the main producers and exporters of the product. The state of Amapa, north of the Amazon, is one of Brazil's poorest areas, and one of the most protected from deforestation in the whole Amazonian forest (55% of the state is protected). Amapa represents 4% of the brazil-nut collection in Brazil, and it is the fifth state in Brazil in brazil-nut production.

The interest in studying the brazil-nut chain in the Amapa state is related to its regional historic that alternated some boom and bust periods. More recently, the state experienced some important development strategies focused on the development of local collectors' communities. From 1988 to 2001, three cooperatives of brazil-nut collectors were created, but until now they are not functioning exactly as they were supposed to be, due to organizational problems, but also to some aspects in the production and distribution infrastructure.

The possibility to work within another group of collectors in the state oriented a research that started with an exploratory study. To facilitate the understanding of the filed context, after the study, the literature review was carried out. For this reason, we present firstly the methodology design, followed by a literature review. The action research seeking to provoke some transformations in the local chain and the discussion of those changes are presented at the end.

### METHODOLOGY

The research started in September 2003 and had three phases, divided in exploratory study, from November 2003 to February 2005, literature review, between December 2003 and December 2005 and action research, from March



2005 until February 2007. Following, there are described each one of these stages.

### **Exploratory study**

An exploratory study was necessary, in order to understand the current and historical functioning of the brazil-nut production chain, i.e., the main processes and social and economic relations. During this study, informal interviews with the brazil-nut chain main actors were carried out, as well as observations during specific reunions and other field events. Some information was also gathered from the analysis of documents concerning the many strategies that were implemented with three groups of collectors, organized in cooperatives.

While the study was obtaining important field information, the consultation to literature references was also being conducted.

### **Literature review**

The literature review was carried out between the exploratory study and the action research, helping in the identification of some similar situations in other NTFP regions and also of some theoretical references concerning the brazil-nut chain specific processes and relationships.

### **Action research**

Another group of gatherers was chosen to participate in the action research. This group, different from the other three studied during the exploratory phase, was organized in an association of collectors. The main difference, among others, is that the association can not commercialize the gatherers' products, and they do not have any other choice than selling to the intermediary agents.

The main objective of the action research was to try to construct a new configuration of the brazil-nut's local production chain. In order to help the association members to think about the potential changes caused by the new arrangement, four workshops were carried out. During these reunions, subjects related to cooperation, legislation, quality control, prices conditions and market requirements were extensively discussed.

### **THE BRAZIL-NUT PRODUCTION CHAIN: AN EXPLORATORY STUDY**

The exploratory study initiated in September 2003 with a diagnosis of the brazil-nut production chain in Amapa, a Northern Brazilian Amazonian state. The initial objective of this study was to understand the specificities and main logistics problems related to the brazil-nut local chain that, besides various recent development projects, still faced important difficulties related to the products distribution and marketing.

The information concerning the brazil-nut chain in the Amapa state was gathered within public, private and non-governmental organizations, and complemented by interviews with the actors involved in some development projects, as well as gatherers – members and no members of cooperatives, cooperatives leaders and some clients.

The study found that, despite the efforts and investments for the three cooperatives creation, the traditional structure of brazil-nut exploitation still

persists, which means that the resellers are still the main buyers, being responsible for almost 50% of the purchases. The marketing of the brazil-nut is concentrated in 25 export companies, with only 8 of them responsible for 90% of the non-peeled nuts, for 75% of the peeled nuts, and for 82.7% of the total exported (Filocreão, 2002).

The cooperatives face several organizational problems and present difficulties to assure the clients supply and the collectors' satisfaction, especially concerning the product's prices.

In those previous projects, the proposal focused in the elimination of an actor, considered harmful to the collectors development. But almost all of them were not successful to attend this initial proposal, because they did not consider the very particular relationships maintained by brazil-nut collectors and intermediate agents. In many cases, the resellers have a better logistics infrastructure than the cooperatives. In the following table, the characteristics and main problems faced by the three cooperatives are presented.

Table 1 – Information concerning the three cooperatives studied.

<b>Cooperative</b>	<b>A</b>	<b>B</b>	<b>C</b>
<b>Number of Members</b>	125	26	99
<b>Main products</b>	Edible oil and dry nut	Raw oil for the cosmetic industry	Dry nut
<b>Main clients</b>	Brazilian exporting industries	Brazilian cosmetic companies	Southeast Brazilian food industries
<b>Collection and distribution infrastructure</b>	One Tractor and two trucks for collection in the forest (one truck is rent by an intermediate agent). The main clients contract transporters to collect the processed products. The warehouses used are rent by intermediate agents that buy the products for the cooperative that also does not invest in small sheds in the forest.	Two small boats for the products transportation by the river. The cooperative does not have any other vehicle. The transportation between the cooperative is paid by the cosmetic companies. The cooperative has a warehouse to stock raw nuts and a small deposit to stock manufactured products.	One Tractor for collection in the forest. Distribution to the main clients is done by transporters. About 10 small sheds distributed near the harvesting areas and two warehouses near the plant.
<b>Production and industrial infrastructure</b>	Dried brazil-nut plant and edible oil industrial extractor	Oil extractor for the cosmetic industry	Brazil-nut drier

Source: Adapted from Diniz and Fabbe-Costes (2006, p. 4).

From the three cooperative's information listed above, it is important to point out some evidences. All of them have no sufficient collection and distribution infrastructure, compared to their production and industrial configuration, what can menace their clients supply or imply in high transportation and storage costs for the cooperative. The inadequate storage conditions also can lead to low quality products, implying in lower prices, if the intermediate still accept these products, and in lost of clients, if they are more rigorous with quality demands. Another problem concerning the products' transportation is that, once the cooperatives have an insufficient transport structure, many collectors will continue selling their products to the resellers, that can finance and transport them in a shorter time, but without meaning that the products have a better quality.

### **LITERATURE REVIEW**

Concerning local and foreign projects seeking the local development by the intensification of NTFP marketing, Shanley et al. (2002) observes that, in practice, they can imply in countless obstacles, putting at risk the results of those initiatives and also generating expectations inside the involved communities. The author also remarks that the transportation difficulties are chronic, what is in accord with our field research. In addition, Bastos and Araujo (2004) pointed out that logistics appears as a key issue in these kinds of projects, but most of the efforts to promote regional development are dispersed, because of the lack of integration among the main stakeholders.

The brazil-nut production chain, as many other NTFP, has historical exploitative relationships, benefiting mostly those who are at the top of the marketing channel. It is a case of oligopsony, an imperfect competition, where, usually, the raw product is bulky and/or perishable and, thus, costly to transport (Sexton, 1990). Its specificities restrict the mobility of the product and limit the producers' outlets only to buyers located close to the collection areas, or able to pay transports up to the processing and exporting plants.

Another characteristic of products exploited by remote forest communities is that intermediaries may have the monopoly of information. Concerning this situation, Newman and Hirsch (2002, p. 67) state that 'lack of access to credit, transportation, information on price fluctuations and storage facilities combine to keep producers at a great disadvantage in the marketplace [...] these conditions provide plenty of opportunities for intermediaries to position themselves as almost unavoidable links in the marketing chain'.

Besides the exploitative conditions, Neumann and Hirsch (2002) also observed that, after achieving better NTFP prices, the collectors, whether individually or collectively, invested in transportation infrastructure, in order to have better integration between their region and outside markets. However, the relationships between collectors and intermediaries are not necessarily exploitative, what can explain why, despite having the option of selling their products to cooperatives, some gatherers still keep their relations with the resellers. Also, some new buyers take on roles that are in many ways not very different from the intermediaries they displace.

## **DISCUSSION ON THE CHANGES WITHIN A GROUP OF COLLECTORS**

Among the action research objectives, there are the transformation of the social reality and the knowledge production from that change (Allard-Poesi and Perret, 2003; Thiollent, 1992). For Dubost (1987, p.140), it is 'a deliberated action seeking a change in the real world, committed in a restrict scale, involved by a general project and submitted to certain disciplines in order to obtain effects in knowledge'.

According to Dubost's definition, the action research was carried out with a group of brazil-nut collectors in an Extractivist Settlement. Most of the collectors' families live in the settlement region for many generations. The main objective was to construct a new configuration of the brazil-nut local production chain, by introducing new information and appropriate technologies.

Considering the field and literature elements described before, most of them present several points in common. In the designing of the action research with the collectors, we tried to consider the previous experiences' conclusions. An exploratory study in the settlement area also preceded the start of the researches intervention.

The exploratory study with the settlement communities and other actors related to the brazil-nut local chain helped us to understand and compare the existing specificities between the other three cooperatives context and the Maraca settlement context, and also between the literature and the local reality. Consequently, the main changes focused in the settlement were:

- Construction of a minimum manufacturing structure, using renewable (solar) energy for drying procedures, in association with an experimental project to introduce alternative energy in remote communities.
- Quality improvement by the introduction of more adequate conservation techniques, storage and transportation.
- Stimulate the discussion about the importance of a gatherers organization as a strategy to add value to their products.
- Stimulate the participation of the gatherers' sons in activities in cooperation with the Family School of the Maraca Settlement.

Sharing some new information within the collectors of the Maraca Settlement made possible their participation in some local strategies for the improvement of the brazil-nut marketing not only with previous intermediary agents, but also with new actors, as other local merchants that were attracted by the new possibilities, and two of the three cooperatives studied before. Also, a potential cooperative is being organized by (and for) the gatherers of the Settlement.

The fact that these gatherers are contacting other cooperatives or trying to organize them in order to compose their own cooperative demonstrates that they are now more conscious about searching other market alternatives. When the monopoly of the information is broken, naturally a new arrangement starts to be designed. The arrival of a new intermediary agent, in a local chain that used to have only two resellers, in a typical oligopsony situation, can contribute to better prices for the collectors, as well as in higher quality exigencies.

Finally, when a development strategy considers the involvement of younger generations, as the sons of the collectors, it is an important sustainability element, once they learn the importance of their parents' activities and how they can contribute to improve their work conditions. It is not only a matter of introducing new techniques and strategies, but of how introduce them and in which local group. Experiences related in the literature and some field situations show that the development of these chains is not so obvious and must be considered in a systemic approach, paying cautious attention to local specificities.

### **ACKNOWLEDGMENTS**

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## **LEVERAGING SUPPLIER COLLABORATION FOR REDUCING TIME-TO-MARKET IN DEVELOPING ECONOMIES: AN AUTOMOTIVE INDUSTRY PERSPECTIVE**

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### **ABSTRACT**

Developing economies are gradually becoming the cynosure of all global players irrespective of the industry. But to enter these markets a completely new product strategy needs to be devised. To leverage the low cost structures in these places, organisations are going about simultaneous product development. In the automotive industry as majority parts are bought-outs, a collaborative relationship with suppliers is a must for successful product development. This paper brings out a process framework for new product development and the corresponding supplier strategies to be adopted for realizing the best outcomes. Numerous challenges have to be overcome for a successful supplier collaboration implementation. And finally to keep the product development process on track, the paper describes the key process measures that have to be adopted and regularly monitored.

### **OVERDRIVE ON THE CHANGE HIGHWAY**

Cost, competition and customer demand have catalysed over-riding changes in the automotive industry. Depleting product life cycles, consolidations through mergers and acquisitions and double-digit growth rate in developing nations is a clear manifestation of such over-arching transformations. Automotive behemoths of the developed nations, who have always viewed the developing nations with scornful scepticism, have turned a Volta face. These mega-corporations have started setting up shops in India and China to fuel their corporate growth engines.

### **DEVELOPING ECONOMIES – A DIFFERENT PRODUCT APPROACH**

When vehicle manufacturers plan to set up bases in these emerging economies, what poses the greatest threats are product selection and product development strategies. Extreme cost propensity of demand, inadequate road infrastructure and excessively high fuel costs propel most automotive big-wigs to redesign products to meet market requirements. Products which have low initial costs have easy spare parts availability and low running costs become necessary attributes for products to enter these markets.

### **SUPPLIER COLLABORATION: ESSENCE OF COMPETITIVE ADVANTAGE**

Age-old strategies of introducing completely-built-units (CBU) or completely knock-down (CKD) kit assembly while penetrating new markets, does not cut much ice in developing economies. In-built high cost proposition lead to an inevitable failure for such strategies. Ability to localize parts and components above the threshold of 70% by value is THE critical success factor (CSF) of any automobile launch here. As anything above 80% by value of the products is in the form of bought-outs, a close knit collaboration with suppliers is the essence of competitive advantage for vehicle manufacturers. This paper provides a structured approach for leveraging supplier collaboration for new product development.

## CHANGING FACE OF THE SUPPLIER INDUSTRY

The ever-growing need for specialization, upstream partner control imperatives and impending design accountability has resulted into modularisation of automotive components. Now, suppliers would provide original equipment manufacturers (OEM) a “wiping module” comprising Wiper Motor, Pivot nuts, link assemblies, Arms and blades, all in one piece. Gain of OEMs is a bolt-and-plug module with fitment and inventory convenience, and suppliers gain from design cost reductions. Modularisation has increased upstream responsibilities of suppliers. This has manifested into closer collaboration with suppliers during new product development (NPD). Fig.1 shows how upstream responsibilities are migrating to suppliers.

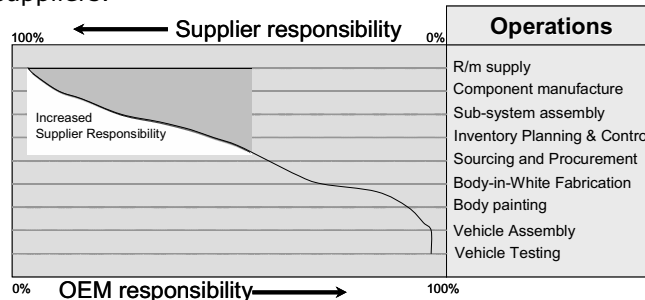


Fig.1 : Supplier responsibility enhancement

## NPD PROCESS FRAMEWORK

NPD in automotive industry follows a multi-stage framework, with parallel processing of tasks among OEM disciplines to ramp down development cycles. Fig.2 shows the NPD framework.

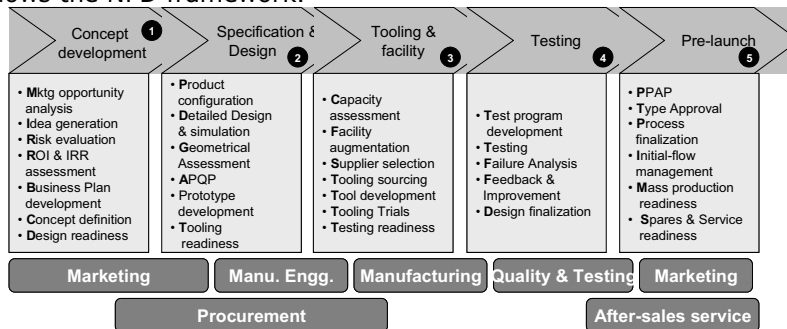


Fig.2 : NPD Framework and parallel task processing

In the traditional system of OEM-supplier partnership, the suppliers are only invited for participation in stages 3 and 4 of the framework. It is mainly an **adversarial relationship**, with over-dependency on OEMs. A lot of lead time is lost due to incomplete and inadequate feedback and subsequent reworks.

The modern approach is a **collaborative relationship**. Synergy is generated due to mutual trust and cooperation. Suppliers are involved in various stages of NPD based on the complexity of the products they handle and the value of the program.

**SUPPLIER CLASSIFICATION ON PRODUCT COMPLEXITIES**

Suppliers are classified into four main classes, which also reflect their level of maturity.

**Standard Product (SP):** These are suppliers producing standard components such as fasteners, bearings, consumables etc. Their involvement is limited to tool multiplications, tool validation tests and ramp-up delivery mass production.

**Contract Manufacturers (CM):** These suppliers are supplied tools by the OEMs and are required to manufacture as per defined service level agreements (SLA). Their involvement is mainly in stages 4 and 5.

**Self Tool manufacture (STM):** These suppliers are provided product and tool designs by the OEMs, and they manufacture tools and products in compliance to these designs. The involvement of these suppliers is a bit early from stage 3.

**Original Design (OD):** These suppliers prepare their own designs based on basic concepts of the OEMs. These are much mature suppliers and get involved with the OEMs in Stage 1 itself, after market opportunity analysis is complete. The collaboration of these suppliers is leveraged to the maximum to reduce time-to-market (TTM) for NPD. These suppliers are the greatest assets for the OEMs and the partnership demonstrate competitive advantage. The level of involvement is shown in Fig.3

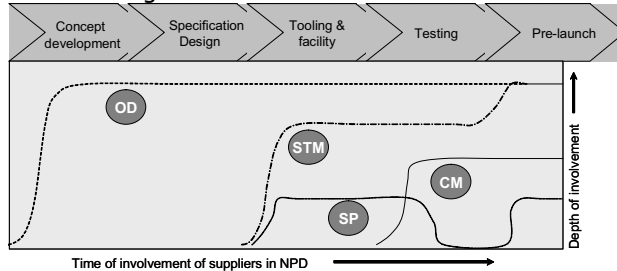


Fig.3 : Supplier involvement in NPD based on parts handling complexity

**NPD PROGRAM VALUE CLASSIFICATION**

A critical dimension which determines the level of supplier involvement in NPD is the value of the product to be developed. In the emerging economies where cost of capital is huge (high prevailing interest rates), automobile manufacturers extract the maximum of any platform design by introducing strip-down versions and extension versions after the basic product has been launched. A case in point is to develop Cab versions (strip down), Sedan versions (extension), and station-wagon versions (extension) over and above the hatch-back version (basic product). It can be seen in Fig.4 that with the increase in value of the product, the involvement of the suppliers increases with their maturity.

	Activities of NPD				Product Value attribute →		
	Product Design	Tool Design	Tool Manu.	Product Manu.	Strip-down version	Basic product	Extension version
OD	✓	✓	✓	✓	●	●	●
STM	OEM	OEM	✓	✓	◐	◐	◐
CM	OEM	OEM	OEM	✓	◑	◑	◑
SP	Univ.	Univ.	✓	✓	◒	◒	◒
	Univ : Universal standard OEM : Activity done by OEM "✓" : Activity done by supplier				● High involvement   ◐ Low Involvement		

Fig.4 : Program Value supplier involvement model



## CHALLENGES IN THE SUPPLIER COLLABORATION APPROACH

Collaboration with suppliers is easier said than done. This zone is fraught with a number of challenges and relationship complexities. The major challenges which become the root causes for other consequent fallouts are explained below.

**Technology familiarization:** The wide variation in the knowledge and skill level among suppliers poses the greatest threat for any NPD program. OEMs have to harmonise and play a leadership role in bridging this gap seamlessly.

**Multi-organizational complexity:** Cultural diversity, decision-making autonomy to centralization disparity and a wide range of performance efficiency among suppliers have to be managed and orchestrated by the OEMs for keeping the NPD program on track.

**Information management:** Multiplicity of players leads to multiple versions of a single "fact". Striking the perfect balance between information visibility and information confidentiality is the key. Deployment of high-end tools and techniques for real-time updates and close-looped feedbacks among all stakeholders can bind all the players together and keep their objectives focussed.

Other impediments such as delays and procrastinations, conflicting interests, inadequate trails and tests, reworks and cost escalations are consequences of mismanagement of the above mentioned challenges.

## MEASURES OF COLLABORATION EFFORT

Three key metrics define the measures to gauge success for supplier collaboration. These are enumerated below:

**Cycle time:** This is a measure of speed of the NPD program. This involves not only the total time for an NPD program from concept-to-launch, but also involves measuring time variations for micro-level milestones. The number of long lead-time activities expedited in anticipation, help reduce cycle times.

**Through-put:** This is a measure of accuracy of the NPD program. Measures of repairs and reworks, the number of Engineering change notifications (ECN) during development and defects-per-thousand units post launch help gauging the through-put level of any NPD program.

**Productivity:** This is a measure of utilization of resources of the NPD program. Persons, processes and paraphernalia contribute to resources, and measures like engineer-hours, machine-hours and number of modules re-used indicate productivity of the project.

The greater and earlier the involvement of suppliers in new product development, the more attractive is the metric results.

## CONCLUSION

Automotive OEMs planning to enter developing markets through their Greenfield launches can follow this framework for determining the level of supplier collaboration. Also the challenges highlighted in this article can be used as guidelines for implementing a smooth product development launch in the developing countries.

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# **LOGISTICS PLANNING AND CONTROL MODELS**



## **REAL-OPTIONS-APPROACH – A BASIS FOR THE ECONOMIC EVALUATION OF AUTONOMOUS COOPERATING LOGISTICS PROCESSES IN INTERNATIONAL SUPPLY NETWORKS?**

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### **ABSTRACT**

The main contribution of this paper is to provide an approach for the economic evaluation of Autonomous Cooperation (= AC) in logistic processes. This is a necessary basis for its application to business logistics and to management in general. Therefore, the Real-Options Approach (ROA) will be discussed as a theoretical framework to evaluate AC in International Supply Networks (= ISN).

### **THE NECESSITY FOR EVALUATING AUTONOMOUS COOPERATION IN ISN**

During the 10th International Symposium on Logistics in Lisbon (Portugal) several contributions of the management approach of AC to balance flexibility and stability in ISN were discussed (Hülsmann and Grapp 2005). AC is described as one opportunity to cope with complexity and dynamics, which are caused by typical drivers of change and diversity like hyper-linking, hyper-competition, hyper-turbulence (Tapscott 1999, Siegele 2002) in a global logistics context. In those logistic structures "companies are involved in different supply chain networks which again compete among each other on the world market (Seebauer 2003, p. 62, Lambert et al. 1998). These networks of supply chains shall therefore be characterized as ISN." (Hülsmann and Grapp 2005, pp. 243) Possible conceptual contributions of AC, which is defined by its characteristics of decentralized decision-making, autonomy, non-determinism, interaction and heterarchy (Hülsmann and Windt 2007), are based on the following overarching assumption, from the perspective of ISN-Management: reducing the quantity of systems and sub-systems which have to be controlled (i.e. companies involved in ISN) means they operate independently towards decisions and gain more flexibility. Sub-systems (e.g. local manufacturers) get a general direction (i.e. by ISN-Management) for their decision-making. Thereby they can flexibly decide within a predefined decision frame. As complexity is absorbed by an increased quantity of decision units, stability is ensured since less coordination work is needed. However, there are also conceptual risks of AC: One is the decrease of the total stability caused e.g. by sub-system egoism (e.g. considering only individual sub-system needs) (Hülsmann and Grapp 2005). Positive as well as negative effects of AC have provided the basis for discussion on the 11th International Symposium on Logistics in Beijing (China), where the measurement of the degree of AC via a monitoring concept has been described.

Flexibility as well as stability seem to represent significant strategic factors for a strategic ISN-Management (Hülsmann and Wycisk 2005). In this regard the question rises if AC could support abilities of reconfiguration (i.e. transformation of the configuration of competences) und replication (i.e. multiplication of existing

processes by standardization) of a company (Teece et al. 1997, Burmann 2002). Both are necessary for the adaptivity of a firm and are assumed to possibly have effects on the company value. In order to prove that the implementation of AC in logistic systems, like ISN, has an impact on the company value its economic advantage in relation to conventionally managed systems has to be evaluated. This in turn creates the need to develop an adequate evaluation system (Hülsmann et al. 2006a). Consequently, this paper's hypothesis is that a sustainable ISN-Management will only implement concepts, methods, and technologies (e.g. formation of autonomous working groups, use of RFID or intelligent freight units) if the economic benefit from increasing the degree of AC is higher than of the degree before. Therefore, it is necessary, that the degree of AC can be systematically evaluated, e.g. by ROA. The following questions and accordingly deduced aims result from the described research context and will be illuminated within this paper:

- **Question 1:** How can AC be evaluated systematically?  
**Aim 1:** Reasoning the selection of ROA as general possibility for evaluating AC.
- **Question 2:** What has to be understood under the ROA?  
**Aim 2:** Describing the ROA as a method from financial management.
- **Question 3:** How far does the ROA contribute to evaluate AC in ISN?
- **Aim 3:** Analyzing contributions of the ROA for evaluating AC in ISN.

#### **WHY CHOOSING REAL-OPTIONS-APPROACH TO EVALUATE AC?**

The development of criteria of the selection of an evaluation concept for AC in logistic processes can be subdivided into two steps: In a first step, the question raises to what extent AC in logistic processes and the economic evaluation of companies are related to each other in general (**General Evaluation Context**). In a second step, it will be examined whether and to what extent the specific assumptions of the selected range of possible evaluation approaches fit to the evaluation problem of AC (**Selection of a Theoretical Evaluation Basis**).

#### **General Evaluation Context:**

By implementing the idea of AC into logistic systems a higher adaptivity and reaction ability under complex and dynamic environmental conditions and thereby higher robustness of the whole logistics system are expected (**step 1&2**) (Probst 1987, Kirsch 1992, Malik 2000, Hülsmann and Windt 2007). Coming along with the paradigm of AC, companies are faced with the problem of evaluation of AC. Besides the assumed potentials of a higher adaptivity by AC there are also doubts about its cost-benefit-relation and accordingly return-risk-relation of flexibility and vice versa stability effects (Clausen and Kraft 2004, pp. 12). Thus, the question rises if AC provides any options for logistic systems (**step 3**) and if so, which ones are relevant for an increasing adaptivity of a system (**step 4**). Consequently, managers are interested in, how these options do affect the return-risk-relation of a company (**step 5**). Considering these questions, a general evaluation problem of AC-effects in logistic processes can be deduced. To evaluate AC in this context, the Real-Options-Theory could be an appropriate basis as the value of flexibility is explicitly considered. Objectives of a real-options-based evaluation are: identifying and assessing options of acting as a result of AC in logistic processes (see Figure 1).

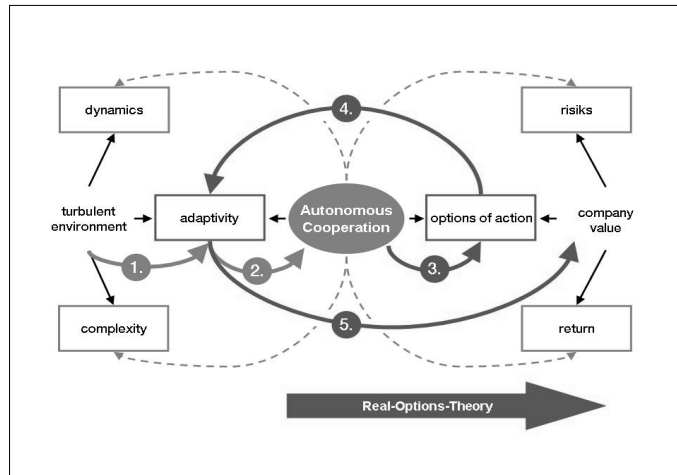


Figure 1. Evaluation Context of AC and Company Value

### Selection of a Theoretical Evaluation Basis:

To evaluate AC specific finance scientific requirements - here understood as criteria - for selecting an evaluation concept: flexibility, uncertainty, irreversibility have to be considered: Flexibility is the main characteristic of AC, which has to be evaluated (criterion a). Uncertainty has to be considered as AC is represented by non-linear processes. This can be reasoned with the attribute of autonomy of every single sub-unit that enables to choose between alternative ways of action. Since the next step of every single sub-unit can not be casually predetermined, the entire logistic system behaviour is not predictable (Prigogine 1996) (criterion b). Irreversibility has to be taken into account, because AC represents irreversible processes (Prigogine 1996) (criterion c).

Figure 2 shows the selection process of a theoretical evaluation basis. Possible evaluation concepts are named on the horizontal axis (Net Present Value, Sensitivity-Analysis, Monte-Carlo-Simulation, Decision Tree Analysis, and Option-Pricing-Model) and are compared according to criterion a), b), and c) on the vertical axis. Every concept has been examined regarding its contribution to each criterion. As a result, especially the ROA seems to be most relevant as a theoretical evaluation basis of AC for the following discussion. Due to its diverse range of options, compared to all considered concepts, only the ROA is fully able to enhance the value of flexibility of investments in one calculation (Trigeorgis 1996), so it meets criterion a). Options permit to calculate investments under uncertainty. Options include the right but not the duty to realize an investment (Copeland and Antikarov 2002). Thus, the higher the degree of uncertainty of an investment is, the higher is the value of flexible acting (option) in the ROA for a company (Trigeorgis 1996), which fulfils criterion b). Options are always bound with capital flows. Taking or not taking an option is a process, which cannot be completely called off without changing the system status at least regarding the lost or gained amount of capital (Kogut and Kulatilaka 2001). Consequently, the ROA meets also criterion c) of irreversibility.

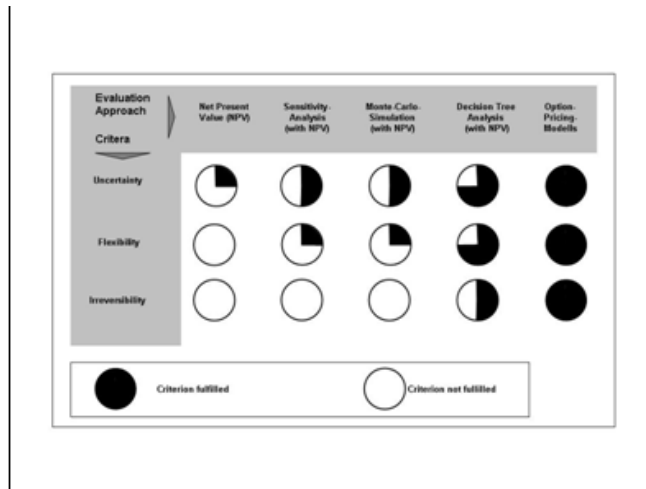


Figure 2. Selection of a Theoretical Evaluation Basis (Hommel and Pritsch 1999, p. 128)

### ROA AS BASIC CONCEPTUAL EVALUATION FRAMEWORK

ROA differs from other financial evaluation approaches in particular, due to its focus on the value of options of flexibility (Trigeorgis 1996). The basic idea of the ROA is to evaluate the profitability of investment projects. Therefore, fundamentals of the options-price theory are transferred on the evaluation process of future projects or investments. In doing so, it is possible to evaluate future options resulting from planned investments in addition to traditional cash flow analysis (Copeland and Antikarov 2002). Hence, it should be possible to identify those options that AC provides in general for logistic systems and to evaluate their financial value (Hülsmann and Grapp 2006). At first, the net present value of the considered system has to be defined (Nowak 2003). The next step would be the assessment of specific options of acting resulting from AC. Different possible types of options can be identified. Hommel and Pritsch (1999) list the following types of options, which represent a main classification of options that can be found in the relevant literature (see also e.g. Trigeorgis 1996, Copeland and Antikarov 2002):

- **Options to Wait/Defer:** Option to wait with the execution of an investment and it is possible to let the option be dependent from the realization of a specific random variable (e.g. decision of market-entry of a competitor)
- **Options to Expand:** Option to expand production capacity at x-percent towards the payment of a capital expenditure
- **Options to Innovate:** Option to generate innovative, further investment opportunities (chain of call options) on the basis of a project investment
- **Switching Options:** Option to switch between two options, e.g. between options to break-up or extend/ between options to expand or reduce
- **Rainbow Options:** Option to react on several sources of insecurity

The single value-determining elements to evaluate the option value consist of the value of the risk-carrying object, which corresponds to the value of the innovative opportunity (e.g. methods, concepts, and technologies of AC) or the cash flow that could be generated by the execution of the innovative option respectively. The preferential price stands for the amount of money which will be callable at the date of transaction. The option maturity describes the duration of an option. The standard

deviation of the risk-carrying object (volatility) corresponds to the insecurity of the expected payment surplus. The risk-free interest rate is represented by the market interest rate for risk-free assessments, e.g. federal savings bond. Finally, dividends and dividend-resembling payments correspond to cash flows which could be generated at immediate execution of the total investment (first or following investment) during maturity of the option, but flow to competitors who have already entered the market (Nowak 2003, Copeland and Antikarov 2002, Trigeorgis 1996).

### **POSSIBLE REAL-OPTIONS OF AUTONOMOUS COOPERATION FOR ISN**

An example of the textile industry shall illustrate possible real options in an ISN. It is assumed that a textile manufacturer in Hong Kong gets direct orders from different European and American retailers to produce high quality garments. Due to the high competitive situation in this market, the orders for the manufacturer become more and more irregular. As ISN are considered as dispersed production networks, the manufacturer may decide to buy a low price yarn from a South Korean producer. However, this yarn maybe is efficiently woven in Taiwan and ordered from there. The company in Hong Kong gets zippers and buttons for its production from a Japanese company etc. Consequently, many different companies located in different countries build up the entire supply chain (Natarajan 1999). Additionally, it is assumed that the distribution processes between the single actors of an ISN are self-organizing. That could mean for example, containers shipping different types of yarn, zippers or buttons are equipped with AC technologies such as RFID tags and micro chips inheriting all information needed to schedule their way from Japan and South Korean to China by their own. Thus, the containers become smart parts within the logistic process and coordinate their way according to their individual logistic objectives (e.g. time, costs, quality and/or quantity) to their destination point. They are able to gather information from their environment (e.g. traffic news, weather prediction) and also exchange information between themselves. What kinds of real options additionally result from those "new" capabilities of an autonomous cooperating ISN compared to one without AC?

To exemplify the existence of additional real options through AC, two types of real options (options to expand and options to innovate) are selected, where the benefit from AC seems to be obvious in the context of the case study:

- **Options to Expand:** Option to expand production capacity at x-percent towards the payment of a capital expenditure. Due to the irregular character of orders entering the observed supply chain, phenomena such as over- or under-capacities of resources and pre-products could occur (also known under the term "bullwhip effect") (Forrester 1961). Without AC, the risk of a bullwhip effect seems to be high, since the quantity and series of orders from European and American retailers are unpredictable. The ability of flexible reactions of a linear configured ISN in order to switch between the quantities of distributed goods is limited. However, Hülsmann et al. (2006b) examine that autonomous cooperated systems are capable of handling additional complexity better than linear structured systems (until a critical degree of dynamics). For an ISN this means that through implemented AC technologies, options to expand offer e.g. coping with irregular quantities of orders (e.g. optimized information processes). Through self-organizing processes between the smart distributed goods, there is a higher margin of good pieces, which could be distributed in the same ISN than in linear structured ISN.



- **Options to Innovate:** The implementation of AC-methods, -technologies or -concepts into the observed ISN could be itself understood as an option to generate innovative, further investment opportunities. The risk-carrying object might be assumed as an innovation of production processes by investing in AC-related technologies such as RFID tags to optimize local material flows. The value of this option then would be represented by the amount of money, which is e.g. saved by reducing throughput times in warehouses or simply by the possibility to take part in autonomous cooperating supply chains. In order to prepare the implementation of AC technologies, the ISN-Management has to fix a certain preferential price with suppliers/sellers of AC-related technologies. However, the maturity to realize this specific option is limited, e.g. AC-technologies could become that popular over time that their acquisition cost will decrease and are affordable for the whole branch. In this case, on the one hand, they would not provide a competitive advantage anymore but on the other hand, AC technologies are then maybe an essential feature to stay competitive.

### **POSSIBLE RISKS & LIMITATIONS OF APPLYING THE REAL-OPTIONS APPROACH ON AUTONOMOUS COOPERATING ISN**

It seems to be a key problem to estimate whether an investment into a new technology, method, or concept of autonomous cooperating logistic processes will be economically successful or not. The question is, which opportunities for risk mitigation across an ISN do exist?

According to Spinler et al. (2003) possibilities for hedging against risks will be considered. Risk mitigation could be possible through risk hedging and sharing. The ISN-Management respectively is understood as buyer and its suppliers as seller (i.e. provider or producer of AC-technologies). It has to face the risk that the chosen innovation might lead to possibly increasing inefficiency in its production processes, whereas suppliers have to carry the risk that they do not find a buyer for the option they offer. Via option contracts among ISN-organizations those individual risks presumably can be mitigated. The ISN-Management could decide flexible, when and to which extent to execute an option, e.g. flexible choice among AC-supplying companies. The supplier themselves should sign long-term contracts to enhance the probability that they will not risk to operate unprofitable (Spinler et al. 2003).

Another aspect is the general applicability of the ROA for evaluating AC that is not completely proved yet. According to Arnold (2005), Hommel and Pritsch (1999) at first, the process of calculation of the options-values in general are said to be complicated. Consequently, the risk of incorrect calculations and mistakes could occur in evaluating options resulting of autonomous cooperating ISN. Secondly, the value of a real-option is seen as quite difficult to forecast due to uncertain future developments of its determining factors. Especially in the field of ISN, the aspects of dynamics e.g. in sudden upcoming customer demands, could worsen the attempts of evaluating options. Similar risks could be seen in the calculation of volatility that is based on foretime information, whose validity cannot be guaranteed. Thirdly, in general the life expectancy of real-options is not scheduled as financial options are. This also could lead to false results in the real-options-analysis (Arnold 2005, Hommel and Pritsch 1999). However, the ROA seems to be an established financial approach in theory and practice due to its ability to evaluate options of acting regarding their flexibility.

## CONCLUSION & FUTURE RESEARCH TASKS

A consistent measurement and evaluation system of AC for ISN-Management is still missing. This article has shown that one possible evaluation approach could be the ROA due to its ability to evaluate flexible options of acting. Furthermore, options to expand and to innovate could be identified in AC logistics systems. However, the objective for future research must be to integrate a monitoring concept (presented on 11<sup>th</sup> ISL) and ROA as evaluation approach (presented on 12<sup>th</sup> ISL) - into one overarching system, in which the degree of AC, contributions and realization requirements are combined.

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## **AN OPTIMIZATION APPROACH FOR TERMINAL LOCATIONS AND TRAIN SERVICES ON A LINEAR INTERMODAL NETWORK**

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### **ABSTRACT**

In this paper, we are addressing the issue of selection of Intermodal terminals in a linear Rail-Road network. The objective of the suggested optimization model is to select optimal locations for Intermodal terminals and optimal train services in a simultaneous rather than sequential fashion. The situation is modeled as an MILP formulation, providing the terminal locations, train services and also the loading patterns as an output for the program.

### **INTRODUCTION**

In the current paper, we address the issue of selection of the intermediate nodes to serve as the Intermodal terminals in an existing rail line network currently serving point-to-point demands. We consider a few terminals, which are already acting as the Intermodal terminals, and candidate locations in the line network, which have potential to operate as Intermodal terminals. We develop an optimization model with an objective of maximizing the revenue for the railway while considering the fixed operating cost of the terminals (number and location) selected by the model. While determining the optimal locations of the terminals, the model also decides the optimal set of train services between various pairs of selected Intermodal nodes, since in addition to the node selection decision, we need to decide about the span and number of train services on various possible routes. These decisions are interdependent and have impact on each other. Considering the interdependencies, our approach is to make a simultaneous decision rather than deciding in a sequential manner. Since the decision about optimal train services also depends upon the loading pattern of the trains, we decide about the loading patterns also during the course of solution. The objective function consists of decision variables about the terminal locations, train services and loading patterns of the trains between various origin destination pairs.

### **PRIOR RESEARCH**

Among the important network location models, Rutten (1995) aims to find out the terminals that attract sufficient load to profitably operate daily to and fro trains. Different individual perspectives of shippers, terminal operators, agents, consignees and carriers are studied by Van Duin and Van Ham (2001). They developed separate models for strategic, tactical and operational level of the

problem. In a rail-road Intermodal set-up, Arnold and Thomas (1999) develop a linear programming model to find out the optimal location for the terminals with an objective of minimizing the total transport cost. Groothedde and tavasszy (1999) applied simulated annealing technique to select the optimal location of the terminal in a rail-road type of Intermodal setting. Meinart et.al (1998) find out the location of a new rail terminal in a specific region which already has three terminals. In a more recent paper, Arnold, Peeters and Thomas (2004) have shown that the modal shares are very sensitive to the cost of rail part of the Intermodal journey. Conversely, the location of terminals has little impact on the market shares of the combined traffic.

## **DESIGN AND METHODOLOGY**

The research problem is divided in parts and is dealt in phases. The first phase focuses on the linear network whereas in subsequent phase we have examined a more general mesh network situation. The problem focuses on finding the optimal location for the Intermodal terminals from amongst the given locations that are already serving as traditional terminals and associated optimal set of train services for the rail transportation part of the overall network. The problem is structured as Mixed Integer Program. The candidate set of routes are all possible O-D pairs and number of trains on each route are selected optimally through the model. The mathematical model is coded in C and solved with the help of Cplex. The network has predefined train services between certain pair of stations along with some fixed Intermodal terminal locations. The model assumes that the extension of the train services beyond the current origin and destination not possible although the trains can be made to stop in between the terminating stations as per the optimization requirement during the model execution. This is a valid assumption as the cost of extending the train services as much higher along with many scheduling and other implications as compared to some additional stoppages in the current pair of O-D terminals. Making a node (station) Intermodal terminal shall involve some fixed cost per period that has been considered in the model. Each candidate node has some predefined incoming and outgoing traffic capacity that it can handle for the Intermodal freight. It has been incorporated in the form of constraints to the model. As in a typical Rail-Road Intermodal setting, the demand can only be fulfilled by the direct available trains between a certain pair of stations in the long haul part of the transportation. The line capacity is limited by the number of trains running between different pair of stations for forward as well as backward traffic.

## **FINDINGS**

In a given linear network, the model simultaneously finds out the optimal location of the terminals that can be chosen as Intermodal nodes for the long haul part of the freight transportation and optimal set of train service routes and frequency to serve these locations. The model also provides the loading patterns of the rail services between different terminals for which the selection is optimal. We have analyzed the impact of variations in the fixed cost of terminals, incoming and outgoing capacities of the terminals as well as the loading capacity of the train services.

The two important limitations of the model, that can be taken in to consideration by extending the scope of the model, are that model does not consider all possible locations of the terminals rather depends on the existing infrastructure. Secondly it does not consider the possibility of freight handling at the intermediate terminal locations.

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## APPENDIX A

### Indices and Notations

- $i, j$  - Indices for origin and destination terminals
- $k$  - Index for trains
- $y_i$  - Binary variable for selected node (as origin terminal)
- $y_j$  - Binary variable for selected node (as destination terminal)
- $x_{ij}^k$  - Amount transported between selected nodes  $i$  and  $j$  through train  $k$
- $d_{ij}$  - Demand between pair of nodes
- $r_{ij}^k$  - Revenue between pair of nodes
- $s_i$  - Fixed expenses per period for  $i^{\text{th}}$  node to serve as Intermodal terminal
- $c_i^O$  - Handling capacity of the node for out going traffic
- $c_j^I$  - Handling capacity of the node for incoming traffic
- $s^k$  - First node of Set of origin nodes served by train  $k$
- $t^k$  - Last node of Set of destination nodes served by train  $k$
- $b^k$  - Capacity of train  $k$
- $t$  - Link (Line segment entity defined for the purpose of line and train capacities through out the route)

- $v_k$  - Fixed expenses for the running the train for  $k^{\text{th}}$  service (route)  
 $h_k$  - General integer decision variable capturing the number of optimal train on  $k^{\text{th}}$  route.  
 $w^{\text{tf}}$  - Available Line capacity in forward direction  
 $w^{\text{tb}}$  - Available line capacity in backward direction

### Model Equation and Explanation

$$\text{Maximize } \sum_k \sum_i \sum_j x_{ij}^k \cdot r_{ij}^k - \sum_i s_i y_i - \sum_k v_k h_k$$

Subject to:

$$\sum_k x_{ij}^k \leq d_{ij} \quad \forall i, j \quad \text{demand constraint} \quad (1)$$

$$\sum_k \sum_j x_{ij}^k \leq c_i^o \cdot y_i \quad \forall i \quad \text{node 'out' capacity constraint} \quad (2)$$

$$\sum_k \sum_i x_{ij}^k \leq c_j^I \cdot y_j \quad \forall j \quad \text{node 'in' capacity constraint} \quad (3)$$

$$\sum_i \sum_j x_{ij}^k \leq b^k \cdot h_k \quad \forall t, k \quad \text{(train capacity constraint for forward trains)} \quad (4)$$

$$\sum_i \sum_j x_{ij}^k \leq b^k \cdot h_k \quad \forall t, k \quad \text{(train capacity constraint for backward trains)} \quad (5)$$

$$\sum_k x_{ij}^k = 0 \quad \forall i, j \quad (6)$$

$$\sum_i \sum_j x_{ij}^k = 0 \quad \forall k \quad (\text{where } s^k < t^k) \quad \text{(train span matching for forward trains)} \quad (7)$$

$$\text{or } [(i < j) \& (i < s^k \parallel j > t^k)] \quad (8)$$

$$\sum_i \sum_j x_{ij}^k = 0 \quad \forall k \quad (\text{where } s^k > t^k) \quad \text{(train span matching for backward trains)} \quad (8)$$

$$\text{or } [(i > j) \& (i > s^k \parallel j < t^k)] \quad (9)$$

$$y_i = 1 \quad \forall i \quad \text{that are fixed in the network} \quad (9)$$

$$\sum_k h_k \leq w^{\text{tf}} \quad \forall t \quad \text{route capacity for forward trains} \quad (10)$$

$$\sum_k h_k \leq w^{\text{tb}} \quad \forall t \quad \text{route capacity for backward trains} \quad (11)$$

## **COLLABORATIVE BUSINESS IN SUPPLY CHAINS - A SYSTEM DYNAMICS APPROACH**

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### **ABSTRACT**

In this paper, we consider the multiple stage supply chain where agents order, produce and distribute goods while considering uncertainties of customers' behaviour. Generally, those operational risks result in undesirable effects of the supply chain, e.g. bullwhip effects. We model the problem in terms of system dynamics which seems adequate for a process-oriented perspective where time is a decisive factor. The original model developed by Forrester (1958) is extended by integrating data warehouse architectures which make the collaborative processes between the agents more handy.

Key figures of the analysis are the bullwhip effect, the maximum production rate, and imbalance period. Some supply chain models are tested by simulation runs where the parameters are adapted to different scenarios. It is shown that, generally, a reduction of the delivery time has a greater influence on the performance of the supply chain than the improvement of mutual trust between the partners.

### **INTRODUCTION**

Supply chain management is one of the hybrid management concepts between market and hierarchy. The big aim of this concept is to achieve the advantages of cooperation without giving up the advantages of autonomy. Hence the reduction of production costs must exceed the increase of transaction costs. Transaction costs mainly consist of information costs that occur due to a complex transmission of information. Indirect information costs result from inefficient processes caused by information distortion between the supply chain partners.

In this article we first characterise global supply chains and then derive different scenarios of regional and continental supply chains with their typical information systems. Finally, we compare these scenarios by a system dynamics approach.

### **GLOBAL WORKING SUPPLY CHAINS**

Global supply chains – unlike regional supply chains – can be described by several characters. First of all, far distances between the supply chain partners determine long delivery times that require a consideration of the inventory in transit (supply line). It has to be considered that the supply line is relatively non-volatile as goods remain between two partners of the supply chain for a long period. All processes in the supply chain are rather inflexible for these reasons.

Second, there exists a higher level of information distortion in a global supply chain that leads to the bullwhip effect (see e.g. Lee, Padmanabhan, Whang (1997), pp. 95). Two reasons can be stated for the information distortion: On the one hand, the lack of personal contact between the employees of global supply chains can cause a lack of trust. This means that fewer information will be exchanged between the supply chain partners and no mature information system



that includes collaborative planning will be implemented. On the other hand, the transmission of information may take more time than in regional supply chains. Last but not least, we have to distinguish which supply chain member is situated in which distance. In one case, only the producer is situated far away from the other members and the market. In the other case, all members are situated away from each other and only the retailer is located near the customer.

### DATA WAREHOUSE ARCHITECTURE

Without having implemented a data warehouse, the impulse of all activity in a supply chain is given by the order of the customer. This order is fulfilled from the inventory of the retailer, afterwards an order to refill his inventory is made. The quantity of that order is calculated by the order-up-to-policy described by Sterman (1989), p. 333. The other supply chain members act corresponding to this order rule, no other information is exchanged between the supply chain members. As all distortions in the system are accumulated a strong bullwhip effect is expected.

The data warehouse concept was designed by Inmon (1996) as a database that explicitly supports strategic decisions (see Kimball et al (1998), pp. 9). Without a data warehouse data is usually located in different information systems. For that reason, on the one hand, data is unstructured and not integrated, much data is stored several times on different places and much data that is not necessary for any decision is stored (information overload). On the other hand, data that is needed for a decision cannot be found easily (lack of information). This problem can be reduced by the data warehouse concept as all kinds of information can be stored and classified. Direct access is possible to all information if requested.

In the last decade, the concept was extended towards a database that provides all processes of the whole enterprise (or, here, the whole supply line) with timely, detailed and integrated information as described in Inmon, Imhoff, Battas (1996, pp. 12). Complex analysis tools that enable a collaborative business are usually included in a data warehouse to precalculate all kind of measures that are needed to control the enterprise. Due to the integrated database all measures are free of redundancies and inconsistencies. Figure 1 illustrates the structure of a data warehouse.

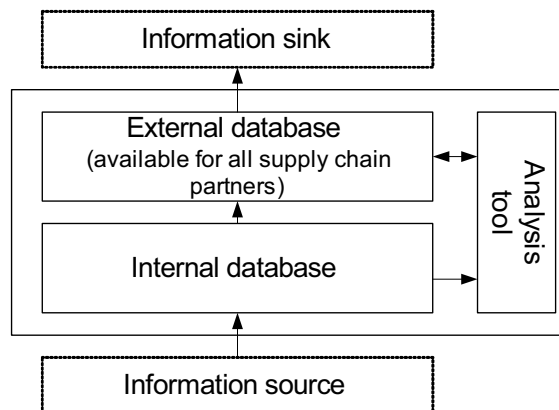


Figure 1: Structure of a data warehouse

A data warehouse includes a central storage of the data as well as a central analysis tool that enables collaborative planning. It is a complex information system that causes a high level of investments and maintenance costs. In a data warehouse the reasons for the delays and distortions are partly eliminated, as the customer's orders are stored in the data warehouse and the future customer's demand is forecasted there. These forecasts of the demand are used by every supply chain member to calculate his order quantities or (in case of the producer) production quantities. As the implementation of a data warehouse requires a high level of trust and cooperation it has to be considered which kind of a data warehouse will be implemented in which supply chain. The general information flow with and without a data warehouse is shown in Figure 2.

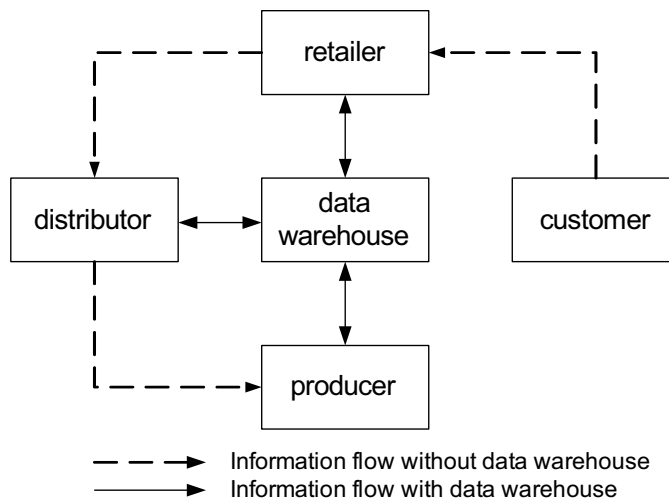


Figure 2: data warehouse architecture

### SCENARIOS OF DIFFERENT SUPPLY CHAINS USING DATA WAREHOUSES

A typical supply chain that consists of three members (retailer, distributor and producer) is modelled in this article. Orders that are not forwarded by the data warehouse take 1 day to arrive at the next member of the supply chain. The delivery time between two members amounts to 3 days if the members are situated nearby and increases to 5 days if the partners are situated further apart. The production of an order takes 5 days, no capacity constraints are modelled here. According to the considerations above, three different scenarios can be modelled for such a supply chain:

In a regional supply chain, all members are situated in the same area. Thus, the delivery time between two chain members is only 3 days short and the information distortion remains low. The high level of mutual trust allows a data warehouse in which all members of the supply chain are integrated and the forecasts of the customer's demand are immediately transferred to all members. Hence all members are able to plan their order and production quantities, respectively, on the basis of timely and accurate information.

In a continental supply chain, the producer is situated in a further distance from the other supply chain members. The delivery of goods from the producer to the distributor will take 5 days for that reason. The delivery time between the distributor and the retailer is still 3 days. Another effect of the distance between the producer and the other supply chain members is a lower level of mutual trust. Hence the producer will not be integrated in the data warehouse architecture unlike in the regional supply chain and he gets the orders by a non standardised and conventional way of data exchange. As mentioned above, orders will take 1 day to be forwarded to the producer. As a consequence, the producer is not supported with useful information that well in this architecture as he has no access to the data warehouse. The transaction costs in this scenario are lower than in the first scenario because less companies have to be integrated in the data warehouse architecture. Another advantage is that collaborative planning stays more manageable and flexible for the same reason.

In a global supply chain, all members of the supply chain are situated in different areas. The delivery time between the producer and the distributor and between the distributor and the retailer will increase to 5 days in this scenario. The lack of personal contact between all members effects that no data warehouse will be implemented at all. All order information is forwarded conventionally with a delay of 1 day.

According to the different scenarios, we will describe the corresponding cost effects. Additionally, we will test how the negative effects can be lowered especially in case of the continental and the global supply chains. Therefore two basic strategies of improving the original results are regarded in both scenarios:

- reduction of the delivery time between the partners that are situated further apart from 5 to 3 days or
- improvement of mutual trust between the supply chain partners that enables the implementation of a more mature data warehouse ( i.e. a data warehouse between retailer and distributor in a global supply chain and a data warehouse where all partners are collaborating in the continental supply chain).

Altogether, seven scenarios are interpreted: three basic scenarios and four improved scenarios. Transaction costs of improvement are not calculated.

Complex systems like the scenarios of an entire supply chain can be modelled with the system dynamics approach (see Forrester (1958)). A set of equations describes all processes of the supply chain so that all variables of all partners can be illustrated at any time. This approach is especially adequate for modelling a global supply chain as information delays and delivery times can explicitly be considered.

The described architectures are simulated with this system dynamics approach in which the system of equations is developed corresponding to Reese, Waage (2007).

## **RESULTS**

In the beginning of the simulation period, the customer orders 1000 units of a product per day, all the system is in balance. After one day, the orders of the customer increase by 10 % up to 1100 units per day. That quantity of orders remains unchanged until the end of the simulation period after 500 days (i. e. nearly 1.5 years).

- The described shock leads to an imbalance that causes a bullwhip effect. According to Sterman (1989) the bullwhip effect is calculated as the ratio

between the variance of the production rate of the producer and the customer's orders.

- Another important measure to demonstrate the negative consequences of the system shock is the maximum production rate because it determines the necessary capacity at the producer's in order to avoid stockouts. Capacity is one of the largest cost factors in each production system.
- A third measure is the period of imbalance (tolerance +/- 10 %). This measure excellently shows how a system can handle disturbances and how it can counteract against these disturbances. Every imbalance of a system requires a special degree of flexibility and thus more capacity than a balanced system.

	reference scenario	delivery time reduction	improvement of mutual trust
<b>regional</b>	27.91	-	-
<b>continental</b>	86.67	47.97	50.44
<b>global</b>	217.78	113.26	184.39

**Table 1: Bullwhip effect**

Table 1 visualizes the increase of the bullwhip effect when the supply chain partners move apart. In a regional supply chain, the bullwhip effect is nearly 28, i.e. the variance of the production rate is 28 times higher than the variance of the customer's rate of orders. In the continental supply chain, the bullwhip effect increases up to nearly 87. Thereby it is 2.5 times as high as in the regional supply chain. In a global supply chain, the bullwhip effect is even 8 times as high as in the regional supply chain. Hence increasing the delivery time as well as establishing a less mature information system both have a clear influence on the bullwhip effect.

Table 1 also reveals that the bullwhip effect in a continental supply chain can be equally decreased by nearly 50 % by reducing the delivery time or extending the data warehouse architecture towards the producer. In the case of a global supply, chain the delivery time reduction again shows a large influence on the bullwhip effect (reduction of about 50 %). However, the implementation of a more mature data warehouse in this scenario has a much smaller effect (decrease by about 15 %). Consequently, a data warehouse architecture comprising of the distributor and the retailer is less promising when considering a global supply chain. More efforts have to be taken into account though it is very costly to also integrate the producer in the architecture.

	reference scenario	delivery time reduction	improvement of mutual trust
<b>regional</b>	1890.10	-	-
<b>continental</b>	2896.66	2330.87	2193.64
<b>global</b>	5184.93	3617.26	4620.11

**Table 2: Maximum production rate**

In the reference scenario of the regional supply chain, the maximum production rate climbs up to nearly 1900 items per day (see Table 2) although the customer's demand is only raised by 10 % from 1000 to 1100 items. This high

amplitude is already done a few days after the external order shock occurs. In the order policy the full consequences of the order shock are only realized after some days so that high adjustments are inevitable. The maximum production rate in the continental supply chain still exceeds those values by more than 50 %. In a global supply chain, the maximum production rate reaches its worst value after another increase by 1.8 as compared with the continental chain. Nevertheless, the impact of globalization on this measure is not as high as the impact on the bullwhip effect. As the costs of capacity are directly concerned the maximum production rate can be easily interpreted.

The four improved scenarios show similar results like the analysis of the bullwhip effect. In a continental supply chain, a delivery time reduction and an improvement of mutual trust that leads to a more mature data warehouse have nearly the same impact on the maximum production rate (decrease of around 20 %). In a global supply chain, the impact of a delivery time reduction is again much higher than the impact of a more comprehensive data warehouse (30 % vs. 10 %). One may argue that is a simple, robust criterion to explain the bullwhip effect.

	reference scenario	delivery time reduction	improvement of mutual trust
<b>regional</b>	52	-	-
<b>continental</b>	155	64	124
<b>global</b>	348	184	305

**Table 3: Period of imbalance**

Finally, regarding the period of imbalance, the results of the reference scenarios again show that the physical distance of the supply chain members has a great influence on the performance of the supply chain (see Table 3). For a continental supply chain it takes 3 times as long as for the regional supply chain to re-establish the balance and for the global supply chain the corresponding value is 7 times as large. In the latter case, a shock of 10 % more orders thus keeps the whole system for approximately 1 year unbalanced.

In contrast to the other measures, the period of imbalance generally produces a higher effect of a delivery time reduction in the continental supply chain as well as in the global supply chain. In the continental supply chain, the period of imbalance can be decreased by nearly 60% when reducing the delivery time. A more mature data warehouse only reduces the measure by 20 %. Similar results can be achieved regarding the global supply chain. As a result, the delivery time reduction has a larger positive influence on the duration of a disturbance than on its amplitude.

## **CONCLUSION**

The simulation study showed that globalization may have a considerable negative impact on the performance of a supply chain. The expected benefits of globalisation must be carefully weighed against the costs which are caused by appropriate efforts. The scenarios in which additional measures were taken to mitigate the negative effects of global supply chains lead to the overall result that a reduction of the delivery time may improve the efficiency of supply chains better than a more mature data warehouse. The difficulty about this comparison is that the corresponding costs of these measures can hardly be compared

because they were determined by many technical factors. For that reason, no statement can be given if a delivery time reduction will always lead to higher profits than measures of improving mutual trust in a supply chain.

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## **BRINGING TOGETHER MPC AND ISA95 MODELS IN PLANNING AND SCHEDULING: A CASE STUDY OF A LABORATORY ENVIRONMENT IMPLEMENTATION**

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### **ABSTRACT**

This paper describes a case study and concentrates on two essential production planning and control models or frameworks: MPC (or MRP II) and MES function model of ISA 95. The aim of this paper is to study how these models present the interface between manufacturing planning and scheduling and shop floor execution and to find best practices on applying the models and ERP and MES applications respectively in production planning and control. The case test involved setting up and running a real production planning, scheduling and execution case in a laboratory environment. The results show that the models can be applied simultaneously and can be combined in various ways.

### **INTRODUCTION**

This paper discusses applying two essential production planning and control models or frameworks: MPC and ISA 95 standard. Presented by Vollmann et al., the MPC model is the core of MRP II and conceptualises manufacturing planning and control system whereas ISA 95 defines - among others - planning and control system hierarchy and functions of the manufacturing execution system (MES)<sup>1</sup> or plant level. Arguably the models are more complementary than parallel. From the applications point of view, ERP systems more or less follow MPC/MRP II logic and MES systems tend to fulfil ISA 95 MES functions. Enterprise control model of ISA 95 was excluded from this study.

The aim of this paper is to study how these models present the interface between manufacturing planning and scheduling and shop floor execution. In addition, the aim is to describe how this interface was perceived during control system implementations in a laboratory environment. The idea was to illustrate the questions arising during the implementations and the method of solving them. The goal is to find the best practices on applying the models and ERP and MES systems respectively in production planning and control. The focus is on the practical implications of applying the models in a concrete system environment.

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<sup>1</sup> By MES we mean the systems following ISA95 MES functionalities (among others Finite Capacity Scheduling, FCS)

The question is whether both models can be applied or only one of them. In addition, a question is raised about the relationship between the MPC/MRP II and the MES functionalities of ISA95.

## BACKGROUND

Both the MPC (figure 1) and the ISA95 (figure 2) define the division between the shop floor and upper level control activities rather loosely. According to Vollmann et al, finite scheduling and loading in some ways is better seen as a shop scheduling process and therefore part of production activity control but it is a capacity planning procedure (Vollmann et al. 2005: 282) too. In the MPC model, however, Vollmann et al. explicitly separate finite loading from shop floor systems, leaving production activity control on the shop floor level. Accuracy of finite scheduling is left undetermined, which is typical for other literature as well.

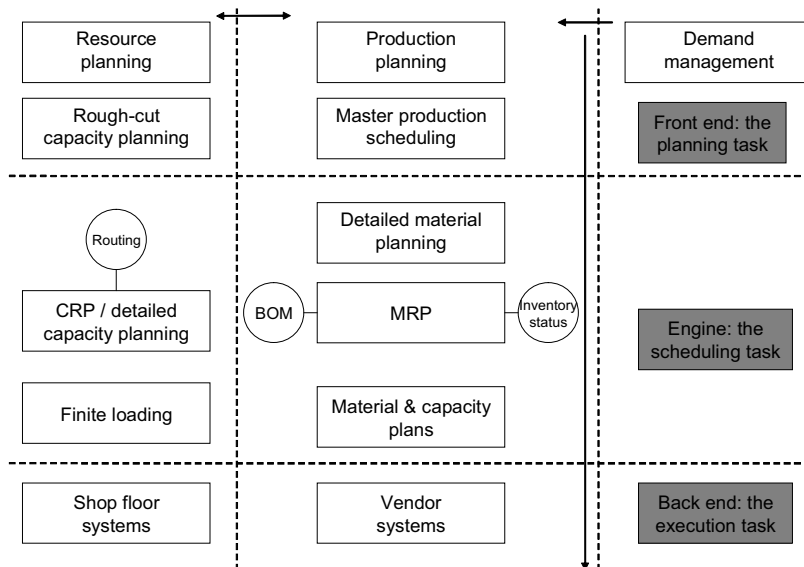


Figure 1. The MPC or MRP II model (adapted from Vollmann et al. 2005)

On the other hand, ISA95 leaves it open which plant control functions belong to the ERP and which to the plant levels. The models do not take each other into consideration. This question has relevance in practice. The openness within ERP-MES or scheduling-execution interface has to be closed when setting up a planning and control system environment. In principle, a logical and consistent chain of planning, scheduling and dispatching is needed in order to execute production in a controlled way. It is unclear, however, where planning ends and execution begins.



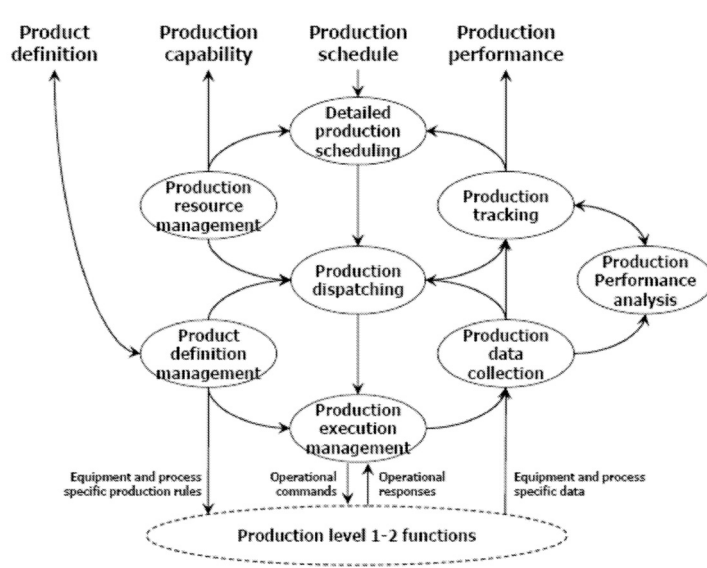


Figure 2. Activity model of production operations management (MES functions) (American National Standard 2005: 30)

Because of the need to produce to customer requirements and the dynamic environment in which they operate, MTO producers face two key problems – that of setting realistic due dates for customer orders, and the development of feasible schedules by which to produce these jobs in an efficient, timely manner. The establishment of delivery dates is a critical act because meeting delivery promises is essential, and delivery promises are easier to meet if they are realistically set. (Dumond 2005: 507) This problematic is significant for other production types such as ATO or MTF (Make to Forecast).

Moreover, it is unclear how and how much planning and execution interact and if they can even be separated. As Little et al state, the plan-schedule-execute model clearly does not apply in all situations (Little et al. 1995: 43). According to Dumond, the traditional view of capacity in planning and control systems is that one first plans the materials, and then the capacity implications, with the assumption that with sufficient time, adjustments to capacity can be made. However, today's organizations must respond to customer demands faster without holding large inventories. To address this requirement, they must simultaneously schedule both materials and capacity. (Dumond 2005: 509-510) Furthermore, it is now generally recognised that FCS (finite capacity scheduling) logic is fundamentally different from MRP and, is capable of exact scheduling solutions almost instantaneously without the need for detailed, higher level planning. (Porter et al. 1999: 195)

From the applications point of view, if separate ERP and MES systems are in use, their functions are often overlapping and division of functions is required. As described above, this division draws the line between two different logics. According to Little et al. the fact that the majority of the FCS tools used are, in practice, operated in conjunction with MRP/MRPII packages is a major difficulty.

The use of finite scheduling tools in production control is likely to produce real benefits only if operated in a structured and disciplined manner. Furthermore, the authors state that MRP/MRP II, when properly installed and managed, continues to produce good results especially when used with good shop floor control. (Little et al. 1995: 46-47)

### APPROACH OF THE STUDY

This is a single case study. The case test involved setting up and running a production planning, scheduling and execution case in a laboratory environment. The case laboratory consists of commercial ERP and MES systems which are integrated together in accordance with the ISA95 standard. The planning and scheduling in the ERP follows MRP II and the MES fulfils the ISA95 MES functionalities. Enterprise control (ERP) model of ISA 95 was excluded from this study. The configuration of the laboratory systems is based on a real discrete manufacturing business case, where the production type is 'make to forecast'. The information systems were configured to handle the complete planning, scheduling and production execution process. The problem was to ensure that the process is seamless in the ERP-MES interface and interacts adequately with the shop floor control. Conceptually, the question was if finite loading and shop floor control in the MPC/MRP II can be completely replaced by ISA95 MES or if adjustments or overlapping functionalities are required.

### RESULTS

MPC/MRP II was followed in ERP until detailed material plans and finite loading. A master production schedule was validated by rough cut capacity planning with overall factors (CPOF). Next, proposed production orders were generated by MRP and the capacity was reviewed by Capacity Requirements Planning (CRP) respectively. After this, the selection had to be made where to draw the line between the models and the concrete applications. The feasible possibilities found were either:

1. sending orders created by MRP and validated by CRP directly to the MES for detailed scheduling (figure 3) or
2. including finite loading in the ERP planning as well (figure 4).

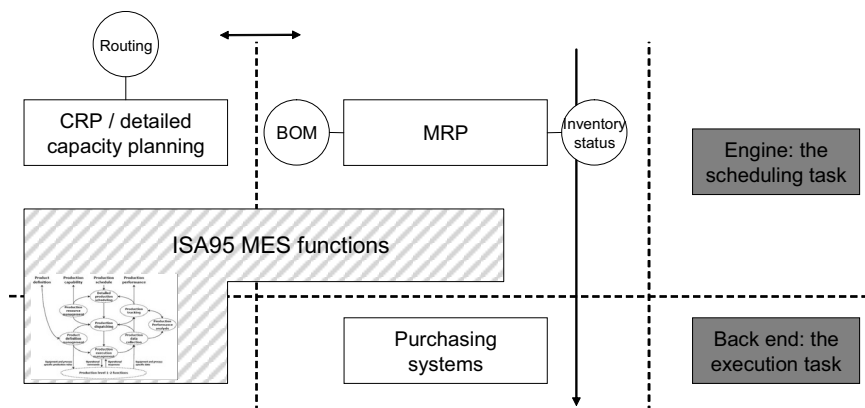


Figure 3. Option 1: no overlapping within the models or applications

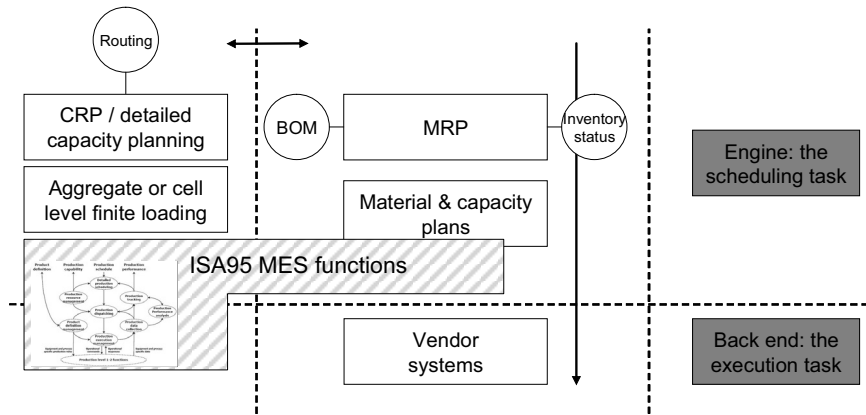


Figure 4. Option 2: detailed scheduling in two phases

In theory, it would have been possible to handle the finite loading completely in the ERP as well and only leave shop floor execution for the MES. This option was, however, rejected for several reasons which are generally described by Dumond. Finite scheduling uses actual shop floor conditions rather than standard queue times and other planning factors to establish the plant schedule; thereby resulting in a schedule that reflects the capacity limitations due to the current mix of jobs in the shop. (Dumond 2005: 508) Finite scheduling can also determine the effect of last minute requirements or changes, manage the impact of unplanned events or job arrivals, or perform "what if" scenarios and analyse the effects of a given schedule. (Dumond 2005: 510) In brief, in order to run finite scheduling utilising accurate real time capacity information as the case required, MES usage was necessary.

The option of clear distinction between the models and the applications (figure 3) would have been the most logical and general one and it very probably suits well in many cases. The option is rather easy to configure into the applications and is probably manageable. Conceptually this means that it is possible to cover or replace detailed scheduling, finite loading and shop floor control in the MRP II with ISA 95 MES functions.

In this particular case, the option was rejected for technical and organisational reasons. First, the most accurate capacity planning phase in the ERP would have been CRP, which however is only a planning tool showing a calculated capacity situation but not directly affecting scheduling. This means that the production planner has an opportunity to let the MRP generated orders flow to the plant without taking instantly visible responsibility of the schedule. More importantly, in large organisations the ERP planner can manage several production plants. It may occur that a plant would confirm a faster production schedule than planned in the ERP and in this case, the other tools than MRP are needed in order to slightly revise and adapt the organisation wide production schedules in the ERP.

These prerequisites led to the option 2 in figure 4, where the solution is division of finite scheduling in two phases. The first phase takes place in the ERP, handles calculated aggregated (cell level) capacity only and ensures or adapts the due dates given by MRP. The second phase is the actual finite scheduling taking place

in the MES. This phase is based on accurate real-time capacity information and interacts repeatedly with shop floor execution. The outcome is accurate detailed scheduling, job dispatching etc. as described in the ISA 95.

## **CONCLUSION**

According to the results, the models are mainly complementing each other although their perspectives seem to be different. ISA 95 seems to be designed for simultaneous material and capacity scheduling, whereas the approach of MPC/MRP II is stepwise, iterative and consisting of distinct transactions. The interface between the models is inside the MPC/MRP II engine, scheduling. From the ISA 95 point of view, all the MES activities belong to the plant level, including detailed scheduling. Possible combinations seem to be completely replacing detailed scheduling and shop floor control in the MPC by the ISA 95 MES functions or overlapping the detailed scheduling phases of the models. These options result in different application configurations and organisational practices. On the other hand, both the applications and the organisational factors affect this setup.

Concerning corresponding applications, it seems feasible to consider ERP as an application of the MPC/MRP II and MES of the ISA 95. In principle, ERP seem to be able handle the complete plan-schedule-execute framework in rather simple cases, where the accuracy of the MPC model is sufficient for modelling and configuring the plant level functions as well. In other cases, application of both models would be useful. The detailed scheduling and finite loading should be in immediate interaction with shop floor execution. If MES level is critical, only front end and engine functions possibly with group or cell level finite loading should be carried out by ERP. A dedicated MES application can then take care of the ISA95 MES functions. In the case where detailed scheduling contradicts with ERP production order deadlines, action outside the information systems is required.

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## **IT-SOLUTIONS AS A PART OF FORECASTING AND PROACTIVITY IN SUPPLY CHAINS**

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### **ABSTRACT**

Currently, the VMI model in the Finnish engineering industry is mostly based on manual work. The main reason for the manual nature of the process is that the inventory balance information is not available. In essence, as long as the item level balance information is not available, vendors cannot use automated systems to calculate replenishment parameters, create detailed reports, forecast item consumption, and adjust the replenishment process using information analysis to proactively prevent SLA (Service level agreement) breaches. To be able to use IT (Information technology)-solutions as a part of the VMI (Vendor-Managed Inventory) process for low-value items in Finnish engineering industry, an automated inventory balance monitoring system is required. This paper considers the Finnish engineering industry VMI process model and scale based automated inventory monitoring system and analyses automated inventory management as a part of the process. Considering the findings, it seems that the current manual VMI model used in Finnish engineering industry is quite efficient. Next step in development of VMI operation should be automated order/replenishment management system and automated exception monitoring services plus collaboration and automated information exchange (e.g. demand/supply figures, sales projections/forecasts, product sales development based item consumption rate change information etc.) between supply chain partners in general (Fliedner Gene, 2003). Both development sectors would result in an enhanced agility and accuracy in VMI services.

### **INTRODUCTION**

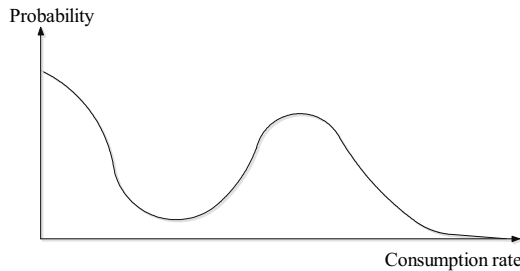
Vendor Manage Inventory (VMI) model based replenishment programs have lately been growing considerably as a service model in Finland. Many engineering industry suppliers provide VMI services to their customers in one form or another. One combining phenomenon between suppliers is that the item level balance, for these low-value items, is not known by the supplier between customer site visits. This paper covers item level monitoring and proactive operation based on early given information about sudden changes in demand/supply. These topics are covered assuming the possibility for item level monitoring based on a technical solution. The concept is analyzed considering the possibilities available through item level balance information, for example for forecasting purposes. Because any automated replenishment process is heavily dependent on accurate balance information the warehouse inventory management model based on Point of Sale information (PoS), used in daily consumer goods sales, is compared to the scale based item level monitoring. The demand information itself is a topic of current interest in academic papers (e.g. Holweg et al., 2005; Vigtil, 2006). However, this research project considers it as one information source among others.

## **METHODOLOGY**

This research project (TEMO, 2006) is based on a constructive research method and on Yin's multiple case study definition (Yin, 2003). As part of the project, an idea of an unmanned VMI warehouse model was constructed. This model was benchmarked in face-to-face theme interviews, in research workshops and by field observations. Totally 3 different field observation researches were conducted. Also interviews among supply chain professionals working within VMI processes were conducted in order to analyse different VMI operating models and enabling technologies. As part of the project, a literature survey was carried out to find out earlier studies about this exact problem area. The result was that there is quite a little research result about VMI and engineering industry replenishment processes. Earlier studies researching technology as part of the VMI operations were found concerning food industry (e.g. Pohlen and Goldsby, 2003; Katz et al. 2000), but those cases were not directly applicable to this problem area. So, it was decided that a new system concept had to be developed. Based on our research a prototype model was developed, providing a technological demonstration of the concept to show that there are no technical limitations on this concept. The optimization ideas for the order quantities are loosely related to the ideas presented by Disney et al. (2002). The research focus is on the utilization of mobile communication technologies with information technologies to make the VMI operation more efficient. The idea is to minimize the need to go to the customer site and to maximize the amount of work carried out per visit.

## **INFORMATION BASED LIMITATIONS OF FINNISH VMI MODELS FOR MACHINERY INDUSTRY**

In Finnish VMI replenishment programs for the engineering industry, there are two basic problems. The problems are unknown consumption rate of the items and absence of the item level balance information. Unknown means that the consumption rate is not stable and easily predictable, the average usage rate can be calculated but the changes in consumption rate are difficult to predict. Even most items have quite stable consumption rates; the few items with "unstable" consumption rate affect the whole service and jeopardise the service level. The information limitations force the VMI suppliers to fill the item shelves to high levels to avoid Service Level Agreement (SLA) breaches. The base level of the items and the average consumption rate are usually the parameters which dictate the shelf level replenishment cycles, which leads to high replenishment cycle frequency. The consumption rate itself is rambling, meaning that the base volume of the item is low or medium at best and the variance of the consumption rate is high. Figure 1 presents the most probable form of the probability function of consumption for these items. This kind of consumption will dictate that there might be quite long periods of time with near zero consumption and some time series with very peaky consumption patterns.



**Figure 1: Two peaked consumption rate distribution function**

The customer site is a kind of black box for the supplier. So the operation model is to check the current inventory balances and to make the replenishment order in the same time as the earlier orders are delivered to the shelves. As there is no measured data about the item consumption rate, statistical forecasting models cannot be used to predict the future of the item balances. Also the safety stock level and order point calculations have to be based on an educated guess and industry knowledge as opposed to data based calculations and the VMI supplier has to send people to the customer site more often than the average consumption rate would dictate. Secondly, there is a space limitation at the customer sites. Usually the VMI model is used to supply low cost items directly to shelves near the assembly points. At the assembly points there is a volume limitation (which is not as high as suppliers would hope) of individual items a supplier can put at the shelves. Considering the high employee expenses in Finland, suppliers try to drive this high inspection rate down, but are constrained by the fact that they do not have enough information to optimize the process.

Consider the base setup, one shelf with approximately 40 different items. Every item will be used independently so there is always a chance that one of the items is near, but a bit above the order point. Therefore, replenishment order is not generated, which means that there might be an out of stock situation before the next check, order, delivery and replenishment cycle is over. A simple solution would be to generate the order earlier, but this would mean that there would be more small deliveries and more space would be required from the customer site (and more capital would be tied up to the process). Because of the space limitations at the customer sites, it usually is not possible to have more space. Smaller delivery sizes would mean more transaction costs and more "paper work". For customer, high frequency replenishment cycles usually mean better service level and smaller space requirements, but suppliers costs per order line grows and basically customer will pay the costs in a long run. So high frequency in replenishment cycles is not optimal considering the whole supply chain.

Based on delivery data, it seems that the average unit delivery cycle of one shelf item is from 2 to 6 weeks. Information this vague is not enough for statistical analysis. It was possible to calculate quite accurate averages for "consumption" (we should note that calculations are based on item delivery information, not the consumption at the customer site) if the time frame was 3 months or more. Considering items which have a 2-week delivery cycle, it is quite obvious that the average consumption based on a 3-month time window would not be sufficient to adjust the replenishment parameters.

### **AUTOMATED ITEM LEVEL MONITORING ON VMI OPERATIONS**

The idea and concept of the scale based system is presented by Happonen and Salmela (2007). In this concept all of the items at the customer site are monitored through scales and a computer system. The idea is to deliver measuring precision that is equal to or better than visual inspection. The system allows stock inventory monitoring without site visits. Inventory is continuously monitored, the information is analysed, cleaned up and used to make replenishment decisions fully automatically. The replenishment decision can be adjusted based on the customer's confirmed order base, predicted sales, production plans, product make-up information etc. By combining the information, the supplier can make an optimal replenishment order, which means orders which minimize the amount of combined sum of the manual (transfer times, replenishment process and management work per order line) labour and maintain the SLA.

### **FORECASTING BASED ON SCALE INFORMATION**

Information gathered from the scales reveals the number of items at a certain moment of time at the shelves. Making frequent checks on the item level (Figure 2), one can calculate the consumption of the items.



**Figure 2: Example of possible information gathered by scale based monitoring system**

Forecasting the future consumption and using this forecasted information is not as straight forward as it would seem in first sight. There are some situations when the automated forecasting is unreliable or can not be used at all. The best way to utilize forecasting would be to divide the items in few classes. For example, first class for items with steady consumption, second class for items with chancing but easy to predict consumption pattern and third group for "hard to predict" items. For the first two classes system can manage the whole replenishment order cycle, but for the third class human intervention is needed. To automate the process as much as possible the system should make the prediction and to generate replenishment order proposal for replenishment process manager who would use that proposal, information from the customer and his/her expertise to optimize and to approve the replenishment order.

### **RESULTS OF THE STUDY**

There are optimization possibilities which can be realized by using automated monitoring as opposed to the current manual visual based checking. For example the quality of the consumption information will be better, short term consumption rate forecasting and customer site shelf space optimization can be achieved, automatic item level replenishment parameter optimization can be



made based on the known history of item consumption and new automated replenishment order models can be achieved.

The customer has space limitations for shelves, so the vendor has to optimize the space per item on shelves. At the moment, space reserved for an item is based on an educated guess. Because the number of visits at the customer site is the main cost driver at the moment, savings could be achieved through item space reservation optimizations. At present, the only way to perform these calculations is to use average delivery information which is not precise enough. So the optimization will happen only when there are some delivery/SLA problems. By using automated inventory monitoring, the system could calculate optimal parameters for the space reservations automatically.

Information consistency is the most important aspect for automated replenishment systems such as the scale based monitoring system. Consider the systems used in the consumer goods sector. Those inventory systems are based on PoS data. This means that the inventories have to be checked every now and then to verify the information in the data systems. For example, if someone forgets to mark incoming/outgoing items, the balance status of the item in the system will be incorrect. Also stolen items and items which are broken in the shop and not reported will lead to incorrect information in the system. Therefore, there will be times when items are out of stock on the shelves, but the system will not order more because it has more than enough items in its balance database. In a scale based system, item level balance information is constantly updated to illustrate the true amount of items on the shelves, so the system will make the orders on time, even if the people working on the assembly lines should stack items on their station to make their own work more convenient. This kind of stacking can produce "monday spikes" etc. on the consumption which is not visible for the supplier on manual VMI model. Making orders on time is the most important function allowing the vendor in a VMI operation to fulfill the SLA agreement.

## **CONCLUSIONS**

This paper presented possibilities a technology based VMI -model could offer to both the customer and the supplier. The main advantages for the supplier are better forecasts, fewer SLA problems, better responses to sudden changes, the possibility to drive down inventory levels at the customer site or possibly to use an extended time frame between inventory checks at the customer site. Advantages for the customer include more detailed reports, more optimized space usage at the factory site, and improved resource utilization as there are fewer out of stock situations.

The manual VMI model used in the Finnish engineering industry is based on replenishment orders which are made at the customer site. The decision to order an item is based on a visual check, and the order amount is typically defined at the start of the VMI relationship process. This process does not allow item level order management in a way which would decrease the needed amount of visits at the customer site. Item level monitoring system could order every item at its normal replenishment point and also order any other item, on the same customer site, already consumed enough to have a "reasonable" replenishment quantity. Delivery optimization would decrease the need to visit the customer

site because items will last longer before the next "normal" replenishment cycle is needed. Making these kinds of "half-orders" means that the management system will have new information for optimizing the VMI process. Consider the situation that there are some items which are constantly the first ones at the order limit. This would imply that by changing the parameters for these items the whole replenishment cycle time could be prolonged, which would mean more efficient inventory management.

As no item level balance information about C-class items has been available earlier, the possibility to work proactively and the feasibility of using earlier supply/demand information should be studied further in future. Part of the next research project will consider potential business opportunities and obstacles of this automated concept as part of the A- and B-class item management system. Basically, how and when technology like this should be used as part of the VMI business when managing customers high and medium value items replenishment processes.

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## **LOGISTICS COST ACCOUNTING: WHICH SYSTEM IS BEST SUITED?**

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### **ABSTRACT**

Although various approaches are suggested in the pertinent literature, such as Weber's logistics cost accounting method or Activity-Based Costing including all further developments, and all of these seem basically suitable, precisely because of the variety of models available, the question poses itself as to which model best fulfils the requirements of a meaningful logistics cost accounting system. In order to answer this question, we must first formulate the requirements that a cost accounting system must fulfil in order to be of practical use for logistics. We will then examine the relevant approaches in order to see how well they meet these requirements. Since none of the procedures does full justice to all the requirements at the same time, at the end of this paper a method will be presented on the basis of the gained insights, that takes into account all the requirements of a meaningful logistics cost accounting system.

### **INTRODUCTION**

According to various empirical surveys, the average logistics costs of an industrial enterprise account for 10-25% of total costs (cf. e.g. Schulte 2005, p. 9 and literature quoted), or 5-10% of turnover (cf. e.g. ELA/A.T. Kearney 2004, p. 11; Pfohl 2004, p. 54 f. and literature quoted). Consequently logistics costs account for a substantial part of product costs (cf. Krüger 2002, p. 313). At the same time logistics services are an extremely important competitive factor (cf. e.g. Wildemann 2004, p. 70). Under these conditions, if an enterprise wants to calculate competitive selling prices it is essential that they can calculate the costs of logistics services accurately and also allocate these costs to the relevant cost unit that generated the costs. It is also crucial in deciding whether to accept or reject an order and in connection with make-or-buy decisions for logistics services. Traditional cost accounting, which is primarily oriented towards production, is generally not able to provide satisfactory answers to these questions.

Against this background, Weber, already 20 years ago, proposed a refinement to traditional cost accounting that took into account logistics costs in an industrial enterprise, which he called logistics cost accounting (cf. Weber 1987). In the meantime, however, there have been a lot of developments in the area of cost accounting which also appear to be appropriate in order to integrate logistics adequately into the cost accounting system and which furthermore include elements that Weber's logistics cost accounting system does not cover, or not to the same extent. In this connection Activity-Based Costing (ABC) is especially important, as it is considered an excellent tool for controlling logistics since it views processes independently of the individual cost centre and thus accommodates the peculiar feature of logistics as a crosswise and coordinating function between a firm's sourcing, production and sales department (cf. Kotzab/Teller 2002, p. 236-237 and literature quoted).

However, ABC in its basic form (cf. Cooper/Kaplan 1988; Cooper/Kaplan 1991; Horváth/Mayer 1989) is designed as a full costing system, i.e. it does not split

costs into fixed and variable components and cannot, therefore, provide the information required in order to make short-term decisions as to whether to accept or reject an additional contract, for example. Various further developments in ABC have tried to remedy this failing. Apart from making the distinction between performance-volume-induced and performance-volume-neutral processes and their related costs as introduced by Horváth/Mayer 1989, a further cost splitting is made between their dependence on the process volumes and/or their life cycles. Of particular importance here are the approaches presented by Reichmann/Fröhling 1993, Glaser 1998, Mayer 1998 and Dierkes 1998.

It is striking that all further developments in ABC based on direct costing come from the German-speaking world. The reason for this is that direct costing systems are very advanced in Germany thanks to the works of Kilger 1993 and Riebel 1994 and German academics therefore attach great importance to an appropriate cost splitting.

### **REQUIREMENTS OF A COST ACCOUNTING SYSTEM FOR LOGISTICS**

In the comments above, some of the important requirements that a cost accounting system for logistics in an industrial enterprise has to fulfil, or which are at least desirable, have already been highlighted. Below a systematic summary of these and other requirements is presented. Of central importance will be the capacity of the system to calculate product-related logistics costs to aid decision-making.

1. Logistics costs are dependent on a variety of cost drivers. In a meaningful logistics cost accounting system the dependence of logistics costs on these different cost drivers should be made transparent and taken into account in product costing by means of appropriate allocation bases that reflect which logistics services have been used in connection with a particular product for sale.
2. Since logistics can be seen as a function whose task is to coordinate the flow of goods across all departments, it would seem expedient to analyse the costs and cost dependencies of logistics processes not only within an individual cost centre, but also across all departments which are involved in the process.
3. A meaningful logistics cost accounting system should aid both long and short-term decision making processes equally. This means that a distinction should be made between performance-related logistics costs, i.e. variable, and non-performance-related costs, i.e. fixed.
4. Even if the costs of most logistics services generated internally are classified as fixed, a lot of them can be adjusted at certain intervals to take into account changes in the volume of logistics services. These semi-fixed logistics costs should be presented separately from the absolutely fixed logistics costs where no such adjustment can be made. If necessary, the semi-fixed costs may be further differentiated according to the level of activity resp. readiness to operate. Whereas, from a long-term point of view, semi-fixed costs should be integrated into product costing, the absolutely fixed costs do not have to be integrated as they are not relevant for the decision-making process.
5. Semi-fixed logistics costs cannot generally be adjusted in line with a change in the volume of logistics services immediately, but only with a certain time lapse. This applies in particular to the reduction of costs in the event of restrictions to services. A practicable logistics cost accounting system should consequently provide information about any commitment periods for logistics costs

and include this into product costing by providing differentiated unit costs based on the decision horizon.

6. The extent to which logistics costs are influenced by the output quantity of the goods to be sold depends very much on the particular stage of the goods flow in which they are generated. Some costs are directly related to the quantity of goods produced or sold, others are incurred largely or even totally independently of the quantity. Only those logistics costs that depend on product volume should be included into product costing for the purpose of decision-making. Depending on the decision horizon, these may include variable as well as semi-fixed costs (which may be reduced during this period). Logistics costs incurred independently of output volume on the other hand do not have to be included, even if these are variable costs (that vary depending on the logistics process volume performed).
7. Calculations intended to aid the decision-making process should always only include those (logistics) costs that are related to and relevant for the decision. This means only direct costs and not full costs are to be taken into account. Nevertheless in practice, the information provided by full costing cannot be entirely ignored (cf. Küpper/Hoffmann 1988, p. 590 and 600). For this reason a logistics cost accounting system must be able to provide information about full costing as well as direct costing. The system, therefore, should be designed to incorporate both full costing and direct costing.

Below the further developments in ABC will be analysed to see in how far they fulfil these requirements. Weber's logistics cost accounting system will be taken as a benchmark and is therefore briefly explained, too.

A central objective of Weber's logistics cost accounting system as well as ABC in all its variations is to increase the transparency of logistics costs or indirect performance areas in general as well as to charge these costs as fairly as possible to the cost units that generate them. The first requirement is consequently fulfilled by all procedures discussed here. Siepermann 2005 provides a comprehensive example about the significance of the selection of the allocation base for charging logistics costs. The creation of cross-department processes is a core element of ABC (at least in its German version) and consequently all its further developments, not however of logistics cost accounting according to Weber, so that we do not have to go into the second requirement in any detail here either. The following discussion therefore mainly focuses on requirements 3-7 which are concerned basically with the intended cost splitting (Requirements 3-6) and the way they are handled in product costing (Requirement 7).

### **LOGISTICS COST ACCOUNTING ACCORDING TO WEBER**

In order to allow for the specific cost structures of logistics, Weber suggests creating three cost categories to analyse logistics costs instead of the usual two categories (fixed and variable costs) used in differentiated standard cost accounting. These cost categories are (cf. Weber 1995, p. 108 ff.; Weber 2002, p. 203 ff. ):

- Performance costs (= variable costs that change depending on the volume of logistics services),
- operating level-based standby costs (semi-fixed costs),
- (largely) non-operating level-based standby costs (= absolutely fixed costs).

Since operating level-based standby costs can only be adjusted to changes in volume of performance taking into account the commitment period of these

costs, a further distinction has to be made depending on the life cycle of standby costs.

With the aid of these cost categories, cost structures in logistics can be presented very accurately. A disadvantage of this high level of differentiation, which Weber also sees, is that accounts become increasingly complex. Against this background Weber comes to the conclusion to forgo the differentiation of logistics costs in the manner described above and to categorise logistics costs in the same way as production costs, i.e. to use only two cost categories (variable and fixed costs) (cf. Weber 2002, p. 218). Charging logistics costs to the cost units follows the functionally-based structure of traditional surcharge or transfer rate calculation.

Weber's approach fulfils a lot of the requirements of a meaningful logistics cost accounting system. Apart from not devoting any attention to the question of cross-departmental processes (Requirement 2), the only question that is not explicitly addressed is that of the interdependence between logistics services and product volume (Requirement 6). A further flaw lies in the failure to sub-divide fixed logistics costs according to their dependence on the operating level and their commitment period and to take this differentiation into consideration in product costing on the grounds of complexity (Requirements 4 and 5).

### **THE APPROACH ACCORDING TO REICHMANN/FRÖHLING**

Reichmann/Fröhling first split cost centre costs into fixed and variable components. The method further differentiates fixed costs according to their life cycles ( $\leq 6$  months,  $\leq 1$  year and  $> 1$  year) (cf. Reichmann/Fröhling 1993, p. 65). This differentiation is maintained when assigning cost centre costs to the cost centre's processes. This leads to differentiated activity costs and activity cost rates depending on the commitment period of costs. Activity costs within one cost category include all costs that can be reduced within the period allocated to the respective category, i.e. also costs with a shorter commitment period. For example, activity costs with a fixed term of up to one year also include costs that may be eliminated after six months as well as variable costs.

Product costing is based on a modified version of the progressive calculation pattern suggested by Mellerowicz 1977: Above all, it entails a further differentiation within the individual levels of fixed costs based on their life cycles. For further modifications of the original proposal by Mellerowicz cf. Reichmann/Fröhling 1993, p. 70.

The main focus of the proposal by Reichmann/Fröhling lies in the fact that it takes into consideration the different commitment periods of fixed costs (Requirement 5). The proposed calculation pattern leads to the calculation of full costs, but direct costs can also be inferred (Requirement 7). The division between variable and fixed costs aids short-term decisions (Requirement 3). Fixed costs are not sub-divided according to their adaptability to changed process volumes (Requirement 4), nor is the dependency of activity costs on product volumes discussed (Requirement 6).

### **THE APPROACH ACCORDING TO GLASER**

In her approach Glaser distinguishes between activity costs that can be reduced in the short, medium and long-term, whereby it is always considered that costs can be reduced within a specific period if savings made in the resources used to create a service actually lead to cost reductions within this period (cf. Glaser 1998, p. 39).

Glaser proposes a three-tier system for product costing: The activity costs assigned to product units that can be reduced in the short-term are added to the marginal costs, which here only include the individual costs; these, together with the individual costs form the so-called "extended marginal costs". Within this cost block a distinction is made between activities or activity costs related to units, batches and (types of) products, similar to Cooper/Kaplan 1991. Activity costs related to (types of) products should only be included into product costing if required. Finally the activity costs that cannot be reduced in the short-term are charged to the product units and added to the extended marginal costs.

The focus of Glaser's approach, as with Reichmann/Fröhling, is that it takes into consideration the different commitment periods of fixed costs (Requirement 5). Information about direct and full costs can be ascertained at the same time (Requirement 7). Charging activity costs related to units, batches and (types of) products separately allows in principle for the different levels of dependence of logistics costs on output volume, if one assumes that in the case of unit-related processes there is a total dependence, batch-related processes a partial dependence and product-related processes no dependence (Requirement 6). One disadvantage of Glaser's approach is that it mixes the operating level-based aspect of costs with the extent to which costs can be reduced over a time period so that requirements 3 and 4 cannot be wholly fulfilled. The missing distinction between fixed and variable costs and the allocation of the latter to costs that can be reduced in the short-term is of only minor significance, in view of the small share of variable logistics costs.

### **THE APPROACH ACCORDING TO MAYER**

As with the form of ABC which Mayer developed together with Horváth, the author rejects a division between variable and fixed activity costs on the grounds that such categorisation obstructs the view of the changeability of costs in individual cases. Instead he proposes the following differentiation (cf. Mayer 1998, p. 175 ff.):

- performance-related material costs,
- personnel costs and
- fixed-term costs of use for technical assets and service agreements.

Whereas he assumes that performance-related material costs can be directly and fully adapted to changes in the process volumes, it is assumed that in the case of fixed-term costs of use any changes in the process quantities will not have a direct impact on costs. It is only possible to influence these costs in the long-term by increasing or decreasing the potential cost drivers. Therefore, additional information about the underlying ownership and contract potential should be provided in conjunction with fixed-term costs of use, giving details of the time period for which these costs are fixed. In connection with personnel costs, it is not possible to make any kind of general statement about the effects of changes in the process volumes in Mayer's opinion.

Production costs are calculated on the basis of the functionally-based structure of traditional surcharge or transfer rate calculation. Sales overheads, on the other hand, are charged in a customer-related cost-volume-profit analysis. In both calculations activity costs are presented separately divided into the three different cost categories. The costs of the non-product-related processes and the costs of such cost centres for which no processes are created are not charged to the product units, but entered directly in the statement of earning (cf. Mayer 1998, p. 184 ff.).

The cost categorisation proposed by Mayer is very similar to the differentiation between performance-based, operating level-based and (largely) non-operating level-based standby costs made by Weber, but has the disadvantage that this division is not clearly related to the underlying cost paths. This means that personnel costs and time-related costs of use can in principle exhibit the same cost path depending on the process volume. It is of great significance for the cost behaviour of these two cost categories whether several similar potential cost drivers can be applied in parallel, regardless of whether these are personnel costs or operating assets, so that when process volumes decline these costs can be reduced successively or (wherever possible) used for other purposes. If this is not the case, a reduction in process volumes merely leads to a fall in the utilisation rate. In the first instance we have operating level-based standby costs or semi-fixed costs and in the second case non-operating level-based standby costs or absolutely fixed costs, irrespective of the nature of the potential cost driver used. Although presenting the three cost categories separately in product costing provides information for a variety of different questions and decision horizons, requirements 3 and 4 are still not wholly fulfilled since the three cost categories are not entirely identical to the different cost paths. The same applies to requirement 5 since the information about the commitment period is only presented as additional information and only for time-related costs of use, but not for personnel costs. The varying degrees of dependence of activity costs on the output volume of products intended for sale (Requirement 6) are taken into consideration through the differentiation taken over from original ABC as developed by Horváth/Mayer between handling, management, preliminary, product-remote and non-product-related processes and the possibility to include or exclude processes resp. their costs flexibly in or from product costing. Since neither non-product-related activity costs nor costs of non-process-related service areas are to be incorporated in the calculation of product costs in any case, as a rule no unit-based information about full costs is provided (Requirement 7). However, since logistics is a service area that is relatively closely related to production and the product and where services can generally be clearly structured and presented in the form of processes, this aspect is only of minor significance.

### **THE APPROACH ACCORDING TO DIERKES**

In connection with performance-volume-induced processes, Dierkes splits activity costs into variable costs, which change depending on the volume of the processes, and fixed costs, which are independent of the process volume. At the same time process volumes are analysed with regard to their dependence on the output volume of the products intended for sale. Performance-volume induced processes where process volume is sufficiently related to product volume are described as output-based, others as non-output-based. The costs of performance-volume neutral processes are always considered as non-output-based and fixed since they do not vary, regardless both of the volume of production or sales and the operating level of the cost centre. In Dierkes' method fixed costs are not subdivided according to the commitment period in the current accounts; such a differentiation is reserved for individual case analyses (cf. Dierkes 1998, p. 13 f.).

When allocating activity costs to the product unit, a distinction is made between short and long-term decisions. For short-term decisions only variable costs of output-based processes are integrated into product costing; for long-term decisions fixed costs of these processes are also included, provided they can be re-



duced within the planning period. The costs of the non-output-based processes are never charged to the product unit, but entered directly into period costing. Due to the strict division between variable and fixed activity costs (Requirement 3) and the exclusive allocation of activity costs dependent on output volume to the product units (Requirement 6), Dierkes' approach is a great help with short-term decisions. In order to be of use in long-term decision making, a further differentiation of fixed costs would be required depending on their adaptability to changing process quantities (Requirement 4) and the commitment period (Requirement 5). The differentiated rules for allocating costs mean that direct costs are always presented in product costing; Dierkes' approach does not allow information about full costs to be provided simultaneously (Requirement 7).

Requirement	Weber	Reichmann/ Fröhling	Glaser	Mayer	Dierkes
1. Use of performance-related allocation bases	x	x	x	x	x
2. Observation of cross-departmental processes	-	x	x	x	x
3. Division between fixed and variable costs	x	x	-	o	x
4. Differentiation of fixed costs according to their adaptability to changing process volumes	o	-	-	o	-
5. Differentiation of fixed costs according to the commitment period	o	x	x	o	o
6. Differentiation between costs related to and not related to the output volume	-	-	x	x	x
7. Combined full costing and direct costing	x	x	x	-	-

x = fulfilled; o = partially fulfilled; - = not fulfilled

Table 1: Comparison of the various approaches to logistics cost accounting

### A SUMMARY ASSESSMENT OF THE APPROACHES ANALYSED

As Table 1 shows, neither Weber's logistics cost accounting method nor the further developments in ABC presented here do full justice to all the requirements of a cost accounting system for logistics. In the following paragraph we therefore present a method that fulfils all the requirements formulated at the beginning of the paper and summarised in Table 1.

### DEVELOPMENT OF A LOGISTICS COST ACCOUNTING SYSTEM THAT DOES FULL JUSTICE TO THE REQUIREMENTS OF LOGISTICS

In order to fulfil all the requirements of a meaningful logistics cost accounting system, Dierkes' model would seem an appropriate basis. This model should be supplemented to include a further division of fixed costs according to their dependence on process volumes as discussed by Weber and they should be included into product costing as proposed in Mayer's approach. In order to provide information on costs for different decision horizons, the operating level-based or semi-fixed standby costs should be further differentiated according to their commitment period. It is not absolutely necessary to divide non-operating level-based, absolutely fixed logistics costs further according to their life cycles since these costs can generally not be adapted to the changing volume of logistics services. In order to provide information on full costs as well as direct costs, the cost components that are not included into product costing in Dierkes' model should also be charged to the product units if required, e.g. using appropriate surcharge rates.

By structuring logistics costs in this way, the composition of logistics costs charged in relation to the product becomes transparent and differentiated infor-

mation can be provided about the effects of product policy decisions on logistics costs depending on the decision horizon. Whereas variable costs of logistics processes dependent on output volume directly state the unit-based changes in logistics costs in the event of an increase or decrease in the output volume and such costs are therefore always relevant to the decision, the absolutely fixed costs in these processes and costs of logistics processes not related to output volume should only be taken into account if information on full costs is required. Semi-fixed logistics costs give the changes in logistics costs per unit for the product for sale which may occur or can be brought about if there is a "significant" change in the product quantity. In order to determine the extent of this (critical) change in the output volume, the process-related operating level intervals have to be divided by the process coefficients of the processes involved.

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## **ANALYTICAL MODEL FOR THE OPTIMISATION OF INDUSTRIAL PLANT TRANSFER PROJECTS**

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### **ABSTRACT**

The present paper proposes an analytical approach to optimise the transfer project of industrial plants, already installed and functioning, in a new productive location. From the operational point of view, to transfer a plant means to transport in a new site the same functional characteristics the plant has in the original one. Given the frequent impracticality to move the plant as formerly installed, the problem is, then, to define a valid transferring project, which should take into consideration the constraints and opportunities related to the execution of two strongly specular phases.

The proposed approach is based on an algorithmic procedure which, once selected the main components of a plant according to typical criteria of the process flow analysis, is able to determine and optimise the transfer global cost, as function of the parameters characterising the three different project phases; disassembling, transporting and local reassembling of the plant.

The core of the procedure is constituted by an iterative structure which, starting from an analytical description of the plant, in terms of components and modalities of breaking down, integrates the loading and transport phases and estimates, at the same time, the best level of reduction of the plant, the relative disassembly sequences and the loading efficiency. Those evaluations allow to optimise the overall cost of the three project phases.

### **INTRODUCTION AND LITERARY REVIEW**

As broadly recognized the last decades have been characterised by a phenomenon of globalisation with subsequent development and interconnection of new markets and fast evolution of the worldwide competition environment.

The first reactions in the industrial arena to the pressures and opportunities of this trend have been mainly represented by a strong delocalisation and fragmentation of the production systems.

Initially, the leading force towards the localisation in new geographical areas was due to the intent of reducing production costs, in terms of less wages, cheaper energy and services and reduced environmental obligations. Rapidly, industrial companies which were aiming to the internationalisation of their productive processes became aware of the more strategic importance assumed by the penetration into the local markets: by means of getting closer to the consumer markets it is easier to sell there the local produced products (Lewin and Peeters, 2006).

The current trend of delocalising the production plants, by someone referred also as "offshoring" (Bidanda et. al., 2006), but also the more traditional realisation of new plants in other countries, requires the transfer to a new site of a plant already functioning elsewhere or of a new plant realised and tested elsewhere.

The problem of plant transfer, thus, emerges when an already installed and operating plant has to undergo a change of location. From a technical point of view, the project of plant transfer can be divided in three sequential and temporally distinct phases:

1. Plant disassembly;
2. Transportation to the new production site;
3. Re-assembly.

Generally, being the distances to cover nearly always significant, the intermodal transport is required. The main characteristic of this kind of transport is that all components, opportunely reduced and packed, are loaded in specific containers, from which are not moved until the final destination is reached. This in order to reduce the risk of damaging and the cost of transport mode changing.

Therefore, with a plant transfer project two problems of relevant complexity emerge:

- the problem of determining the best disassembly and subsequent, symmetrical re-assembly level and sequence;
- the problem of the optimum loading of subassemblies into containers.

These two problems have been largely analyzed in literature; the state of the art relative to them is briefly reported in the following paragraphs.

#### *The Disassembly problem*

In the last two decades, disassembly techniques have been studied for a variety of crucial applications: design of assembly processes, maintenance and repair, end of life processing, etc. (Gupta and McLean, 1996).

Disassembling an object can take place in many different ways, called disassembly sequences. Much work has been done on determining the complete set of disassembly sequences and selecting the most appropriate sequence within this set.

Useful for these studies is the representation of the possible disassembly sequences in one network. For this purpose, the state diagram (De Fazio and Whitney, 1987), the AND/OR graph (Homem de Mello and Sanderson, 1991) or the disassembly precedence graph (Miller and Stockman, 1990) are applied.

Starting from these representation diagrams, the literature proposes exact methods to select the optimum disassembly sequence or heuristic/metaheuristic methods to define near optimum solutions.

The number of sequences is subject to combinatorial explosion when complexity of the object increases, which means that an NP-complete problem is encountered. This causes a computational difficulty in searching the optimum disassembly sequence with exact methods when the number of components becomes large. In this cases heuristic or metaheuristic approaches are preferable since they reveal "good enough" solution at the cost of a moderate CPU time (Lambert, 2005).

Many authors have proposed exact or heuristic methodologies for the optimum disassembly sequence definition, generally based on the reduction of the total disassembly cost (Gungor and Gupta, 1997) or on the maximization of a profit function in case the components can be sold for reuse or recycling purposes (Johnson and Wang, 1998; Lambert, 2003).

#### *The Loading problem*

The loading problem is the study of the modalities to load a subset of boxes into a regular container of fixed dimensions such that the volume of the packed boxes

is maximized. This falls into a wide topic called also "cutting and packing problems" and has been studied since the early sixties; from then, several scientific works and algorithms have been proposed for the solution of various aspects of the problem. Indeed, there are many variants of the container loading problem, depending on the "target function" and side constraints involved. Dyckhoff (1990) and Pisinger (2002) provide exhaustive distinctions of the different cutting and packing problems and, in particular, of the loading problems, which can be grouped in different ways. A basic distinction exists between cases in which a given set of goods has to be completely loaded and cases which allow some goods to be left behind. This latter case is generally limited to a single container while the former can require more containers. Another important distinction concerns the goods to be loaded, which can be homogeneous, weakly heterogeneous or strongly heterogeneous.

In our specific case the problem is generally known as *bin-packing* problem. In this problem the containers have fixed dimensions and all the goods have to be packed into a minimum number of containers. A variety of other constraints may be imposed to the problem: specific rotations may be allowed; it may be demanded that the weight of the container is balanced; may be restrictions on how many boxes can be put on the top of each other, etc. (Bischoff and Ratcliff, 1995; Eley, 2002). Hence, approaches that neglect these additional factors are likely to be of limited value.

In any case, the loading optimization problem refers to the NP-hard problem class and also in practice is very difficult to solve; this means that only small sized instances can be solved with exact methods based on dynamic, linear or integer programming, while real-life instances of large size require heuristic approaches to define near optimum solutions. For this reason a large number of papers propose heuristic methodologies to solve specific container loading problems (Pisinger,2002; Eley, 2002).

In addition, hybrid approaches including genetic algorithms and taboo search have been applied and have achieved reasonable results. In particular the ease of considering practical constraints speaks in favour of a genetic approach (Gehring and Bortfeldt, 1997; Litvinenko et al., 2002; Lewis et al., 2005).

## **THE PROPOSED MODEL**

### **The integrated approach**

The proposed approach aims to overcome the traditional logic scheme, characterized by two sequential and independent phases: the separated determination of the disassembly sequence and the items loading into containers (Figure 1-a).

A more deepened analysis would evidence that the cost connected the these two phases is function of the chosen level of plant disassembly, and that this will impact the disassembly and local re-assembly costs. Thus is evident that they would be lower if the plant remains assembled during the transport. The transport cost, on the contrary, would decrease with the raise of the disassembly level; it is widely known in literature that a reduction of the average dimensions of the items produces a more effective loading, with possible optimization of the number of containers and then transportation cost.

These considerations suggest the possibility to find an optimum disassembly level which minimizes the sum of disassembly, transport and re-assembly costs. Therefore, a new logical scheme for the problem approaching is configured as shown in Figure 1-b. The phases of disassembly and loading are no longer

independent: a further connection “area” will take into account all the possible disassembly modalities and evaluates them on the overall generated costs basis. The structured procedure proposed for determining the optimum modality of plant transfer, according to the total cost minimization criterion, requires the following activities:

- analysis of the items subject to the procedure;
- disassembly/assembly sequences identification;
- identification of the optimum level and global costs calculation;
- determination of the Shipping List.

In Figure 2 the general flow chart of the procedure is illustrated. It is easy to notice the presence of an iterative block justified by the mutual dependence of the disassembly and loading/transportation phases.

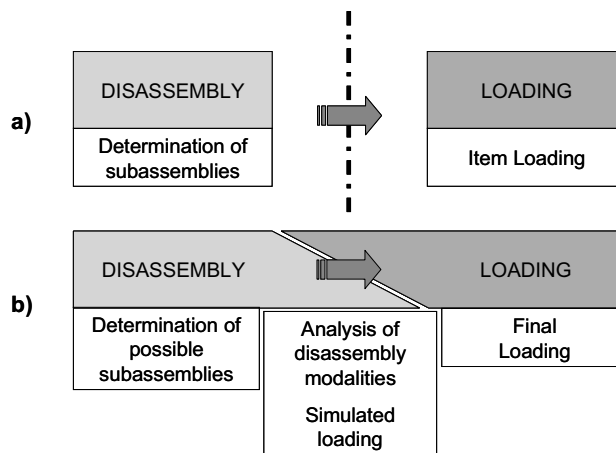


Figure 1 – Traditional (a) and integrated (b) approach to the plant transfer problem

### Analysis of the items subject to the procedure

In order to simplify the disassembly and loading algorithms, the procedure considers two levels for the plant components selection: the first takes into account items transportability in standard containers while the second determines on which components the application of the procedure is effective.

Specifically, the generic item is classified as “standard” if it can be divided in subassemblies fitting an ISO 40’ OT container. The standard components are then subjected to the analysis of impact according to parameters linked to the specific transfer project; eventually it is possible to choose the weight or a measure of a characteristic dimension of the plant.

The entire procedure is applied to the standard-critical components, the standard-non critical intervene in the loading algorithm only, while the non standard are directly added to the shipping list.

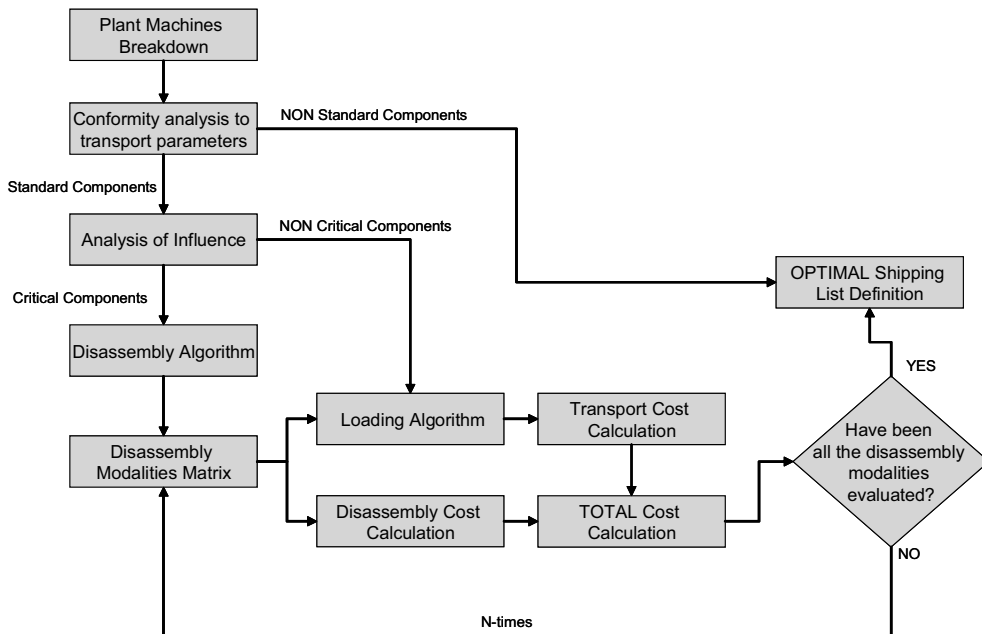


Figure 2 – The proposed procedure

**The algorithm and modality selection**

Given the dependence of the transport costs from the disassembly phase, the algorithm starts determining all the possible disassembly modalities, loading modalities and classifies them according to the resultant global cost.

In practice, the algorithm produces a  $M_{(N \times R)}$  matrix, in which N is the number of possible disassembly modalities and R is the number of disassembly actions present in one modality at least. Will be:

- $M_{ij} = 1$  if the  $j$ th action occurs in the  $i$ th disassembly modality;
- $M_{ij} = 0$  in the contrary case.

		Actions							
		1	2	...	j	j+1	j+2	...	R
Modalities	1	0	0	0	0	0	0	0	0
	...								
	i	1	1	0	1	0	0	0	0
	i+1								
	...								
	N								

Table 1 – Matrix of the disassembly modalities

The first line corresponds to the fully-assembled component and therefore is characterized by the 0 value for every action. Once obtained the matrix, the procedure goes through two paths:

- calculation of the disassembly/re-assembly cost;
- implementation of the container loading algorithm and subsequent calculation of the transport cost.



The disassembly/re-assembly cost relative to the  $i$ th modality  $C_{dis(i)}$  can be expressed as:

$$C_{DIS(i)} = (2 \cdot C_{man} \cdot T_{OP(i)} + C_{ext} \cdot T_{ext}) \cdot N_{wor} + C_{eq}$$

in which:

- $C_{man}$  = manpower hourly cost [ $\text{€}/h$ ];
- $T_{OP(i)} = \sum_{j=1}^R M_{ij} \cdot T_j$  = operation time associated with the  $i$ th disassembly modality [ $h$ ]; the factor 2 means that the same time is assumed necessary also for the reassembly phase;
- $T_j$  = time necessary for the  $j$ th action [ $h$ ];
- $N_{wor}$  = number of necessary workers;
- $C_{ext}$  = travelling daily allowance [ $\text{€}/day$ ];
- $T_{ext}$  = number of necessary transfer days.
- $C_{eq}$  = equipment cost.

The implementation of the container loading algorithm requires, for each disassembly modality, the list of components with relative dimensions. The result is the total number of containers necessary to contain the entire disassembled plant, which influences directly the transport cost.

At this stage will be possible to identify the disassembly/assembly level-sequence corresponding to the minimum total cost and, therefore, to define the optimal shipping list.

## CONCLUSIONS AND FUTURE RESEARCH

The paper proposes a structured approach to industrial plant transfer problem; the main result is a procedure which allows to correlate all possible disassembling-loading modalities of the standard-critical components with the relative global transfer cost, identifying, then, the optimum. The procedure consists of an iterative cycle in which, for each disassembly modality, a run of the container loading algorithm is performed. The sum of the consequent disassembly and transport costs determines the best disassembly sequence for the plant.

Future developments of the research will be targeted to an increase of the procedure efficiency. Indeed the number  $N$  of the disassembly sequences, being the plant a complex object, can be extremely large; this means that the algorithm of container loading has to be run  $N$  times with the risk of not acceptable computational times. An interesting starting point could be the definition of a method to pre-select the "more promising" disassembly sequences in order to reach the best solution in a limited number of interactions. The risk of achieving only a local optimum solution should be compared with the advantages of the computational time saving.

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# **OUTSOURCING AND GLOBAL LOGISTICS**



## **THE CENTRALITY OF CENTRAL ASIA: ISSUES FOR EURASIAN LOGISTICS PLANNERS**

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### **ABSTRACT**

Central Asia seems forever to have been special for East/West North/South land-based traders. The regions' deserts and fertile valleys were home to the early diaspora of humankind and the local population became trade facilitators between the Chinese and Greco-Roman Empires. Little seems to have changed over time since their logistics routes still support Eurasian trade: but now they have oil, gas and mineral deposits that are sought after by the outside world. Since 1991, after the dissolution of the USSR, the infrastructures of the former Socialist Republics have been neglected although globalisation has intensified. "Time-to-market" has become a strategic criterion for firms and their logistics agents. The sea routes from Asia to the US take about 25 days, and to Europe between 35 (via Suez) and 45 (South African Cape) days, while block trains to Europe may take 15 days.

We argue that the time is ripe to install maglev railways (super-conducting levitating ultra-high speed) across China, Central Asia and into Europe thereby reducing the Eurasian journey times to about 2 days. Central Asia has the material resources and the intellectual capacity to grasp the opportunity that will aid global trade, increase local trade and boost tourism, while at the same time reduce pollution. A win-win situation?

### **INTRODUCTION**

Transport routes though Central Asia from the Mediterranean to Indo-China have been used regularly since the 3<sup>rd</sup> or 2<sup>nd</sup> century BC, though the northern routes across the steppes of modern Russia and Siberia have been used for 5000 years by hunter-gatherers, then the Celts, and now Chinese traders. Modern trade however needs coherent (end-to-end) transport modes to move people, goods, and fluids fast and effectively from originators to marketplace. These needs imply that the original routes, sensibly chosen to follow valleys and cross the lowest cols of mountain regions, be re-engineered to meet modern standards.

Although this requires the cooperation of all nations, since trade is globalised, there are a few States that occupy such a key location as those of Central Asia. Many of the countries of Central Asia were managed by the Ottoman Empire (1399 – 1923) that caused Christianity and Islam to co-exist and work reasonably harmoniously with the secular management of State affairs. During the First World War the Ottoman leaders chose to support the 'wrong side', so their empire was disbanded. Earlier, in the mid-1800s, several countries in the region had become Republics of the Soviet Union but reverted to independence following its break-up in 1991. However, to differing degrees they remain dependant on the [new] Russian Federation.

In the present political climate of Central Asia we find to its west there is the European Union; to the far east we have China (becoming more open perhaps), and towards the south there is India (democratic, but with an old Socialist mentality). Also in the south there are the 'difficult' states of Pakistan, Iran, Iraq and Afghanistan (within which *The Great Game* (Mahan, 1905) was played out through the 19<sup>th</sup> century, and which seems to continue today); to the north there is Russia (also a closed, tightly managed nation); and then there are the tightly controlled Central Asian states themselves. In general, corruption and lack of trust are a serious concern for managers and decision makers across Central Asia and in its totalitarian neighbours (Kets de Vries et al, 2004; DeWoskin & Stones, 2006; Saidazimova, 2006; Michailova & Husted, 2004; Kidd et al, 2003).

In open systems logistics managers are able to review transshipment rates schedules and modes to offer their customers a choice between speed, cost and service predictability. Although these managers can offer routes into or through Central Asia the schedules and costs are subject to many imponderables. Many alternatives are dependant on East/West relationships at a high political level, others relate to terrorist activity, while the openness of all routes ultimately rest on the good-will of local Presidents or the War-lords, or sometimes neighbouring presidents (e.g. Putin's stances towards the Ukraine and Georgia): as well as on the illegal rent-collecting of local police.

We offer views on the transportation developments in Central Asia that are planned to open East/West and North/South routes to facilitate 'joined-up' transport planning. In parallel, these new developments may open up states that are currently quite closed and which have poorly maintained infrastructures at all levels. At a simple level, for instance, increasing tourism will bring in much needed foreign currency to local communities (though these flows are miniscule when compared to the oil and gas revenues incoming to the governments of many Central Asian states). Mixing and talking with tourists opens up the minds of local people to the concepts of outsiders, especially towards open communications, the rule of the law, and transparent governance. Opening up favours the development of 'trust' upon which business is predicated, and the development of new transport routes and their associated developments – new townships, new enterprises, new schools, new institutions, and so on – will be great a shock to these once-closed states, but change can be managed.



Note: the CAREC programme also includes as 'Central Asia' parts of Afghanistan, Iran and Mongolia as well as the Xingjian Province of western China.

The Central Asian states control vast reserves of oil, gas and coal as well as other minerals and crops of commercial interest. Their petro-chemical reserves are subject to considerable political pressure from the developed nations as well as the managers of OPEC. Often internal bi-lateral agreements are negotiated, but to realise this trade pipelines have to cross the lands of other nations. Further, new pipelines need roads and railways for their initial construction and their maintenance. It would be better if these routes included Eurasian needs since end-to-end through trade will generate considerable rental income from the passage of goods or people. The CAREC programmes are directly concerned with these interactions.

In contrast we find the Eurasian and northern hemisphere trade very well supported by deep-sea shipping integrated in Europe, Asia and the US to short-sea shipping and to associated hinterland transport modes based on road and rail services. These multi-modal modes should operate with security systems already in place (e.g. RFID) since enhancements are always enforced by the Homeland Security in the US or by other agents. For logistics planners such integration is of enormous benefit, and while sea passage is slower than the proposed land routes noted above, they offer end-to-end security [though piracy is a problem] and high tonnage volumes with relatively flexible routing of the containers once they reach the transshipment ports.

The economics of deep-sea shipping and the lobbying that shippers bring to bear in the US Congress and in other global assemblies ensure their voice is heard and their wishes minded. They have a relatively coherent voice, especially when compared with the many spokespersons along, for instance, the proposed



North/South rail route which has goods passing through European Russia, Central Asia and Iran, then by sea to Asia. The benefits of this N/S mainly land-based route are difficult to uphold when transport planners look to journey times, costs and cargo security and make comparisons with the longer but more secure sea journey from Asia to Europe - with shippers like Maersk offering daily sailings in their line of Malacca-max ships (e.g. the *Emma Maersk* holding up to 12,500 containers). However, we propose that the Eurasia 'Landbridge' should use ultra high speed maglev to reduce the journey to ~2 days.

The map above indicates how the Central Asian countries are located with respect to the suppliers and customers of Europe and eastern Asia (in particular, China). It is noted that only about 40% of China's production is internally sourced, the remainder being sourced from Europe or the US. Thus there is a flux between these trading blocks which involves multiple suppliers, multiple assemblers and multiple customers based in all three regions. Therefore we need good, fast and secure logistics to enhance future globalised trade.

### **THE POLITICAL AND GEOPHYSICAL REALITIES**

The health of a nation depends on many factors all of which influence the development and maintainability of its infrastructures. Sometimes externalities inflict their pressures, as in war time, or in times of financial turmoil. In this paper we suggest 'infrastructure development' may be viewed as a pseudo-mathematical function which links several factors

$$ID = fn(T, C, E, HM, Ed | OG \& Tr)$$

We propose that infrastructure development (ID) is linked to a number of factors

*T = Transport development*

*C = Communications*

*E = Energy management*

*HM = Health management*

*Ed = Education provision*

Given: *OG = Open governance* and *Tr = Transparency*

There is not sufficient space herein to develop a full discussion upon all the factors in this 'equation'. However we will note that many NGOs are active across Central Asia and most support the principle of this equation.

Considerable investment has been made by the EU in an attempt to align Central Asian railways to link with the development of the pan-European network as well as provide routes into Asia. As might be expected, the terrain of Central Asia hinders straightforward development as do the nature of country-by-country politics and their government's fear of insurrections that might utilise well constructed modern railways to move troops. A further issue is the track gauge. The Soviet legacy in the former SSRs is broad gauge track (1520 mm) and much of the Indian rail system uses an even wider broad gauge (1676 mm), while both Europe and China use standard gauge (1435 mm). The change of gauge at border crossings delays transit as [usually] the axles along the length of the train are swapped (but not the engine, which returns to its home-country base).

All modes of transport have to be considered across the region, and of the various multilateral initiatives, the EU TRACECA program beginning in 1993 is the best financed and has had a strong positive effect in technical know-how

transfer, and in extending familiarization with international norms and practices. But there remains an understandable local suspicion about regional initiatives. Central Asia has not been left out of the global [IT] wired-system. In particular it hosts nodes along the Trans-Asia-Europe (TAE) cable. Agreed in 1993, it is the world's longest overland fibre-optic system (27,000 kms) and it provides digital circuits for transmitting voice, data, fax and video information from Shanghai to Frankfurt and hundreds of other cities on the way. Most of the route follows the ancient Silk Road linking China to Europe. Participants in the project include China, Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, Turkmenistan, Iran, Turkey, Ukraine, Belarus, Poland, Romania, Hungary, Austria, Germany, as well as Georgia, Azerbaijan, Armenia, Pakistan and Afghanistan. Of course, the telecoms companies in each of the countries involved can extend into their local network, thereby globally linking their cities.

In addition to the co-ordination by the CAREC programme (Central Asia Regional Economic Co-operation initiated in 1997), the Central Asian Countries Initiative for Land Management (CACILM) agreed a 10-year programme in June 2006 to co-ordinate land (re-)use. It aims to implement a comprehensive and integrated approach to sustainable land management that would produce benefits at the local, national, and global level – and this includes transport policy.

We must note Ian Bremmer (2006) writing upon the nature of the 'J' Curve. He states that some nations are to the left of the curve (being closed, authoritarian and run by a unique leader) while others lie to the right of the curve (and are open, democratic, and have transparent public institutions). Both groups of nations may seem equally stable, but inevitably if the leader in a left-hand nation was to die, or be deposed, his country would rapidly sink down its 'J Curve' into crisis, and maybe into instability. Bremmer considers all the nations of Central Asia lie to the left side of his curve, as too are India, China, most Middle East states, as well as Egypt.

It is with some reluctance that we agree with Bremmer's arguments when he considers the instabilities of the Central Asian states (including Russia and China). These states are highly dependant upon oil and gas revenues and the tight maintenance of their highly controlled chaotic institutions. Their Presidents fear for their position if their peoples learn too much of the freedoms in the outside world. So, while transport systems will undoubtedly be put in place, they will serve initially only the petrochemical and minerals industries that create the revenues which in turn help Presidents maintain tight policing of their states. Of course, if road and rail links (and pipelines) are in place, global transport planners will use them. Gradually as timetables, confidence, and trust develop so will the use of these routes on a through-route basis. It is this goal that the CAREC members, including the Asian Development Bank, European Bank for Reconstruction and Development, International Monetary Fund, Islamic Development Bank, United Nations Development Program, and World Bank strive for. Meanwhile deep-sea shipping will continue to maintain global trade.

### **AN OPPORTUNITY?**

The Central Asian states wish to upgrade their old Soviet-style transport systems (both road and rail), and TRACEA, CAREC and so on suggest they use the European standards. We note that China is spending a vast budget on its own rail

infrastructure development, and the Chinese Vice Premier Zeng Peiyan on opening the 8<sup>th</sup> China Development Forum said "China is determined to build an environmentally friendly society by enhancing energy conservation and promoting the use of clean energy" (*China Daily*, March 23, 2007). We have suggested (Kidd & Stumm, 2007) that China, in conjunction with the Central Asia transportation development programme as well as some States in the EU 7<sup>th</sup> Framework, should install maglev ultra-high speed transport systems. This plan for China crossing Central Asia and into Europe should be adopted for two reasons: commercial viability (vastly reducing time-to-market journeys across Eurasia, down to ~2 days end-to-end), and ecological support (maglev has a very low carbon footprint). This is a bold initiative, but environmentalists (Stern, 2007) and our own concerns for our future population demand radical thinking. As maglev systems are less costly than TGV systems, we think it will be the preferred system of the [near] future. In particular, keep an eye on Russia. On Tuesday 24<sup>th</sup> April 2007 they announced plans to 'bridge' the Bering Straights. Arkady Dvorkovich, presidential economic adviser, and the head of Russia's rail monopoly, Vladimir Yakunin discussed "Mega-projects of Russia's East" - an ambitious project to build a 6,000-kilometer (3,700-mile) transport corridor linking Russia with Alaska. Their proposal has great impact on our discussions above relating to the possibilities of implementing the Eurasian maglev.

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- As well as -*Directives* and *White Papers* from the EU, TRACEA, UNDP, CAREC, etc.
- White Papers* from The Central Asian Institute, Johns Hopkins University, Washington DC, USA; and other sources.

## **GLOBAL SUPPLY CHAINS: A CASE STUDY OF OPTIMISATION OF THE CONTAINERISED FLOW OF GOODS BETWEEN THE US AND EASTERN EUROPE**

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### **ABSTRACT**

The fact that the globalisation is on the way is highlighted by the figures currently achieved in the world-wide international trade, which reflect a significant growth in general and in particular areas. The global container transport increase amounts to about 8-10% on a yearly basis. Operational efficiency of the global transportation chains is affecting by all actors involved: linear companies, port authorities, stevedores, forwarders, agents, and also hinterland transportation modes so, we have to balance "freight logistics", "container logistics" as well as "vessel logistics".

A transportation – logistical chain is integrity of technical, technological and organisational operations, synchronised in space and time (e.g. packaging, loading, discharging, transshipment, warehousing and delivery of goods), providing fast, secure and optimal flow of goods from their raw basis to the consumer. This research focuses on the container transportation chain aiming to optimise it and identifies its advantages. Even though the system of optimal functioning of international transportation chains depends on several factors (traffic infrastructure, modern transportation technologies, development of foreign trade exchange etc.), it seems that the integral information system based on modern information technology represents its fundamental precondition.

### **INTRODUCTION**

The transportation problems take an important place in the operation research as well as in the application of quantitative methods for the solution to complex problems. The approach of the quantitative analysis consists of defining the problem, developing a model, acquiring inputs, developing solutions, testing them, analysing results and applying them. The transport problem of linear programming occurs when the transport of definite goods from several points of departure and several points of destination has to be programmed (e.g. transport of containers with cargo from production points to seaports and from there to consumer points) with minimum costs. Accordingly, a hypothesis is proposed: The electronic Excel data table, being a representative packet for mathematical programming in the function of solving the transportation problems, enables an effective optimisation of the multimodal transportation chains. The data table includes the computer programs that may be used for computation and publication of the quantitative analysis. A data table may compute the majority of mathematical problems totally or partially. Even though there is a definite number of table programs on the market, the most popular is

the Excel data table. The standard data tables, which solve the problems of the quantitative analysis, are further supported with specialised programs in order to widen their capacity. They are called "add-in" programs and once they are added, they may be used as an integral part of the data table. An example of an "add-in" program is the Solver. Usage of Solver application in mathematical programming and limitation programming technology requires ability to create a transport problem-solving model. It is necessary to integrate highly specialised knowledge about computer-supported optimisation methods such as matrix generation, data preparation for solver, mathematical programming, and programming in computer program languages that support mathematical programming. Solver, as a computer-supported method of optimisation supports the creation of transport problems solving model which describes relations between problem area, decisions and limitations, contains a set of logical procedures that are incorporated in computer application for finding an optimal transport problem solution. It is used to solve problems with many variables and assists in finding a combination of variables, which raise the target value to the maximum or reduce it to the minimum.

In order to simplify a complicated problem of container transport in the multimodal transport chain comprising four traffic branches with their technical, technological, organisational, economic and legal specificity, first, four individual, partial problems are formulated. Then, after these problems have been solved and optimal solutions found, the problem is formulated for the whole multimodal transport chain. It is presumed that the multimodal transport operator should arrange dispatch of a greater number of containers with cargo from several shore terminals in the US by road vehicles through several US ports (i.e. port container terminals - New York, Norfolk, Long Beach, Oakland); from there to the European ports (i.e. port container terminals - Koper, Rijeka, Trieste, Antwerpen); further to distribute containers with cargo by rail to several shore terminals (i.e. rail-road terminals); and finally from these terminals distribution would continue by road vehicles to consumers in the countries of Central and Eastern Europe ( Hungary, Austria, Czech Republic ...).

In order to prove the proposed hypothesis the following methods are used: analysis, synthesis, system, mathematical modelling and mathematical programming.

### **DEFINING AND OPTIMISATION OF THE CONTAINER TRANSPORTATION CHAIN**

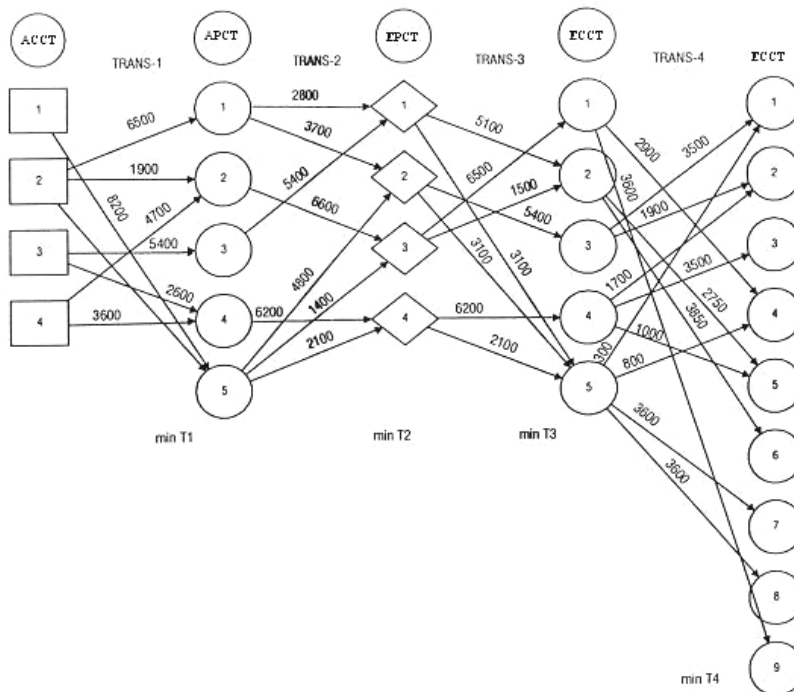
The first partial problem (fig.1:TRANS-1) shows container transport by road vehicles from four American continental container terminals (i.e. ACCT<sub>1</sub>, ACCT<sub>2</sub>, ACCT<sub>3</sub>, ACCT<sub>4</sub>) to five American port container terminals (i.e. APCT<sub>1</sub>, APCT<sub>2</sub>, APCT<sub>3</sub>, APCT<sub>4</sub>, APCT<sub>5</sub>).

The second problem (fig.1:TRANS-2) shows transportation and distribution of containers with cargo by container ships of the fourth and fifth generation from five American port container terminals (i.e. APCT<sub>1</sub>, APCT<sub>2</sub>, APCT<sub>3</sub>, APCT<sub>4</sub>, APCT<sub>5</sub>) across the Atlantic Ocean to four European port container terminals (i.e. EPCT<sub>1</sub>, EPCT<sub>2</sub>, EPCT<sub>3</sub>, EPCT<sub>4</sub>).

The third partial problem (fig.1:TRANS-3) of transportation and distribution of containers with cargo shows transportation of containers by rail from four European port container terminals (i.e. EPCT<sub>1</sub>, EPCT<sub>2</sub>, EPCT<sub>3</sub>, EPCT<sub>4</sub>, EPCT<sub>5</sub>) to five European continental container terminals (i.e. ECCT<sub>1</sub>, ECCT<sub>2</sub>, ECCT<sub>3</sub>, ECCT<sub>4</sub>, ECCT<sub>5</sub>).

The fourth partial problem (fig.1:TRANS-4) of transportation and distribution of containers with cargo shows transportation of containers by road vehicles from five European continental container terminals (i.e. ECCT<sub>1</sub>, ECCT<sub>2</sub>, ECCT<sub>3</sub>, ECCT<sub>4</sub>, ECCT<sub>5</sub>) to nine European continental container terminals (i.e. ECCT<sub>1</sub>, ECCT<sub>2</sub>, ECCT<sub>3</sub>, ECCT<sub>4</sub>, ECCT<sub>5</sub>, ECCT<sub>6</sub>, ECCT<sub>7</sub>, ECCT<sub>8</sub>, ECCT<sub>9</sub>).

Figure 1: Distribution of containers (TEU) presented by all four optimal programs: TRANS-1, TRANS-2, TRANS-3, TRANS-4 with the number of containers and the sum of the manipulating transport costs



$$\Sigma T = 8\,456\,000 + 51\,630\,000 + 5\,382\,000 + 3\,202\,000 = 68\,670\,000 \text{ €}$$

The total manipulation costs amount to 68 670 000 € or 2080,9 € per container unit (TEU) of the multimodal transportation chains for the 33 000 full containers (TEU). If the optimal program for the distribution of the whole quantity of containers (33 000 TEU) is compared with the most unfavourable empirical programs of distribution of the same quantity, the multimodal transport operator shipping containers under FIATA Bill of Lading may save even up to 25 426 773 €. The said saving derives from the following calculation of four most favourable and four most unfavourable programs of distribution of 33 000 containers (TEU):

TRANS-1 empirical (most unfavourable) program	$\Sigma T = 11\,583\,561,6 \text{ €}$
Most unfavourable program	$\Sigma T = 8\,456\,000 \text{ €}$
Saving (27%)	$\Sigma T = 3\,127\,562,6 \text{ €}$

TRANS-2 empirical (most unfavourable) program	$\Sigma T = 71\,708\,333,3$ €
Most unfavourable program	$\Sigma T = 51\,630\,000$ €
Saving (28%)	$\Sigma T = 20\,078\,333,3$ €
TRANS-3 empirical (most unfavourable) program	$\Sigma T = 6\,900\,000$ €
Most unfavourable program	$\Sigma T = 5\,382\,000$ €
Saving (22%)	$\Sigma T = 1\,518\,000$ €
TRANS-4 empirical (most unfavourable) program	$\Sigma T = 3\,904\,878$ €
Most unfavourable program	$\Sigma T = 3\,202\,000$ €
Saving (18%)	$\Sigma T = 702\,878$ €

## CONCLUSION

The international multimodal transport operator is often faced with the problem of continuous distribution of containers with heterogeneous or homogeneous cargoes from numerous starting and destination points using several different traffic branches, meeting all supply and demand with minimal manipulation and transportation costs. In such case the operator may first identify partial transportation problems for the individual traffic branch and then for the whole transportation chain. The basic aim of this treatise is to research into relevant features of the multimodal transportation chains as well as the problems of the synchronization of work of all participants. With the development of information technology the method of optimisation of the multimodal transportation chains is more and more based on the computer programs being representative tools in solving of the comprehensive tasks. It is believed that the present research, the methodology applied and its findings, should promote and improve the multimodal transportation chains in order to cope with the complex contemporary logistic demands of global economy.

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**A COMPETENCE-BASED ANALYSIS OF COLLABORATION IN GLOBAL SERVICE SUPPLY CHAINS – DESIGN OF A FRAMEWORK FOR THE IDENTIFICATION AND EVALUATION OF PROBLEMS AND OPTIONS OF LOGISTICS MANAGEMENT IN THE SERVICE SECTOR\***

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**ABSTRACT**

The main contribution of this paper is to design a competence-based framework for the analysis of problems and design options in the collaboration of Global Service Supply Chains (GSSC). For GSSC-Management it is required to systematically identify and evaluate typical logistic service problems and prospective design options. For this reason, the competence-based view (CBV) will be closer examined in a GSSC-context as it is assumed to provide an adequate theoretical basis for a conceptual discussion.

**IDENTIFICATION OF PROBLEMS IN GSSC**

GSSC can be characterized by a structure of different service providers (SPs) collaborating in a world-wide network (Hülsmann and Grapp 2006, pp. 370). Nowadays, GSSC have to face change drivers like hyper-turbulence (e.g. a current change of market demands for services), hyper-competition (e.g. fast development of substitutional services) and especially hyper-linking (i.e. that many different service partners are involved in the GSSC) (D'Aveni 1995, pp. 45–57, Tapscott 1999, Siegele 2002, pp. 18–24) leading to problems of complexity as well as dynamics (Hülsmann and Grapp 2005, pp. 243). That might induce the risk of becoming a so called "locked organization", which "describes dysfunctional and suboptimal situation with a limited choice of possible decisions (Schreyögg, Sydow and Koch 2003, p. 259). The adjective 'dysfunctional' in this context describes the limited ability of a rational decision-making. The immanent lack of information of a decision - the problem of bounded rationality (Simon, 1972: a manager cannot have the complete information about his problem of decision) - is connotated with the adjective 'suboptimal' (Hülsmann and Wycisk 2005a). But, to ensure their existence or even increase their firm benefit (Müller-Stewens and Lechner 2005, pp. 220) GSSC need to build up competitive advantage (e.g. producing new generations of products, increased service level) (Hülsmann et al. 2006) enabled by its management (e.g. producer of a movie production company), which is responsible for the strategic planning, design, control (Ulrich and Fluri 1995, pp. 180) and coordination of its structures (e.g. in media branch: movie production companies and SPs). That means, its main central task is to organize collaboration among its global SPs (i.e. here providing movie production companies with services) (Hülsmann and Grapp 2006, pp. 370).

However, the fulfilment of this task seems to become an increasing challenge for GSSC. This might result from the fact that on the one hand GSSC-Management has to fulfill typical (service) logistic goals in a global context (i.e. logistic services have to be allocated and distributed in good quality, in the right quantity, at the exact

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point in time, at low cost) (Mikus 2003, p. 48). On the other hand it has to consider a fast changing environment which endangers the achievement of these goals (e.g. individual customer preferences, timely restrictions). It seems that in GSSC there is a lack of strategic adaptivity for adequately responding to changing requirements (Sanchez 1993, 1995, 1997), e.g. coping with new service logistic demands. Strategic adaptivity is necessary, aiming at effective as well as efficient service collaboration in GSSC by balancing flexibility (e.g. specific SPs for special service processes) and stability (e.g. SPs for basic service processes) of its structures. From a social systems perspective, flexibility refers to the ability of the system structure to change (Hülsmann and Wycisk 2005b). According to Luhmann these changes are enabled by boundary openness of the system (Luhmann 1973), which absorbs a part of the cited complexity and dynamics of the environment (e.g. information for collaboration of SPs). Stability refers to the ability of the system to keep the information inflow at a manageable level by ensuring a certain level of closure, which means the systems' boundaries closeness (Luhmann 1994). But obviously, under the current phenomena it seems to be quite difficult for GSSC-Management to ensure the required adaptivity (i.e. balancing flexibility and stability of SPs' collaboration in GSSC). Thus, the initially stated competitive advantage (e.g. through performance differences by extraordinary design of its services) over other GSSC can hardly be generated.

An approach of modern management which has recently been gained relevance is the CBV that aims at the explanation of the formation and further existence of performance differences which become evident in above-average returns or manifest themselves in competitive advantage over competitors. In this view, performance differences are mainly explained by competences (Barney 1996, Hamel and Prahalad 1997). Transferring the CBV on a GSSC-perspective, the GSSC-Management itself could be understood as organizational competence (e.g. producer of a movie production company) to bundle and allocate single competences of its SPs (i.e. technical, transportation support services etc.) (Hülsmann and Grapp 2006, pp. 370). An organizational competence in general is understood as "the ability of an organization to sustain coordinated deployments of resources in ways that help the organization to achieve its goals" (Sanchez and Heene 2004, p. 7). By reflecting the above stated problems of GSSC from the perspective of CBV implies that the mentioned task of organizing the collaboration among GSSC's SPs holds competence deficits. There seems to be a dysfunctional bundling and allocation of GSSC-competences (e.g. unsystematic coordination of SPs) taking place on two levels. On the one hand service competences are needed for managing and on the other hand they represent the objective of GSSC, i.e. a meta-competence to coordinate other competences (Bouncken 2003, p. 64). But, which competence problems in fact are there and are relevant for GSSC-collaboration? After Freiling competences have to be analyzed in the sense of action-oriented potentials to realize and activate resource-immanent potentials (Freiling 2004, p. 6). Strategic Competence-based Management (CbM) is considered to be one application of the CBV (Sanchez 2004, pp. 518-532). CbM includes the systematic identification, evaluation, arrangement, building and leveraging of the competences of a company (e.g. Barney 1996, Thiele 1997, Hamel and Prahalad 1997). In turn, this implies a planned and controlled development and use of competences, but in a turbulent environment is not the case as competences always have to be adapted to changing requirements (Freiling 2004, p. 9). This is a problem as adaptivity of organizational competences is considered to be limited due to inertia of systems to change their structures

(Schreyögg and Kliesch 2006, pp. 455). So, which competence-based design options are there for the collaboration in GSSC?

Following this argumentation line, this paper's hypothesis is that GSSC-Management needs a systematic approach to identify and evaluate its problems and options in the collaboration of GSSC described within a framework of a competence-based analysis. It is assumed that thereby it might be possible to act strategically adaptive and finally build up competitive advantage. The following aims result from the research context described above and will be illuminated within this paper:

**Aim no. 1:** Designing a competence-based framework for analyzing collaboration in GSSC, i.e. providing a basis for systematically identifying and evaluating competence problems and options by using the CBV. **Aim no. 2:** Discussing contributions for collaboration in GSSC of the competence-based framework to GSSC-Management, i.e. systematic analysis of problems and options for GSSC-collaboration by reflecting the CBV.

### **CONCEPTUAL ATTEMPT OF A COMPETENCE-BASED FRAMEWORK FOR GSSC**

For the conceptualization of a framework, which consists of a competence-based analysis, two components of analysis will be considered. On the one hand it shall be possible to systematically identify and evaluate problems of GSSC representing a reference system of logistic service structures. Therefore the "model of an organization as a goal-seeking open system" (Open Systems View) of Sanchez and Heene (Sanchez and Heene 2004, p. 5, Sanchez and Heene 1997, pp. 303-317, Sanchez and Heene 1996, pp. 39-42) will be further examined regarding its potential to analyze GSSC' problems (**Framework Component 1: Competence-based Problem Analysis: CbPA**). On the other hand it is intended to enable the identification and evaluation of new strategic options in GSSC-collaboration for a CbM of GSSC. For the analysis of options the concept of "competence building, maintaining, and leveraging" (Sanchez and Heene 2004, p. 7) to possibly generate competitive advantages for GSSC will be used (**Framework Component 2: Competence-based Option Analysis: CbOA**).

From a science theoretical perspective the aim of scientific research consists of the identification of causes and effects that explain causal relations (Hill et al. 1994, p. 35). This has to be reflected for the design of the framework that will be deduced from the concepts cited above. Each framework component includes essential elements aiming either at the explanation of causal problem (see no. 1 a) to 1 c)) or option (see no. 2 a) to 2 c)) relations which are assumed to enable a competence-based analysis. Furthermore, because GSSC are supposed as object of research its basic characteristics have to be included by giving examples in the framework. **Component 1** consists of three main elements – oriented at Freiling's considerations on the CBV (Freiling 2004, pp. 16-19) – being part of the framework design: **Element no. 1 a) (resource market): Adaptations and changes result from misfits between the system (i.e. GSSC) and its environment (i.e. competing GSSC or resource holders)**. Such kind of discrepancies shall be compensated by making resources accessible which are important for a system's own processes of refinement. Therefore, the system needs the capability to identify adequate resources for sustaining the GSSC's existence or building up sustainable competitive advantages, to integrate respective resources and to generate a maximum benefit from them. **Element no. 1 b) (product market): Balancing between the need of the environment and the supply (i.e. services) of the**

**system is determined by customer preferences.** Therefore, systems must have the capability to develop its resources or competences aimed at the specific market requirements (e.g. logistic services). **Element no. 1 c) (market process): Back coupling processes by the exchange of market data enable changes as well as the development of the system's resource structure.** Therefore, a system has to ensure its capability to provide itself with market relevant know-how for the design of its management processes (e.g. decisions on inventing alternative service logistic concepts in a GSSC). A CbPA itself is executed by examining a specific object of research (e.g. problems of GSSC) regarding elements no. 1 a) to 1 c). Competence problems are assumed if different capabilities to adapt to environmental changes or increasing competitive advantage respectively cannot be generated. Component 1 refers to the concept of organizational competence which understands an organization as competent if it is able to create and distribute "value to all providers of resources essential to maintain the activities of the organization". However, a competent organization requires a Strategic Logic and system design capable to simultaneously building, maintaining, leveraging competences (Sanchez and Heene 2004, p. 7).

This means for the design of **Component 2** a CbOA has to consist of three elements (no. 2 a) to 2 c)) which are considered as parts of the framework (Sanchez and Heene 2004, pp. 7-9): **Element no. 2 a) (competence building):** Processes to using qualitatively new kinds of resources or new abilities to coordinate resources aims at the creation of options for future action in the collaboration of GSSC; **Element no. 2 b) (competence maintenance):** Processes to continually adapting and improving a system's coordinated deployments of resources in order to maintain their effectiveness in achieving the goals of the system aims at the creation of options for taking actions in pursuit of its goals; **Element no. 2 c) (competence leveraging):** Processes to achieving the goals of the system by using resources and coordination abilities qualitatively similar to the ones the system already possesses aims at the creation of options for qualitative or quantitative actions. A CbOA itself is executed by examining an object of research (e.g. options of GSSC) regarding elements no. 2 a) to 2 c). Then, competence options are deduced from the conception of each element.

### **COMPETENCE-BASED ANALYSIS OF COLLABORATION IN GSSC**

The following discussion shall exemplify how far the deduced competence-based framework contributes to analyze collaboration in GSSC by the application of above shown components and their elements. Examining typical GSSC-problems named in the beginning of this paper by a CbPA (elements no. 1 a) to 1 b) results in the following competence problems, all affecting GSSC-collaboration: **Application Element 1 a) → Competence Problem 1:** The coordination of information for logistic processes in GSSC seems to be difficult if reflected that exchange of information among global SPs has to take place under high timely pressure (Hülsmann and Grapp 2005, pp. 243). A GSSC might have problems to react to environmental changes and distribute only the relevant package of data (e.g. in movie production processes a lot of data has to be processed and despite long-planning periods unexpected situations require ad-hoc decisions (Hülsmann and Grapp 2006, p. 371) weakening its quality because of a limited quantity of information (Bronner 1999, pp. 27-31). **Application Element 1 b) → Competence Problem 2:** Providing a market-adequate range of logistic service offers seems hardly realizable, because the needs of individual customer preferences are different and often the optimal SPs are not available. (e.g. in movie production pro-

cesses there exist many different and often rapidly changing service needs such as technical, financial, and informational support which increases the pressure to develop and offer new services (Hülsmann and Grapp 2006, p. 371)). **Application Element 1 c) → Competence Problem 3:** This problem is linked to the former ones and shows the current informational risk of undersupply in GSSC as on the one hand data is required *for* the execution of different SPs' service logistic concepts and on the other hand data *of* the service logistic market is needed to adapt to changes (i.e. movie productions a constant monitoring of movie market technology trends as well as customer preferences for movie process optimizations is required).

The different competence problems have shown the present discrepancies between a GSSC as a system and its environment undermining the competent logistic service value creation and distribution of GSSC-Management to all providers of resources or competences. To gain competitive advantage by a competence-based Management of GSSC Freiling actually shows the need for a strategic architecture to close the cited misfits which he explicitly sees in the formation of networks among partners (Freiling 2004, p. 10) – such as SPs in GSSC? This would mean that GSSC already hold fundamental preconditions for coping with its competence problems. Which options for collaboration in GSSC – reflecting inertia in the adaptivity of organisational competences (Schreyögg and Kliesch 2006, pp. 455) result from a CbOA (elements no. 2 a) to 2 c)) of GSSC-collaboration? **Application Element 2 a) → Competence Option 1:** an option for future actions in GSSC could be generated by the acquisition of intangible assets, e.g. special know-how of new logistic SPs would support the competent design of logistic processes. **Application Element 2 b) → Competence Option 2:** an option for taking actions in pursuit of GSSC-goals could be generated by the continuous optimization of operations meaning the improvement of service logistic processes. **Application Element 2 c) → Competence Option 3:** an option for qualitative actions of collaboration in GSSC could be gained by increasing the level of service logistic processes, e.g. meaning their efficient as well as effective service design. Transferring this view of GSSC-options on movie productions - as a context of service logistics - could be understood from a portfolio perspective. It refers to a pool of competences (Bellini et al. 2000, pp. 1, Purcell and Gregory 2000, pp. 161). A portfolio of competences is needed for the coordination in regard to specific requirements of movie production projects which need a certain quantity and quality of resources (Gaitanides 2001, pp. 167-170). New competences are acquired if necessary, then are available for specific short-time demands (operative level: e.g. ensuring transportation processes) as well as for long-term requirements (strategic level: e.g. ensuring availability of main responsible persons like producer, director). Finally, on the basis of such a portfolio the aimed and thereby leveraging of service logistics competences for movie production processes is assumed to be possible.

## CONCLUSION

In general, the competence-based framework for the analysis of GSSC presumably seems to lead to gain competitive advantage over other GSSC-competitors, because it holds a systematic approach integrating both the analysis of problems and generation of options for collaboration in GSSC to survive or even dominate on the service logistic market. But, it has to be stated that only a first attempt to design a competence-based framework for the analysis of GSSC-collaboration has

been shown. Future research should focus on a more detailed formulation of the framework's elements to increase the broader applicability of this analysis tool.

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## TOTAL ACQUISITION COST (TAC) OF CHINA SOURCING—INDICATIONS FROM CASE STUDIES

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### ABSTRACT

Through five case studies, this paper tests the comprehensiveness and usability of a total cost framework for global sourcing. Cost items measured in the case companies are identified. The sources of the information for populating the framework are investigated and the accuracy is analyzed.

**Keywords:** total acquisition cost, China, sourcing, case studies

### INTRODUCTION

Attracted by low cost, more and more manufacturers in the UK have recently begun to purchase parts or components from China. But overseas outsourcing can be costly. The cost savings may not be as great as they seem (Gilley and Rasheed, 2000). Although cheaper labour can be obtained, other extra expenses may also occur. Song et al. (2006) proposed a total acquisition cost framework of global sourcing, indicating about 50 cost items that may happen during the global sourcing process (table 1). They also argued that a challenge of calculating the total cost of global sourcing is the shortage of necessary information in companies' accounting system. This challenge is also addressed in the TAC literature because it hinders the application of the total acquisition cost method in practice (Ellram 1993; Ellram and Siferd 1998; Lindholm and Suomala, 2004). This research aims at answering the following questions. Is the framework comprehensive? What costs in the framework are measured in practice? What are the sources of information to calculate the TAC of China sourcing, if the costs are not measured by companies and, furthermore, the necessary information is not directly available from the accounting record? What are the accuracy and reliability of the information?

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#### 1 Information collection, supplier selection and negotiation (one-off)

- Gather information and codify knowledge of the process transferred
- Package the process for IP protection
- Modify and pilot the process outsourced or re-sourced (including modification due to different climate)
- Search for and visit supplier
- Quality audit cost
- Tooling cost

#### 4 Quality issue (ongoing)

- Rejection, return, re-receiving and retesting
- Defective material disposition
- Rework
- Scrap
- Production line downtime
- Warranties and customer complaint handling
- Loss of sale because of quality

#### 5 Supplier management (ongoing)

- Supplier training and technical support
  - Co-operation with supplier for innovation
-

<ul style="list-style-type: none"> <li>● Negotiation with supplier</li> <li>● Add supplier to internal IT system</li> <li>● Invest in suppliers' IT systems (e.g. MRP, ERP, TCM etc).</li> </ul>	<ul style="list-style-type: none"> <li>● Update forecast and convey it to suppliers</li> <li>● Performance review and meeting</li> <li>● Renegotiation</li> <li>● Costs of phone calls, faxes, video conferences</li> <li>● Litigation</li> <li>● Impact on residual supply from the previous supplier</li> </ul>
<p><b>2 Extended price (ongoing)</b></p> <ul style="list-style-type: none"> <li>● Price</li> <li>● Tax and duty</li> <li>● Benefit from payment terms changes</li> <li>● Currency exchange rate fluctuation</li> </ul>	<p><b>6 Other costs</b></p> <ul style="list-style-type: none"> <li>● Personnel recruit and training</li> <li>● Expatriating employees</li> <li>● The impact of "made in China/Mexico/India...." on customer</li> <li>● Get rid of redundant capacity and labor</li> <li>● Dealing with inferior infrastructure Special regulations from local government (e.g. environmental policy, working hours and pattern restriction, etc)</li> <li>● Culture and language issues (additional costs for training and re-designing of job process, performance measurement system, etc.)</li> <li>● Cost for dealing with counterfeit products</li> <li>● Dealing with corruption of local government</li> </ul>
<p><b>3 Administrative (ongoing)</b></p> <ul style="list-style-type: none"> <li>● Forecasting/ordering process</li> <li>● Payment/billing process</li> <li>● Bank charges</li> </ul>	
<p><b>4 Logistics and inventory (ongoing)</b></p> <ul style="list-style-type: none"> <li>● Transportation</li> <li>● Expediting</li> <li>● Lost sales owing to late deliveries</li> <li>● Holding and administrative costs related to early delivery</li> <li>● Receiving (including moving heavier packaging for shipment protection)</li> <li>● Inspection</li> <li>● Holding inventory (heating costs, warehouse maintenance, etc.)</li> <li>● Insurance</li> <li>● Obsolescence</li> <li>● Capital charge for keeping inventory</li> </ul>	

**Table 1 A framework of total cost of global sourcing (Source: Song et al. 2006)**

## METHODOLOGY

To find out the sources of the information for calculating the TAC of China sourcing projects and to analyze the accuracy of the information, in-depth investigation in companies was required. Answering the question of what costs happened during the China sourcing also needed to investigate in the process in detail. Therefore, case study was adopted as the research method. Five companies with the experience of China sourcing were studied (table 2). The companies were selected on the basis of variation in size, sector and for how long the project has lasted.

	A	B	C	D	E
Sector	Agricultural equipment	Tape measure	Control panel	High-tech printer	Electronic parts
Turnover (£)	10 million	6.5 million	2.5 million	190 million	30 million
How long	3 years	0.5 year	2 years	1 year	10 years
Purchased product	Post driver	Un-labelled tape measure	Circuit breaker	Cabinets of printers	Fused terminal block
Headquarter	UK	UK	UK	UK	UK
Host country	China	China	China	China	China

**Table 2 Information on the five case companies**

During the case studies, the manager director or the project manager of the case company was first interviewed for a general introduction and their perceptions of the



China sourcing project. They were asked about what cost they measured for the project. Then, people from the group of engineering, purchasing, manufacturing, logistics and accounting were interviewed. These interviews were semi-structured on the basis of the cost items in the framework (table 1). The purposes of these interviews were: to ask about whether they measure the cost items in the framework; to calculate the costs; to find out the sources of the information for calculating each cost and to analyze the accuracy of the information; to test whether there are new cost items which are not covered by the framework. Documents such as invoices, orders, contracts etc. were also referred to when necessary.

## RESULT DISCUSSION

The case studies demonstrated that the framework covered all the costs entailed in the China sourcing process, except one: the impact from 'made in China' on customers. In one case company, customers had many concerns about the quality of the products when the company planned to purchase some parts from China. To assure its customers about the quality, the MD had to give several presentations addressing the intensive inspection process for the parts from China. He spent extra time for the presentations which entailed extra wage cost.

Table 3 outlines what costs were measured in all the case companies/some of the companies/none of the companies. The sources of the information are also discussed. In the table, all the estimates were made during research interviews. They were not normally calculated by the companies.

<b>Costs measured by the five companies</b>	Quoted price, Tax & duty, Obsolescence, Reworking/rejection of the whole shipment, Tooling cost (only relevant in three companies)	
<b>Costs measured in some companies</b>	Technical transfer and quality audit	Engineering time was measured in three companies; in the other two, it was estimated by the relevant engineers on the basis of the timetable of the project and the proportion of the time they were working on the China sourcing project. Cost of DHL postage of samples, drawings and so forth were not measured by any of the companies and were buried in the general overhead. This information was collected from the original invoices.
	IP protection	Only one company registered IP in China and measured the cost.
		Modify the design for IP protection: it occurred in one company, but the engineering time was not measured. The relevant engineer was interviewed and he estimated the time he spent for the modification.
	Add the supplier into internal IT system (mainly staff's time cost) One company measured it. In the others, the buyers who did the work were interviewed and they estimated the time they spent in adding the supplier into the IT system.	
	Transportation Four of the case companies measured the transportation cost. One case company did not have enough records and cost was extrapolated by weight from one shipment where detailed records existed.	
Expediting	Three companies used airfreight in emergency. Two companies measured it. The others did not. The cost was collected through referring to the original invoices.	

		One company hired outworkers in the UK to produce the products sourced from China in emergency. The cost was measured.
	Insurance	Only one case company measured the cost for insurance. Two companies paid CIF (carriage, insurance and freight) and did not need to pay for the insurance separately. Two companies had insurance policy to cover all the shipments; but the insurance fee needed to be allocated among different products. This research allocated the insurance on the basis of annual purchasing value of each product. Information on the purchasing value was collected from the purchasing managers' personal computer.
	Receiving and inspecting cost	In one company, work's order was adopted to record the engineering time for inspection. In the other companies where no accurate record was available, we asked the operations managers to estimate the time for receiving and inspecting.
	Warehouse	One case company used a third party warehouse and had accurate payment information. Two companies had expanded their warehouses after China sourcing. But the additional cost was not allocated among the different kinds products purchased from overseas. The cost was allocated by the research according to the space occupied by the products. The space was estimated by the operations manager or the warehouse manager.
<b>Costs measured by none of the companies</b>	Supplier selection, visiting and negotiation	Travel expenditure In four companies, it was buried in general overhead and needed allocation, because one trip had more than one purposes, such as visiting several different suppliers, taking part in trade fares, meeting customers and so forth. The travel expenditure was allocated to different projects according to how many days were spent on each of them. In the fifth company, the cost occurred 10 years ago and the record was not available. Hence, the cost was extrapolated from the costs of the recent trips to China where records existed.
		Staff's time cost was not measured in any of the five companies and was estimated by the relevant individuals during research interviews.
	Loss or benefit from payment term changes It was quantified by the research with the information on the payment terms, the purchasing value and the borrowing rate of the company.	
	Loss or benefit from currency exchange rate fluctuation In three companies, it was not necessary to exchange currency when making payment, because they had enough USD income from their global market to pay their Chinese suppliers. Therefore, there was no impact on them from the currency exchange rate fluctuation. The other two companies had to exchange GBP to USD. But they did not measure the gain or loss. It was quantified by us through comparing the exchange rate when money was transferred, with the initial exchange rate when the price was negotiated with the supplier in China.	
	Costs resulting from the increasing working burden on administrative processes, including forecasting, ordering and billing were not measured in any of the companies. After interviewing the relevant staff, it turned out because the China sourcing product usually substitutes the products purchased from the UK supplier, the ordering frequency was reduced and the overall work burden did not increase, although for individual ordering and billing processes the work amount had increased.	
	Bank charges In all the five companies, the bank charges were buried in the overhead. The cost was collected by asking the accountant to check how many transactions had been made. In one company, the charges needed further allocation among several products because the supplier provided more than one products. Hence, the charges were allocated by the research by the purchasing value of each kind of product.	

	<p>Capital cost of inventory None of the case companies measured it. Three companies did not have the historical records on inventory. Hence, sales and ordering records were referred to in order to calculate the inventory amount. The capital cost of inventory was quantified with the average inventory amount and the borrowing rate of the companies.</p> <p>Staff's time cost of analyzing and handling the quality problem. The operations managers or shop floor supervisors were interviewed for estimates of the time.</p> <p>Labour cost for re-receiving and re-inspecting the re-sent shipment. The operations manager or warehouse manager were interviewed for estimates.</p> <p>Scraps were usually recorded (except for one company), but the labour cost and engineering time cost related to handling scrap were not measured. The operations managers or the shop floor supervisor were interviewed for estimation.</p> <p>Cost of phone call, fax or video conference The research referred to the original telephone bills to find the cost. When the bills were not available, relevant staff (purchasing, engineering, financial and so forth) were asked for estimations during the research interview.</p> <p>Renegotiation (Staff's time) This cost was only relevant in one company and it was not measured. The project manager was, therefore, asked to estimate the time spent in renegotiation.</p> <p>Performance review and meeting (staff's time) The purchasing staff were asked to estimate their time spent in it.</p> <p>Recruiting and training This cost only occurred in one company and the cost was not measured. The cost was buried in overhead and it was necessary to allocate the recruiting cost because the new employees were working for more than one project. Then, for the China sourcing project, the proportion of the recruiting cost was estimated by the new employees according to the working amount for the project among their total working amount.</p> <p>The impact of "made in China/Mexico/India..." on customer In one company, to assure its customer about the quality of the parts purchased from China, the managing director had to give several presentations to the main customers. But his time spent on the presentations was not measured. Therefore, his estimation was required during the research interview.</p> <p>Cost incurred due to culture and language difference Payment and travel expenditure of translators were buried in general overhead. They were collected by going through the original invoices and the accountant's record. The loss from the delay of project because of the language barrier was not measured. It was evaluated by the research as the net present value of the delayed cashflow.</p> <p>Dealing with IP infringement. It occurred in one company and the cost was not measured. Staff's time for dealing with the issue was estimated by the relevant people, the managing director and an engineer. Cost for hiring a lawyer was buried in general overhead and was collected by the accountant at inquiry.</p>
<b>Costs not incurred in any of the five companies</b>	<p>Invest in suppliers' IT systems (e.g. MRP, ERP, TCM etc).</p> <p>Lost sales owing to late deliveries</p> <p>Holding and administrative costs related to early delivery</p> <p>Shelf life scrap,</p> <p>Production line downtime cost,</p> <p>Warranties and customer complaint handling,</p> <p>Loss of sale due to quality issue</p> <p>Expatriating employees,</p> <p>Get rid of redundant capacity and labour,</p> <p>Dealing with inferior infrastructure,</p> <p>Special regulations or corruption from local government</p>

**Table 3 The sources of information**

The accuracy of the information also varied. When companies had records on the cost items and it was not necessary to allocate the cost among different products, the accuracy was high. When allocation was involved, the accuracy might be reduced, depending on whether or not the basis for allocation is close to reality. Sometimes, accurate records were not available, and people's estimation was taken, e.g. staff's time cost. Then the accuracy was low.

## **CONCLUSION**

This paper tests the comprehensiveness, feasibility and usability (see Platts, 1993) of a total cost framework for global sourcing and investigated the sources of the information used for populating the framework. The cases demonstrated that the framework was comprehensive and it was feasible to identify and calculate the costs for China sourcing. However, due to the lack of available information, the usability of the framework is in doubt. More than 50% of the information was not directly available. This is consistent with the total acquisition cost literature (e.g. Ellram 1993 and Song et al. 2006). The data were either buried in the general overhead and needed further allocation among different products; or were not recorded and needed the estimation of relevant staff. There are no systematic systems in the five case companies. Among the cost items in the framework, only six cost items were measured by all of the case companies. Nearly twenty costs were not measured although they had occurred. This circumstance is consistent with the argument that that systematic utilization of cost measurement in outsourcing is rare in practice (Lindholm and Suomala 2004).

We are aware about the limitation of the generalizability of the results from five case studies, but the cases were selected based on certain criteria in order to improve their representativeness. We believe that the case studies have shown common problems in the UK manufacturing companies' cost measurement system for China sourcing projects.

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## **EVALUATING THE IMPACT OF THE LOGISTICS INDUSTRY TO GDP: THE THAI EXPERIENCE**

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### **ABSTRACT**

Thailand has experienced steady growth and structural changes in its economy in the last four decades. However, the emergence of global production networks and increased trade among nations has created a high demand for an efficient logistic industry that is able to provide cost and time effective transportation service and other value added services such as packing, warehousing or distribution. The purpose of this paper is to propose an overall methodology that can assess the contribution of the logistics industry to the national GDP. Thailand is chosen as an illustrative case study

The paper provides the rationale behind the methodology utilised to measure the logistics industry's share of the GDP. Calculation is then made for the logistics industry's ratio of contribution to national GDP, which is based on a des-aggregation of the national Input-Output table where a number of logistics related sectors are identified.

The results are further analysed in order to examine how to increase the logistics industry's contribution to GDP growth and provide guidelines for the direction of government policies related to logistics and transport-related sectors.

### **INTRODUCTION**

The emergence of global production networks with an increased dependency on efficient inter and intra firm relationship has given modern logistics a crucial role in connecting customers with suppliers. This process has created increased trade among nations as firms search for efficiency gains as a consequence of national and regional competitive advantage. Extract of these gains are dependent upon high performing logistics industry capable of adding value through the whole production process (Rushton & Croucher, 2000). The scope and elements of logistics services provided are experiencing change in the same pace as economic activities demand better co-ordination of information and input of goods in order to manage the global market and external factors influencing local, national and international business climate.

Economic factors affecting rate of exchange and interest rates, regulatory frameworks are influenced by deregulations for example in the transport sector (Banister & Berechman, 2001), technological progress and innovation contributing to higher productivity and faster exchange and transfer of information and input goods are all factors affecting the logistic industry (Ballou, 1999). This change imposes pressure on the logistics industry to be flexible and

dynamic in order to follow and adapt to constraints and demands within the environment it serves. The purpose of this paper is to describe an overall methodology to assess the contribution of the Thai logistics industry to the Thai national GDP. Thailand as a developing country believes that having strong logistics capabilities as well as an efficient logistics industry will improve the competitiveness of the country as a whole (NESDB, 2004).

## METHODOLOGY

Assessing the contribution of a logistics industry to any country's GDP can be quite a daunting task. Traditionally most studies related to the logistics industry are mostly focused on their market size and the types of logistics services provided (Wilson, 2004) not on their impact on national GDP or their value added. GDP figures themselves cannot be easily separated to provide the precise value added that is derived from the logistics industry as data has been aggregated beforehand (Bronzini, 2001). It was therefore decided to use the input-output table of Thailand for this study. The main reason for using the input-output table of Thailand is because of the level of details in the table can theoretically help better identify the value added created by the Thai logistics industry as value added in industrial or service sectors are represented. The input-output table is one of the ways in which the national economy of a country can be represented by grouping activities into branches of industry: agriculture, manufacturing, transportation, etc. For simplicity, each industry is assumed to produce only one good with only one process of production. To produce any given good or service, an industry will have to buy raw materials from other industries as well as using inputs such as labour and capital equipment, which can be considered "primary inputs". The produced goods or service can then sold to other industries to be used as inputs, or to households, governments, or to foreign countries. Sales to other industries are called "intermediate demand" while sale to consumers are called "final demand". These inter-industrial transactions can be shown in the following table 1 hereunder.

**Table 1: Example of input-output table inter-industrial transactions**

Input Structure	Output distribution		
	Intermediate transactions ( $x_{ij}$ )	Final Demand (F)	Total Output (X)
	Primary Input (V)		
	Total Input (X)		

Source: NESDB (1989)

The above table shows how the output of each industry is distributed among other industries of the economy (along each row). At the same time, it shows the inputs to each industry from other industries (along each column). The row thus represents the structure of distribution (or sales) of output while the column represents the structure of production (or costs). The table is called the input-output table.

Currently in the input-output table of Thailand there are 180 sectors that represent the Thai economy as a whole. Each sector covers a number of

activities. The activities are designed to ensure consistency of the commodity base as well as to keep the homogeneity of the activity in accordance with the scale of production. In the case of Thailand, the “informal” sectors are quite significant. This sometime does pose a problem in terms of how to classify an activity to a sector. In the input-output table, services such as transportation or logistics are valued at the prices paid by the sectors receiving such services. Table 2 illustrates the close relationship between Thai GDP and input-output table of Thailand as the final results must be related to GDP.

As shown in the table 2 hereunder, there is a very close relationship between GDP and input-output table. Even though the input-output table is used as the main source of data the results can be reconciled with national GDP.

Another issue that must be dealt with is the composition of the logistics industry that will be studied. Logistics and logistics industry has many definitions and in this paper the classification provided by the West London Skills Council seemed appropriate. Table 3 provides a proposed classification for the logistics industry.

However, when analysing the input-output table of Thailand it was discovered that there was no logistics industry sector or codification per se. It was therefore necessary to find which sector or codes where the most closely related to logistics. In the input-output table of Thailand, there exist codes related to transportation and warehousing. Hereunder are the related Input/Output codes.

- Code 136: Distribution of Natural Gas
- Code 149: Railways
- Code 151: Road Freight Transport
- Code 152: Land transport support services
- Code 153: Ocean Transport
- Code 154: Coastal and inland transport
- Code 155: Water transport services
- Code 156: Air transport
- Code 157: Other transport services
- Code 158: Storage and warehousing



**Table 2: linkages between Thai GDP & input-output table**

<b>Economic Activities (GDP)</b>	<b>I-O (001-180)</b>
<b>Agriculture</b>	
Agriculture, Hunting and Forestry	001 – 027
Fishing	028 – 029
<b>Non-Agriculture</b>	
Mining and Quarrying	030 – 041
Manufacturing	042 – 126, 128 – 134
Electricity, Gas and Water Supply	135 – 137
Construction	138 – 144
Wholesale and Retail Trade; Repair of motor Vehicle, Motorcycles and Personal and Household Goods	145 – 146, 127, 177
Hotels and Restaurants	147 – 148
Transport, Storage and Communications	149 – 159
Financial Intermediation	160 – 162
Real Estates, Renting and Business Activities	163 – 164
Public Administration and Defense; Compulsory Social Security	165
Education	167 – 168
Health and Social Work	169
Other Community, Social and Personal Service Activities	166, 170 – 176
Private Households with Employed Persons	178, 180

Source: *The Author*

**Table3: Tentative logistics industry classification**

**Standard Industrial Classification (SIC) codes for logistics.**

60.10: Transport via railways	62.30: Space transport
60.21: Other scheduled passenger land transport	63.11: Cargo handling
60.22: Taxi operation	63.12: Storage and warehousing
60.23: Other passenger land transport	63.21: Other supporting land transport activities
60.24: Freight transport by road	63.22: Other supporting water transport activities
60.30: Transport via pipelines	63.23: Other supporting air transport activities
61.10: Sea and coastal water transport	63.40: Activities of other transport agencies
61.20: Inland water transport	64.11: National post activities
62.10: Scheduled air transport	64.12: Courier activities
62.20: Non-scheduled air transport	

Source: [www.westlondon.com/researchcentre/sectorbriefings](http://www.westlondon.com/researchcentre/sectorbriefings)

Even though the input-output table of Thailand may not have all the logistics sectors, there is at least a good starting point with the transport and warehousing codes. Transport and warehousing are key activities within logistics management and are usually the most easily understood type of logistics activities. Sectors such as freight forwarding, customs brokerage or third party logistics service providers do not have an input-output codification and are therefore not presently represented in the current input-output table of Thailand. This lack of coverage related to the codification of the logistics industry is a limitation that cannot be ignored. This limitation can only be rectified by

introducing new sectors into the input-output table to reflect the changes in national economic structures but this may take quite a long time. For the purpose of this paper, it is proposed that all the codes related to transport and warehousing be used as a proxy for the Thai logistics industry<sup>1</sup>. The calculation method to find the value added of each sector is relatively straightforward. Code 210 or Control Total for each sector (from code 136 to 158) must first be selected. Code 210 is the sum of total intermediate transactions and value added. The total intermediate transaction or Code 190 will then be subtracted. Code 190 is the sum of codes 001 to 180. This value added is considered as the contribution that is directly derived from a sector.

$$\text{Code 210 (Control Total)} - \text{Code 190 (Total Intermediate Transactions)} = \text{Value-added (VA)}$$

In order to find the ratio of the total contribution of the Thai logistics industry to national GDP, the contribution of each individual code 136; 149; 151; 152; 153; 154; 155; 156 & 157 must be added up and then divided by GDP value.

$$(\text{VA}_{136} + \text{VA}_{149} + \text{VA}_{151} + \text{VA}_{152} + \text{VA}_{153} + \text{VA}_{154} + \text{VA}_{155} + \text{VA}_{156} + \text{VA}_{157} + \text{VA}_{158}) / \text{GDP}$$

## FINDINGS

Table 4 describes the contribution of the Thai logistics industry to national GDP as per the calculation explained in the methodology.

**Table 4: Contribution of the Thai logistics industry to national GDP (million of Baht)**

Logistics industry sector	2001	2002	2003	2004	2005
Distribution of natural gas	22,433	24,652	30,935	38,822	48,717
Railways	1,087	1,084	1,662	2,391	3,463
Road freight transport	73,230	74,444	76,093	83,334	102,486
Road freight support services	17,380	19,753	21,828	23,104	23,459
Ocean Transport	9,041	9,726	10,843	12,088	13,476
Coastal & IWT	10,412	10,130	9,940	10,004	11,586
Water transport services	4,130	4,597	4,844	5,271	5,609
Air transport	6,185	6,905	7,047	7,051	7,997
Other transport services	13,642	14,755	16,467	19,873	16,365
Storage & Warehousing	6,373	6,242	8,482	10,528	9,606
Total Value Added	163,913	172,288	188,141	212,466	242,764
GDP	5,443,812	5,770,095	6,288,841	6,974,391	7,533,655
<b>Logistics industry value added per GDP</b>	<b>3.01%</b>	<b>2.98%</b>	<b>2.99%</b>	<b>3.04%</b>	<b>3.22%</b>

Source: The Author

Ratios can be somewhat misleading as in terms of value, the contribution has gradually increased but Thailand's GDP has also increased. In fact Thailand's GDP has increased a lot quicker than the contribution of the Thai logistics industry and that is the reason why the ratios in table 4 must be utilised and interpreted with great care. The value or the ratios themselves also provides clues about the level of value added services provided by each of the sectors in the input-output table. This means that operators in sectors such as road freight

<sup>1</sup> Even though it is incomplete.

transport or storage and warehousing are offering very little value added services. This would mean that these sectors as defined in the input-output table mostly provide basic service and minimal value added.

## **CONCLUSIONS**

This paper has tried to present a methodology to estimate the contribution of the Thai logistics industry to national GDP. This methodology is based on using data from the input-output table of Thailand and then identifying the value added of each logistics related sectors. There is no logistics sector classification in the input-output table but a proxy was created by selecting sectors related to transport and storage and warehousing. Even though this is a major limitation, the results are interesting in the sense that there is very little value added or contribution by these sectors to national GDP. This means that these sectors mostly provide their core services with very little value added. This creates an opportunity for the Thai government if it wants to increase the contribution of the Thai logistics industry to national GDP by helping each of the related sectors in providing more logistics value added activities.

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## DECISION PARAMETERS AND VARIABLES FOR OUTSOURCING MANUFACTURING SUPPLY CHAINS

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### ABSTRACT

Recently there has been increasing trend in locating manufacturing operations in Asia with a view to taking advantage of lower labour costs, capitalising on specific skills and know how, as well as exploiting the potential of entering emerging markets. In essence the main driver of this trend is to develop the capability to compete globally. However, decision makers often transfer operations 'like for like' from Europe to Asia, therefore they inevitably face the challenge of contextualising supply chains or manufacturing operations in uncertain or unfamiliar environment. The aim of this two year study, conducted by the authors, and hence the aim of this paper is to address some of the issues and intricacies involved when outsourcing or transferring operations from Europe to Asia. The data for this study was collected through various means; including workshops in Europe and Asia, interviews, case studies, surveys and an international conference focused on outsourcing. As a result a Europe-Asia contextualisation framework was developed. This framework includes information on better understanding the potential nature of the relationship between an outsourcer and an outsourcee. It also provides guidance on specific operating environment contexts and answers key questions like 'how to understand uncertainty through contextualisation in that particular environment'

### WHAT IS OUTSOURCING?

Outsourcing has different meanings or connotations to different people. For instance when one refers to Collins dictionary 'outsourcing' is defined as: '*obtaining services from specialist bureaus or other companies, rather than employing fulltime members of staff to provide them*'---P.H.Collin (1995) English business dictionary, Peter Collin Publishing. In addition, the Oxford Dictionary has the following meaning of '*outsourcing*': '*arranging for (work) to be done outside a company*' (Oxford paperback dictionary thesaurus & word power guide, oxford university press, publish year: 2001, 9th edition). However, when referring to academic literature, Ellram and Maltz (1999) give the definition of outsourcing as "*the transfer of responsibility to a third party of activities which used to be performed internally*".

Generally speaking, outsourcing is defined as the procurement of products or services from sources that are external to the organisation. For services, this

usually involves the transfer of operational control to the suppliers. It is important to clarify that outsourcing is different from subcontracting because the customer (outsourcer) does not own the raw material or manufacturing process but buys the product based on the specifications offered by the supplier (outsourcee). The customer trains and develops the supplier to form a supply chain partnership.

### **WHY THERE IS A NEED TO CONTEXTUALISE OUTSOURCING?**

Over the last two decades there has been significant increase in locating manufacturing operations internationally with a view to taking advantage of lower labour cost, capitalising on specific skills and know how as well as penetrating developing and emerging markets (Ferdows, 1997). More recently there has been a considerable number of studies in the area of outsourcing manufacturing operations from the west to the east.

Several studies have shown that a large number of sectors including manufacturing, software development, retail, and financial services are considering outsourcing to Asia. However, the biggest challenge which decision makers often face is whether to transfer operations 'like for like' from Europe to Asia and hence how to contextualise supply chains or manufacturing operations in uncertain or unfamiliar environment.

### **CONTEXTUALISATION DYNAMICS**

The proposed contextualisation framework initially addresses the issue of new outsourcing arrangements, i.e. when an outsourcer has no previous work experience with a particular outsourcee. This is the static part of the framework. Then the framework elaborates on the relationship dynamics of the outsourcer and outsourcee arrangement. It discusses how the outsourcing arrangement evolves as the outsourcer gains more knowledge about the outsourcee performance and capability.

### **DECISION VARIABLES AND PARAMETERS FOR OUTSOURCING**

In the proposed framework, the authors recommend that the decision to outsource should depend on two input variables: the process being outsourced and the potential outsourcee. The output decision is arrived at based on measuring the input variables in the form of three parameters i.e. the outsourcing decisions input variables; proposed framework parameters; and the proposed output variables, as shown in figure 3. On the basis of these parameters the company decides the level of involvement required in the outsourced operations and the nature of the relationship with the outsourcee.

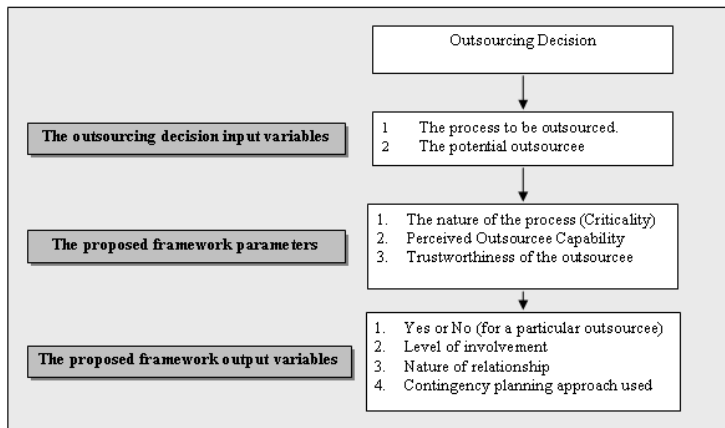


Figure 1: An overview of the proposed decision variables and parameters for outsourcing

All these factors and variables come into play as far as general relationships over time between outsourcer and outsourcee are concerned. However, in the case of a new relationship, the outsourcer has no performance or relationship history to refer to and the level of confidence and trust placed in the outsourcee is low. On this basis decisions are made with respect to the outsourcing arrangement and the outsourcer would take measures towards contingency planning.

Once the outsourcing arrangement is implemented as per the decision variables listed in figure 3, the outsourcer evaluates the outsourcing arrangement on an ongoing basis using preset parameters. These can be divided into two basic categories namely: Order-qualifiers and Order winners. The performance of the outsourcee is monitored over time causing a change in the perception of the outsourcee capability from the outsourcer's point of view and the level of trust between the two entities.

### **WHAT ARE THE INPUT PARAMETERS OF THE OUTSOURCING FRAMEWORK?**

As shown in Figure 3, the outsourcer is typically concerned with two primary issues (variables) namely the process to be outsourced and the potential outsourcee (supplier) in order to determine the most suitable outsourcing approach to adopt.

#### **Nature of process**

A process or manufacturing activity to be outsourced may be classified as a Critical process or a Non Critical Process. The higher the criticality of a process it would be likely that there would be greater involvement from the outsourcer.

#### **Outsourcee perceived capability**

At the initial stages, when an outsourcer is evaluating a particular organisation for outsourcing, the factors such as Senior Management Attitudes, Supplier skill/

capability levels Supplier track record, compliance to specific quality certifications like ISO 9001, and delivery reliability.

It is argued that the outsourcer's perception of the outsourcee capability is a direct function of the operating environment separation index (OESI).

### What is the operating environment separation index?

The operating environment separation index essentially measures the level of differences in the environment of the outsourcer and the outsourcee. This difference in the environment normally exists at two levels: the external and the internal as shown in figure 4.

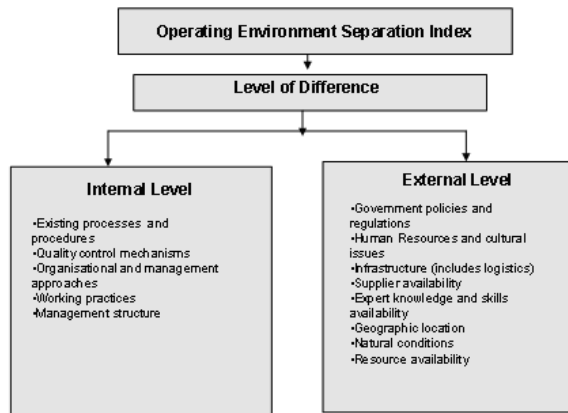


Figure 2 : Operating environment separation index (OESI)

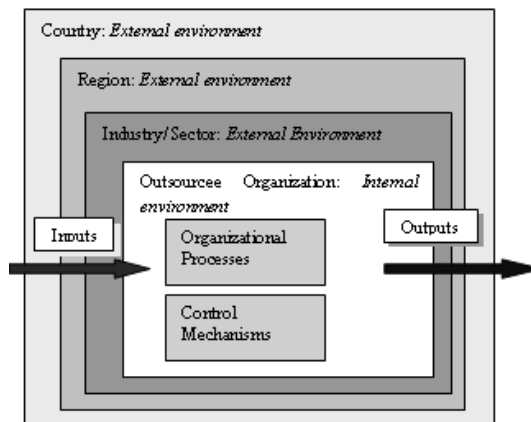


Figure 3: Environment in which an organisation operates: External and Internal

### How to assess outsourcee's trustworthiness?

The factors that are likely to influence the level of trust in the outsourcer and outsourcee relationship are asset specificity, behavioural uncertainty, and the degree of information sharing. These are related to costs associated with

transactions between outsourcer and outsourcee. In addition to these there are a number of social exchange related factors such as perceived satisfaction, partner's reputation, and perceived conflict influencing the trust (Kwon and Taewon, 2004).

There have been a number of studies on building trust in supply chain relationships suggesting that at the start of the relationship the level of trust is low. As the two alliance partners work with each other over time the level of trust in the relationship goes up as a result of a series of interactions between the parties involved. Positive interactions strengthen the belief in the co-operation of the other party.

### **WHAT ARE THE OUTPUT VARIABLES FOR OUTSOURCING FRAMEWORK?**

The outputs variables (whether to outsource, nature of the relationship, and contingency planning) for the proposed framework shown in Figure 3:

#### **How does the nature of relationship evolve?**

As the relationship between the outsourcer and the outsourcee evolves, the outsourcing arrangement may undergo changes in one or a combination of the following:

1. It may expand to accommodate more critical processes
2. The level of monitoring carried out by the outsourcer with respect to the outsourcee's operations would reduce.
3. The relationship could move through the three scenarios i.e. master –servant, consultant-client, peer-to-peer as highlighted in Pawar et.al. (2004):

However, as the relationship progresses the trust between the two parties and the knowledge about their supply chains enables each partner to meet the expectations of the other in a mutually beneficial manner. This allows each of them to concentrate on their critical or core processes and focus on improving their respective processes. At such a stage the outsourcer would depend on the capability of the outsourcee and the level of involvement in the outsourcee's operations. This is likely to result in the reduction in the degree of monitoring.

#### **Do we require contingency planning?**

As the outsourcee location is geographically separated in distance and time from the outsourcer location. Thus the outsourcer would need to develop a contingency plan to minimise the risks and uncertainties. Possible planning could include: strategic inventory; multiple sourcing; and the use of faster channels for transportation such air instead of sea.



## **THE OVERALL DECISION-MAKING FRAMEWROK**

Once the outsourcer makes a decision to outsource a particular process, the outsourcer has to decide the level of criticality of the manufacturing process being outsourced. For the outsourced process the outsourcer would then stipulate various performance measures to ensure that they receive required levels of quality and service. These measures can be divided in two categories – “Order-Qualifiers” and “Order-Winners”.

### **What performance measures are needed?**

By embarking on an outsourcing arrangement the outsourcer makes a major change in its manufacturing strategy. In order to ensure that the outsourcer continues to meet its corporate objectives; it is important to consider the qualifying and the order-winning parameters. Specific qualifiers and order-winners will exist for a particular outsourced manufacturing process. The essence of differentiating between order qualifying and order winning in the outsourcing arrangement is captured by the following statement: “An outsourcee needs to meet certain minimum quality and service levels (Qualifiers) to be considered for an outsourcing arrangement. However, to win a particular order from an outsourcer the critical factor will be the total cost (order winner) of outsourcing arrangement”.

### **Outsourcer-Outsourcee relationships**

As discussed in section 7, the relationship between an outsourcer and an outsourcee can be viewed in three different scenarios i.e. master-servant; consultant client; and peer-to-peer. This framework proposes that during the initial period of an outsourcing arrangement the relationship between the outsourcer and the outsourcee is directly related to the operating environment separation index (OESI) between the two parties. However, as a particular outsourcing arrangement evolves, it is possible that the relationship moves to a different scenario depending on the performance of the outsourcee and the level of trust built up in the relationship (see figure 7). On the other hand it is feasible that an outsourcer enters in the relationship at scenario 2 (consultant-client) provided there is already high level of trust and performance by outsourcee. Through increased interaction between the two organisations (outsourcer and outsourcee) cultural influences could also contribute to increased similarities leading to reduction in the level of OESI

If there is a high level of perceived capability of the outsourcee and a high level of trust, this would facilitate the movement of the relationship through the scenarios from scenario 2 (consultant-client) to scenario 3 which is ‘peer to peer’ relationship” (see figure 8). It is argued that without a high level of trust between the outsourcer and the outsourcee the relationship is unlikely to move to a “peer-to-peer” stage.

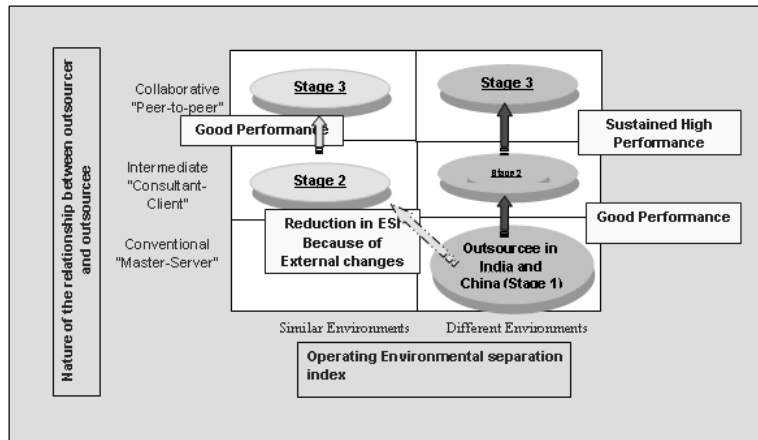


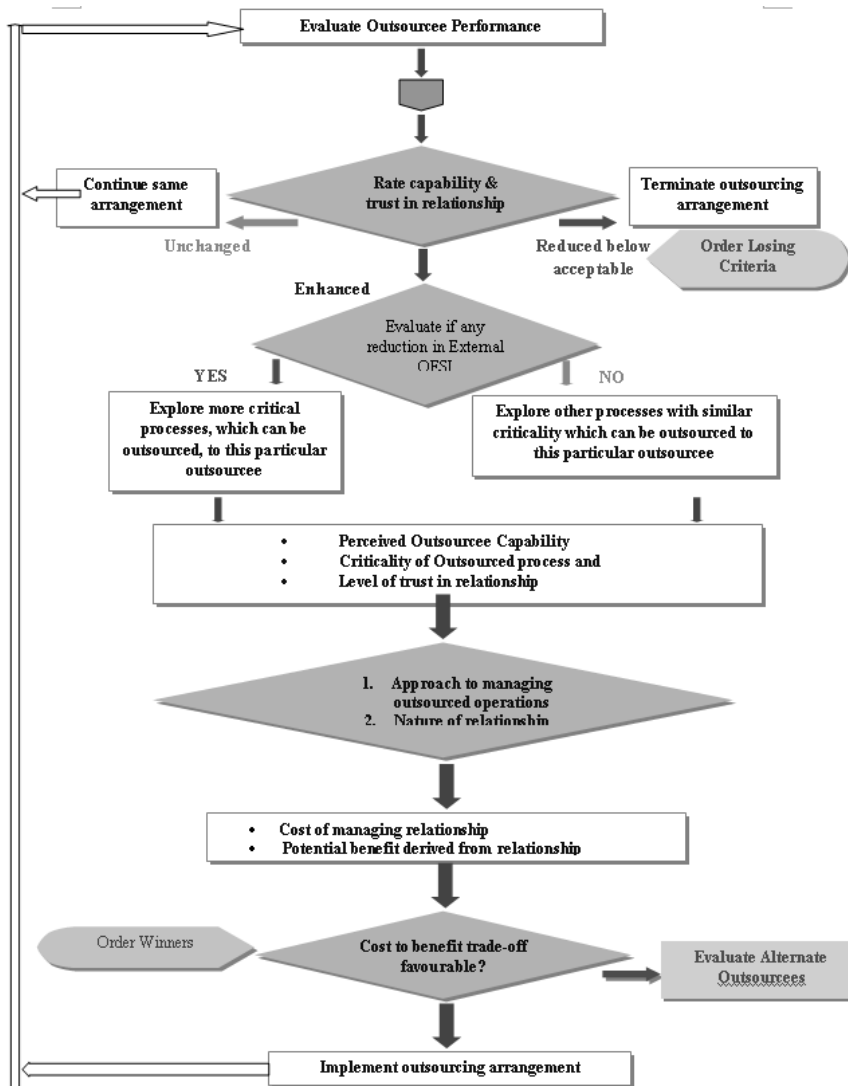
Figure 7: Evolution of outsourcing relationship and movements across environments

As the outsourcee develops a greater degree of expertise and higher process efficiency through knowledge transfer from outsourcer to outsourcee there is likelihood that the outsourcee would acquire independent product design capabilities thus becoming a direct competitor to the outsourcer. This can be termed as scenario 4: competitive. There is also a risk that the outsourcee could transfer 'new designs' to competitors of the outsourcer. .

The decision-making framework from a relationship evolution point of view is shown in figure 9.

## CONCLUSION

Outsourcing has become increasingly important for companies to survive in current highly competitive market. This document is based on a two year study conducted by the authors involving a range of approaches including workshops, interviews case studies surveys and an international conference. From the findings of the research, this document outlines a contextualising framework which key decision makers in Europe or North America can use to better conceptualise or understand the intricacies of outsourcing to Asian countries such as India or China. An attempt has been made to provide the required information for operationalising such a framework and, as well, for depicting the potential nature of relationships between an outsourcer and outsourcee. The framework potentially provides guidance on specific operating environment context and answers key questions like 'how to understand uncertainty through contextualisation in that particular environment'



**Figure 9:** The Outsourcing Relationship Evolution Dynamics

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# **ENVIRONMENTAL LOGISTICS**



## **ENVIRONMENTAL AWARENESS IN THE CLOTHING AND TEXTILE SUPPLY CHAIN: A EUROPEAN PERSPECTIVE**

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### **ABSTRACT**

The turnover of the Clothing and Textiles (C&T) industry, in the EU-15 zone, is of about 200 billion euros per year. During recent years, at the same time that environmental regulation increased in Europe, we witnessed the growth of competition coming from the Far East. Against such background, we investigate in which degree environmental awareness is present in the European C&T supply chain and in which decisional areas such consciousness is developed the most. The aim of the paper is to analyse how tackling the “environmental critical factors” can re-shape the future of the European supply chain within a context of fierce competition from Asian countries.

### **INTRODUCTION**

The turnover of the Clothing and Textiles (C&T) industry, in the EU-15 zone, is of about 200 billion euros per year, with 177 000 companies employing 2 million persons (CEC, 2003). During the last years, we witness the growth of competition coming from the Far East. The delocalisation of production to Far East in recent years is also contributing to an inversion in the economic growth of the T&C industry in Europe. In 2002, Europe imported 1 million tons of synthetic fibres, three times more than exports. In addition, the end of the multifiber trade agreement in 2005 only steeped the rise of Chinese exports.

Because of the mounting competition, and the C&T inherent importance for Europe’s economy, European Union considers this sector to be a priority sector to which support should be given. The rationale behind is avoiding further escalation of the trade imbalance, and loss of market share.

At the same time, the European Union is engaged in a long term process towards environmental protection. It becomes crucial for Europe to arbitrate between the support to priority sectors and the promulgation of stringent environmental regulation, which may bring about concerns for sensitive industries, such as the C&T one. It has been acknowledged that the main environmental concern in the textile industry is about the amount of water discharged and the chemical load it carries. Other important issues are energy consumption, air emissions, solid wastes and odours, which can be a significant nuisance in certain treatments (European Commission, 2002).

In this paper, we investigate in which degree environmental awareness is present in the European C&T sector and which environmental issues are perceived by the actors as being the more urgent to cope with. The aim of the paper is to discuss how tackling the “environmental critical factors” can re-shape

the future of the European Supply Chain (SC) within a context of fierce competition from Asian countries.

Besides desk research on the environmental concern in SC (see the following section), we make direct use of the view of stakeholders. We carried out an extensive dialogue with stakeholders and we administered a questionnaire (via mail, email or telephone) to about fifty European stakeholders and experts, mainly in France and the UK. Among those there were supplier designers, manufacturers, retailers, fashion bureaus, logistic, software and other service providers. The questions discussed here aimed at pointing out the environmental factors shaping the sector and the environmental issues that are taken into account in managerial decision-making. For a broader view of the outcomes of the study, we refer to De Brito et al. (2007).

### **SC AND ENVIRONMENTAL CONCERN**

In the post-war years, Europe attention was on rebuilding the economy. In the beginning of the fifties, six European countries, among which France, signed a treat establishing the European Coal and Steel Community, the embryo of the European Union. The objectives were 'economic expansion, growth of employment and a rising standard of living.' These reflect primarily economic and social concerns. Today, European Union strives to lead the fight against 'climate change,' expressing that the environmental concern is of high priority ([www://europa.eu](http://www.europa.eu)).

At the supply chain level, environmental initiatives are extremely significant, more than ever in sensitive business areas in terms of intensive natural resource use or accelerated consumption, as it is the case of the clothing and textile supply chain (Smith, 2003). Furthermore, the principle of Extended Producer Responsibility (EPR) pervades the new regulatory framework for the Registration, Evaluation and Authorisation of Chemicals (REACH). This regulation affects directly the dyeing industry and therefore the C&T supply chain, a heavy user of pesticides and dyes.

Extended producer responsibility (EPR) goes along with the "Polluter Pays Principle" (PPP), i.e. that the polluter pays for the cost of pollution. The PPP nourishes European transport policies, whose various objectives are controlling CO<sub>2</sub> emissions, reducing infrastructure congestion and favouring co-modality (CCE, 2006). The overall principle is the internalisation of the environmental and social externalities caused by freight transport (Böge, 1995). As one of the major trends characterising the structure of the global C&T SC is the increasing internationalisation of flows, transport policies inevitably affect the organisational and the spatial structure of the chain (Carbone, Meunier, 2007).

There are several policy instruments in order to implement the EPR and PP principles, such as: economic (taxes, subsidies, refund schemes), voluntary agreements, regulatory (take-back regulations, recycling quotas) and informative instruments (reporting, eco-labelling), (see e.g. Lindhqvist, 2006).

The aforementioned instruments are being employed in the C&T supply chains. A tax-scheme to support recovery of clothing and textiles and the end-of-use/life is for the first time in place in France since November 2006. Producers and/or

importers of textiles and clothing, shoes and household linen pay the tax and charities (like Emmaüs) are in charge of the process. This French tax is leading the way to similar initiatives at the European level. Rreuse, a European network of associations and companies with activities in re-use and recycling, is lobbying for the adoption of similar instruments by the European Commission (Rreuse, 2005).

Issues that are forced by legislation coexist with voluntary initiatives. There are several examples of multi-party environmental partnerships in the C&T supply chains, such as the one of Nike and its suppliers, with the environmental goals being recycled packaging, green alternatives for chemicals and raw materials, and training on environmental management (Tsoi, 2003). In Europe, it is in place the European eco-label, which assures customers that e.g. pollution is mitigated during production.

### **STAKEHOLDERS' VIEW ON ENVIRONMENTAL ISSUES**

This section discusses stakeholders' view on the environmental factors shaping the C&T sector and the environmental issues that are taken into account in managerial decision-making .

Regarding the environmental factors which most affect the competitive dynamics of the sector, four main groups of responses were given by the about fifty panellists involved in our dialogue with C&T stakeholders. A first group of responses comprises issues related with the improvement of resource use (water, chemicals, energy, raw materials), which gathers the highest stakeholders consensus. This is consistent with the optimisation concern in SCM. A second group explicitly mentions the need for legislation compliance, in order to reduce any risk of legal dispute (with other actors of the chain, employees, consumers and other stakeholders) or sanction (inflicted by public regulatory bodies). Thirdly, all the environmental issues that may protect or enhance corporate and brand image have been put forward. In particular, the use of organic fibres and the promotion of the related organic standards and labels draw together an increasing number of actors (see [www.indigoclothing.com](http://www.indigoclothing.com) and [www.saftag.com](http://www.saftag.com)). Finally, apart from these specific areas, stakeholders put emphasis on all the issues that weight on costs.

Though corporate image is among the answers, the main environmental factors mentioned by the stakeholders are cost and legislation related. Many respondents stress the negative impact on competitiveness of uneven legislation (on waste, packaging, or quality), which is stricter in the EU countries than elsewhere. According to stakeholders, European laws are too complex, too rigorous or too many, or they are the 'wrong' laws (e.g. no legal protection regarding 'joint ventures' in the Far East, or no legal barrier against imports based on underage labour or non-certified – plants). Conversely, most of the panellists mentioned some positive environmental responses coming spontaneously from the companies of the sector, such as the adoption of clean or less polluting processes (e.g. effluent treatment and improved dyeing), reuse and recycling options, and the set up of networking initiatives to promote the nationally "made in" labels.



They also referred to some environmental awareness, on the demand side, about e.g. recycling, even if the current demand for eco-fashion (green and organic products) is still low. This indicates that the consumer is relatively environmentally aware and expects the producer to take responsibility but does not seem open to change its behaviour, e.g. bearing higher costs.

When questioned on environmental issues affecting decision-making, the panellists include issues related with water, packaging and chemicals; among others. To some extent, this is in line with the literature (see Introduction). Waste, transportation and consumers' health were also mentioned, even if less than expected. Logistics and transport related responses show that an environmental-friendly logistics organisation is difficult to define. Hence, our panel of experts could not reach a consensus around a unique or homogeneous environmental friendly logistics organisation. At least four dimensions have been put forward to indicate a "sustainable logistics organisation":

- a logistics solution using the so-called clean transport modes (barge, railway transport, multimodal, piggyback traffic for deliveries to the points of sales;
- a logistics organisation ensuring goods safety and consumer health (ex: via the set up of tracking and tracing tools all along the chain);
- the search for transport scheduling and routing optimisation (ex: load factor improvement, optimisation of replenishment and deliveries, delivery trip reconfiguration, integrated planning of both production and sourcing sites, etc.);
- logistics asset sharing (the joint use of a warehouse by two or more actors of the SC; deliveries optimisation for two or more customers; etc.).

### **SUPPLY CHAIN IMPACT**

The impact of the environmental issues on the C&T SC is analysed according to the distinction proposed by Hakansson (1987) between *transformation activities* and *circulation activities* (the links between transformation and its environment comprising suppliers, customers and other producers).

As far as the *transformation activities* are concerned, cleaning the outputs and increasing recycling are viewed as the way to boost environmental performance. This is actually the focus of legislation, i.e. reduction of CO<sub>2</sub> emissions and the setting of recycling targets. Technological investments are more predominant in clean production technologies while recycling technologies seem to be lagging behind. Both process (sonic welding, automated knitting or ink-jet printing on textiles) and product innovation (e.g. technical textiles) is contributing to the spatial and organisational reconfiguration of the global SC (Sarma, 2004): transformation of innovative products is more likely to be kept in Europe, while basic products are increasingly transferred in delocalised industrial plants, mainly in the Far East. This is true especially for the clothing SC, as the textile one is less dependent on Asian Imports.

The reconfiguration of the structure of the SC is however influenced also by the evolutions of the *circulation activities*. The stakeholders' emphasis was on the current trend towards flow management optimisation and flow consolidation along the international SC. This leads to the search for a higher control of the entire supply chain both from the upstream stages downward until retailers, and vice-versa, with an optimisation concern. As clean transport modes (maritime,

rail and inland waterways) can be used to link centralised distribution centres backwards to plants and downward to final markets, it can be argued that flow consolidation encourages the use of clean transport modes. Other positive cost effects deriving from flow consolidation are: vehicle load factor improving, delivery trip optimisation and subsequent reduction of the number of trips, reduction of fuel consumption and improvement of energy efficiency, lower dependence from road transport in fuel price increasing periods.

In more general terms, beyond a general search for optimisation, the main characteristics for environmentally friendly logistics solutions, as proposed by our stakeholders, rely on logistics integration along the supply chain and information sharing. So, the environmental orientation of companies in the SC seems to be better achieved via the adoption of the SCM model, with respect to internal and external integration, through improved relationship and ICT management.

Concerning the influence of the environmental concern on the final market, despite consumers' high level of awareness of ethical issues, factors such as price, quality and style have a greater influence on their apparel purchase behaviour than their concerns about the ethical and green practices of the supplier (Iwanow et al., 2005). Even if there is an opportunity for the development of the ethical and green market segment as a niche (Birtwistle and Moore, 2007), price, quality and style costs will dominate the decision rationale of consumers. Thus companies maybe have to approach it in an integrative way: embedding environmental-friendliness as part of the style, with good quality and in a cost effective way.

## **CONCLUSION**

Environmental concern is a rather sensitive issue for the C&T supply chain due to its inherent characteristics (high resource use) and due to accentuated delocalisation of manufacturing to low cost countries leading simultaneously to: sourcing in countries with lenient environmental and social concerns; and to the disappearance of manufacturing in some regions, like in Europe. Because of such sensitiveness of the fashion SC to sustainability and current sharp competition, the pursuit of environmental-friendly strategies represents at the same time a constraint and an opportunity for the actors of the chain.

Stakeholders indicate both end-of-life issues (recycling and re-use) and issues related with early stages of the supply chain (new product development, sourcing strategies, etc.) as the most sensitive to the environmental concern. Reconfiguration of SC and sustainable logistics solutions pave the way to new organisational arrangements within the entire SC. However, in accordance with the view of our stakeholders' panel, we believe that there is no optimal form of environmental-friendly supply chain management, but a variety of strategies and "dynamics", whose drivers and objectives can be diverse.

Having acknowledged that the prior motivation for dealing with the environmental concern consists in managing risks and reducing costs, and that new preferences of customers for green-ethic products arise, it is suggested that the environmental challenges contribute for increasing business 'turbulence', both in terms of changing and unfamiliar environment (Calantone et al. 2003). It is thus important to incorporate the environmental variable in supply chain

strategic planning in order to cope with risk-taking decisions, as the challenge is to learn how to deal with it in a profitable manner.

Risk-taking decisions are to be taken all along the supply chain. This also shows that companies/governments/ stakeholders cannot develop measures/policies in isolation. Organisations are encouraged to interact with new actors (rating agencies, recycling institutions, public bodies, etc.), new stakeholders (ecologist associations, citizens, etc.), with whom it is advisable to develop new relationships. The company environment is enlarged to include stakeholders' needs and claims. The broadening of the company environment calls for the broadening of the performance criteria a company should adopt, in an integrated way, to evaluate the outcomes of its activity. Thus, environmental supply chain partnerships not only benefit organizations and their suppliers but the society as a whole (Tsoi, 2003). Furthermore, in addition to the traditional performance indicators focussed on financial returns and quality of service, a new set of indicators should be conceived in order to evaluate the environmental impact of this type of SC partnership on the society.

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## **A BASIC RESEARCH FOR LOGISTICS ACCOUNTING ON ENVIRONMENTS**

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### **ABSTRACT**

An existing guideline for environmental accountings just aimed at accounting expression on environmental aspects of an industrial firm as a whole and lots of industrial firms have been announcing accounting results on environmental issues based on this particular guideline. As a result, few industrial firms are making public announcement on environment accounting based on proper logistics accounting on environments. In addition, there are few industrial firms applying environmental indexes to evaluate results of business activities in terms of accounting evaluation. Therefore, this research aims at proposing a conceptual model for a logistical accounting on environment and proposing a new accounting evaluation system for practical implementation in the real world adding eco evaluation index to traditional financial evaluation indexes.

### **RESEARCH MOTIVATION**

After Kyoto agreement for environmentalisms, most of nations have been paying attention to environmentalisms. A lot of white papers on environments have been publicly announced through home pages of industries. However, there are some deficiencies in terms of major indexes adopted in their announcements as well as accounting formats themselves.

Major reasons for these deficiencies are originated from the guidelines ever published by governmental sectors, the former Ministry of Transportation and Ministry of International Trade and Industry and also a guideline for environment accounting by Environment Agency. As a result of insufficiencies included in governmental versions of both managerial and environmental accounting guidelines, industrial firms are unable to make detail analysis on environmental activities as originally expected. On the other hand, eco evaluation indexes have been neglected in the field of traditional

financial analysis system and so we propose a new way of financial analysis model taking eco evaluation indexes into considerations on a conceptual basis.

### **RESEARCH PURPOSE**

Main research purposes of this paper are to propose a practical concept for logistics environment accounting after discussing current guideline concerned with environmental accounting and also to propose a conceptual model with environment and social evaluation indexes for existing accounting evaluation indexes:

- To analyze current status of environment accounting report in Japan.
- To make clear insufficiency and historical development of governmental guidelines.
- To analyze current situation of items to control environmental issues and make clear their deficiencies.
- To propose a new way of managerial accounting for environmentalism with newsample format.
- .-To propose fundamental evaluation indexes from two aspects: Environment Indexes and Social Contribution Indexes.

### **RESEARCH PROCESS**

Literature survey and analysis of current environment accounting system are made and as a result accounting models by functional and by area are proposed while EVA, MVA and cash flow indexes as well as social indexes for management evaluation are added to traditional financial analysis on a basis of dynamic and static financial analyses. A basic research process is shown in Fig.1. First of all, current concept and formats of Governmental guidelines, issued mainly by Environment Agency, are analyzed and theoretical insufficiency has been pointed out and then a new proposal is discussed about. After researching actual status of environmental accounting and collecting actual format used in leading companies, insufficient aspects of control format for environments and analysis method are discussed and a new conceptual model for logistics environment accounting and analysis indexes are discussed and studied. Finally a new approach for evaluation on environment managerial accounting has been proposed.

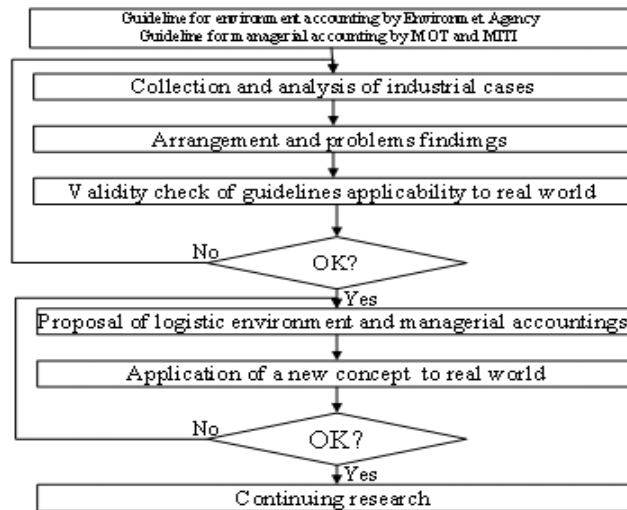


Fig.1. Research Process

## RESEARCH CONTENTS

### LOGISTICS ENVIRONMENTAL ACCOUNTING

There are two types of approaches, decision making information disclosure and cost benefit approach to environment, including revenue/expenditure, asset/debt and eco balance of environment when we look at research directions of environmental accounting based on research objectives and scope of research. In general, it is said that decision making and environment cost are regarded as important in U.S.A while in Europe and Japan information disclosure of environment is rather focused on. Of course there exists another way of thinking, to quantify eco problems using LCA or Eco balance, that Germany or Swiss is taking. In addition, environment assessment required at the time of introduction stage of ISO14001 has similar meaning. Environmental accounting has been studied from various viewpoints but it has not been completed in terms of logistics environmental accounting. Therefore it is one of the most important issues for us to make an indepth research on this field in order to cope with problems.

### SAMPLE OF CURRENT ENVIRONMENTAL ACCOUNTING

There are two types of environmental accounting: guideline basis (H company and T company) and independent basis(T company). In general they are rather different in character which is brought about by industry characteristics. Only item of "environment cost v.s. effectiveness or merit" is similar or common to the all types. Typical cases are shown in Table 1 and Table 2.

Table 1. Case T-1

ECO Maintenance Cost				(Unit: 100 m¥)
Category	Contents	H.Q	Subsidiary	Total
Cost within Business	Clean Cost for NOx, CO2 etc	119	47	166
Eco Cost Upper/Lower Stream	Recycle Cost, Green Maintenance Cost Reuse cost	10	12	22
Control Activity Cost	Personnel Cost, Eco Education Cost, EMS Maintenance Cost	32	24	58
R&D Cost	Development Cost for Product, Technology, Packaging, Others Related Cost	77	27	104
Social Activity Cost	Nature Maintenance, Greening Activity, Eco Advertising	9	4	13
ECO guarantee Cost	Land Restoration Cost, Law Cost	12	3	15
<b>Total</b>		<b>259</b>	<b>117</b>	<b>376</b>

EFFECTIVENESS				(Unit: 100 m¥)
Category	Contents	H.Q	Subsidiary	Total
Direct Effect	Utility Cost and other Visible Cost	26	4	30
Invisible Effect	Reduced ECO Workload	168	△7	161
<b>Total</b>	-	<b>194</b>	<b>△3</b>	<b>191</b>

\* Minus Effect shows figures more than reduced workload

As shown in Table 1 and Table 2, major items of eco accountings are composed of eco cost, eco cost and revenue, eco asset and debt, materials accounting (eco balance calculation. input v.s. output basis), etc. And finally both cost and revenue are compared and evaluated on trade-off logic and finally those numerical results are judged.

Table 1: Case T-2.

Detail Contents : Direct Effect							
Item		Reduced Eco Workload		Money Conversion		Expected Effect	
Energy	H.Q.	14,854	KL	1400M¥		Item	ECO Workload Deduction Effect
	Sub.	△3,227	KL	△900M¥			
	TOT.	11,627	KL	500M¥			
Disposal	H.Q.	401	Ton	700M¥		Chemical Emittance Effect	Money Conversion Amount
	Sub.	149	Ton	1.4B¥			
	TOT.	550	Ton	2.1B¥			
Plant Water	H.Q.	1,213,441	m <sup>3</sup>	500M¥		TOT	5.49Ton
	Sub.	△358,913	m <sup>3</sup>	△100M¥			
	TOT.	854,528	m <sup>3</sup>	400M¥			
Total	-	-	-	3B¥			16.1B¥

Ref : M. Komuro and R. Fukami, Environment Accounting, Itogyonshon, 2003, P113

Table 2. Case H-1.

Cost		(Unit: 100m\$)	
Item	ITEM	Cost	Major Contents
	① Reduced Eco Workload at Mfg.	97.7	Maintenance/Depreciation cost for Eco Machine & Equipment
	② Reduced Eco Workload at Upper/Lower Process of Production	18.0	Cost for Recycle ,Reuse ,Green Purchasing,,
	③ Control Activity	26.1	Personnel Cost for Eco Management, System Maintenance Cost for Eco, Maintenance Cost
	④ R&D Activity	111.4	R&D and Design Cost to reduce Eco Workload in Job shops
	⑤ Social Activity	10.6	Environmental Improvement of Plants ,Cleaning P.R.
	⑥ Other Cost Related to Eco Maintenance	3.3	Local Tax, Cost related to Eco Activity
	Total Cost	267.0	
Total Investment	67.6	Equipment Investment for Energy Saving ,and direct deduction of Eco Workload	

Effect		(Unit: 100m\$)	
Economic Effect	Item	Deduction Cost	Major Contents
	① Effect of real Revenue	11.0	Sales Profit by Disposal Sales
	② Cost Reduction Effect	30.6	Machine Operation Cost Deduction by Energy Saving
Total	41.6		

Material Volume Effect	Item	Deduction Volume	Household Conversion No.	Major Contents
	□ Energy Deduction At Mfg. Time	94 MkWh	27K	Energy Saving By Energy Saving Facility & Equipment
	□ Final Disposal Deduction at Mfg.	792 t	3K	Operation Deduction Cost by Sorting, Recycling
	□ Energy Saving Cost for Product	165 MkWh	48K	Energy Saving Cost in use of Own Brand Product by Customers

We rather propose a logistics process oriented model for a environmental accounting combining logistics process (inbound, production and outbound ) with management process(pre operation, under operation and post operation).

Table2. Case H-2.

Eco Efficiency		(Unit: 100MM)	
Saving Volume by Eco Workload Item			
Item	(A) Saving Volume	(B) Saving Cost	(A) / (B) Saving Rate
Energy Consumption	94MkWh	1.14\$W	82MkWh/100MM
Final Disposal Volume	792 t	1.23\$W	64 t./100MM

Sales Amount of Eco Consideration Type Product		(Unit: 100MM)	
Item	Sales(100MM)	Sales	(%)
Maintenance Product	81		0.2
Eco Consideration Product	10,187		27

**BUSINESS EVALUATION INCLUDING ECO INDEX**

What is proposed in this research includes not only existing static financial analysis as well as dynamic analysis but also considers EVA, Cash Flow, Social Indexes and Environmental Indexes. Indexes for business evaluation are categorized into four items; Traditional Type of Financial Index, New Management Index, Social Contribution



Index and Eco Index.

Traditional Type of Financial Index is composed of Asset ratio, Capital ratio, Sales Turnover rate, Sales per Capita, Profit Before Tax (PBT), Profit After Tax (PAT), etc. while A New Management Index includes such indexes as Economic Value Added Index, Cash Flow Index and so on. Typical indexes of Social Index are No. of Employees (historical comparison), Sexual/Age rate of Employees, rate of Handicapped Persons, Vacation Acquisition rate, Foreigners Employment ratio, Oversea Localization ratio, etc..As environmental indexes, Returnable Bottle rate, Product/Co2, Recycle /Reuse rate. Zero Emission ratio, Resources Saving ratio, Energy Saving ratio, Disposal ratio and so on.

Table 3. Numerical Results of Sample Analysis

Company	ECO	Social Index	Judge
A	10	9	○
B	10	0	×
C	8	10	○
D	7	8	○
E	6	0	×
F	5	7	○
G	4	0	×
H	0	0	×
I	0	6	×

Based on principal component analysis, results of 9 firms are shown in Table 3. However it is impossible to evaluate any company without statistical weight. In this sense, weighting logic should be further studied.

## CONCLUSIONS AND ISSUES

### CONCLUSIONS

In this research, environmental guideline issued by Government is discussed and its characteristics of the contents are pointed out by showing analytical results of two companies. In addition, a new concept for an environmental accounting is shown since the governmental guideline is not sufficient for practical use of industry as a tool for environmental control in a sense of real world.

### ISSUES

On the other hand, a new concept for evaluation indexes has been proposed and discussed. A new concept is a concept having added social contribution index and environmental index as well as a new management index to existing type of indexes. In other words, a new conceptual model for business evaluation indexes is an integrated version of current workable indexes and numerical results as a sample is shown and

discussed.

However, we have neither applied the proposed models to real cases and nor checked validity of the proposed models. Further and indepth study should be done in the future in order to justify validity and effectiveness of the proposed models.

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## **A LITERATURE REVIEW OF REVERSE LOGISTICS ISSUES**

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### **ABSTRACT**

We provide a critical review of recent literature related to reverse logistics (RL) issues. Based on 46 papers published between 2000 and 2007, RL literature is categorised into 6 topics, from "general overview and definition" up to "emerging technologies". Grounding on the review performed, we identify gaps where future research is needed and derive suggestions for future research.

*Keywords: reverse logistics, review*

### **INTRODUCTION**

During the last decades, the increasing focus on environmental protection and waste reduction has led to significant changes in logistics processes. In addition to distribution to the customers, reusable packaging and/or goods to be recycled or remanufactured have to be transported in the reverse direction. Hence, the term "Reverse Logistics" (RL), originally describing the movement of material/packaging from the point of consumption toward the point of origin, has recently gained increasing importance in several different contexts and additional activities have been included into RL operations. RL is currently recognised to have a strategic role in reducing the environmental impact of the supply chain (Rogers and Tibben-Lembke 1999) and in the e-commerce arena, where buyers need to be assured they can return items ordered online and receive a refund if the purchase does not match the catalogue description (Meade and Sarkis 2002). Through a survey of the literature, this paper aims at identifying recently emerged topics of RL and to derive suggestions for future research. Moreover, in order to contribute to existing literature, we focus on works published between 2000 and 2007, which are not included in past reviews (from Fleishmann et al. 1997 up to Dowlatsahi 2000). We proceed by first providing a description of the research methodology, as well as taxonomy of papers reviewed. According to the taxonomy, we analyse RL literature based on the resulting topics. Suggestions for future research are finally provided.

### **CLASSIFICATION OF RESEARCH IN RL**

In the followings, we review a total number of 46 documents published between 2000 and 2007; most of them appeared in international journals (78.3%). Based on the theme addressed, RL literature has been categorized into the following topics: (i) general overview and definition; (ii) activities and type of items involved in the reverse flow; (iii) reasons for RL development; (iv) barriers and constraints to executing RL; (v) RL effectiveness and efficiency measurement; (vi) emerging technologies. In the following sections, we examine recent literature related to RL according to the above taxonomy.

## **GENERAL OVERVIEW AND DEFINITION OF REVERSE LOGISTICS**

First definitions of RL date back to the '80s and emphasise its role in managing the reverse flows of products from consumption to origin. Recent works mainly highlight the strategic role of RL in managing environmental and ecological issues, in terms of packaging, pollution control, energy and resource preservation (Abukhader and Jonson 2004). Although RL activities are recognised not to be limited to efforts to reduce the environmental impact of the supply chain, many activities exist that can be included both in RL and "green" logistics, such as, among others, utilizing reusable containers (Srivastava 2007).

## **ACTIVITIES AND TYPE OF ITEMS INVOLVED IN THE REVERSE FLOW**

A critical objective of RL is to retrieve the highest value from items collected through direct resale, refurbishment or material recovery; nonetheless, it is recognised that the type of items, either products or packaging, involved in RL greatly influences the destination of flows. Hence, literature has separately investigated: (i) items involved in the RL flows; and (ii) activities of RL.

As far as point (ii) is concerned, selecting the most profitable reselling channel for each item to be resold appear as a key issue to be tackled. To this extent, Hughes (2003) provides an overview of typical returns disposition, where products that present different levels of functionality and value follow as many paths and reach different destinations. Tibben-Lembke (2002) examines how RL is impacted by changes in sales over the Product Life Cycle (PLC) (Kotler 2000) in contrast with many academics which study the reverse flow only related to the end-of-life (EOL) products. The author focuses on RL in countries where EOL products recovery is not mandatory, and thus the major source of reverse flow is products returning after purchasing. Under this scenario, it can be expected that, as product sales increase, returns are likely to increase rapidly, then to remain almost constant as long as sales remain constant; finally, returns decline as sales decline.

As regard to previous point (i), the environmental impact of packaging waste is gaining increasing recognition from consumers and governments, although with different characteristics depending on the country considered (Rundh 2005). In order to reduce the environmental impact of packaging, materials consumption should be reduced at each stage of packaging lifecycle; packaging redesign, reuse and recycle are recognised to play a strategic role to achieve such aim (Skjoett-Larsen 2000). Mandaraka and Kormentza (2000) describe qualitative and quantitative reduction of packaging waste: the first means reducing or avoiding the use of dangerous and toxic substances in packages design, while the latter indicates using lightweight materials, avoiding over-packing and finding substitutes for non recyclable materials. While recycle is often the most appropriate solution for sales packaging, reusing is a typical activity of transport packaging. Ross and Evans (2002) argue that such packaging should be reused several times before recycling, to offset the additional cost of its collecting.

## **REASONS FOR REVERSE LOGISTICS DEVELOPMENT**

The main reasons affecting RL adoption encompass in environmental concerns, customer satisfaction's objective, high return rates, limited and expensive landfill capacity (Ravi et al. 2005) competition and marketing motives (Ravi and

Shankar, 2005). Schultmann et al. (2006) summarise the above argumentations stating that RL can be motivated by compliance to legislations and profit-oriented reasons. To this latter extent, Rogers and Tibben-Lembke (2001) highlights that companies act in order to achieve competitive advantage through RL: their survey shows that competitive reasons play an important role in implementing return programs for about 60% of USA companies. Such a proactive behaviour also helps firms to gain experience in efficiently managing disposal costs, and creates new profitable trade opportunities, since firms can enter the secondary market and sell refurbished products (Schultmann et al. 2006). Moreover, the "green image" usually increases the sales of the specific firm (Georgiadis and Vlachos 2004).

Many countries are proactively taking measures to establish economically viable production and distribution systems that enable remanufacturing of used products in parallel with the manufacturing of new units (Savaskan et al. 2004). Nonetheless, the legal motivation appears as particularly relevant in Europe, since about 200 European directives specifically deal with environmental concerns (Price-White 2002). European legislation is expected to involve both significant changes in many industrial fields to comply with law, and the creation of new industries for transportation, storage and distribution companies specifically oriented towards RL processes (Bautista and Pereira 2006). Accordingly, many authors study the impact of the European directives on RL. Fernie and Hart (2001) and Mandaraka and Kormentza (2000) investigate the implications of the 94/62 Directive respectively on UK and Greek legislative system. Guide and Van Wassenhove (2002) provide an example of application of 99/31 Directive in the European tire industry. Schultmann et al. (2006) study the peculiarities of new Closed Loop Supply Chains (CLSC) considering the EOL treatment in Germany, complying with the 53/00 Directive. After comparing the current EOL treatment system to the new one, the authors provide an analytical model for product recovery networks, aimed at generating a routing plan with minimal cost. Finally, Walther and Spengler (2005) claim that the adoption of the 95/02 Directive on waste from electrical and electronic equipments (WEEE) causes essential changes in the field of electronic scrap recycling, since the directive expands responsibility of manufacturers to the treatment of discarded EOL electronics devices. The authors analyse future scenarios for WEEE treatment in the German infrastructure, in order to assess the economic impact of the directive on the current system.

### **BARRIERS AND CONSTRAINTS TO EXECUTING REVERSE LOGISTICS**

Previous studies highlighted vertical coordination between suppliers and buyers, stakeholders commitment and employees rewards as the main points affecting the implementation of RL activities. Recently, authors agree that the deployment of RL faces two main groups of constraints, such as technical constraints and managerial commitment. Form the technical point of view, Geyer and Jackson (2004) identify limited access to EOL products, limited feasibility of their reprocessing and limited market demand for the secondary output from reprocessing as the main weaknesses of current supply loops. Moreover, the quality of renewed or remanufactured products and of recycled raw materials is a

main concern, since it has potentials to greatly impact the purchasing behaviour (Prahinski and Kocabasoglu 2006). Moreover, a recently emerged hurdle to the implementation of RL is the substantial lack of good Information Systems (IS). Successful RL activities need to be supported during various stages of the PLC, to track and trace products reverse flows, to help in the inventory management and to plan and control the product recovery activities (Richey et al. 2005a). Ravi and Shankar (2005) provide an exhaustive overview of barriers to RL implementation. First, financial resources are recognised as a key constraint to good RL programs, since finance is essential to support the infrastructure and manpower required in the RL system. Funds are often inadequate because RL relevance against other company's processes is perceived as low. Hence, lack of awareness about RL is a further significant obstacle, leading to poor commitment by the top management towards the RL function; this, in turn, involves lack of strategic planning pertaining to RL activities. Moreover, lack of human resources and training is a significant barrier to RL implementation. Finally, resistance to change represents a fundamental obstacle, both because reluctance to changing is inside the human being and because of the lack of a clear RL vision. Resistance to change is always a consequence of the lack of appropriate IS.

### **REVERSE LOGISTICS EFFECTIVENESS AND EFFICIENCY MEASURES**

RL has potential to become an opportunity to build competitive advantage, cut costs, and increase customer loyalty (Stock et al. 2002). Nonetheless, the majority of practitioners, managers, and entrepreneurs still look at RL as an inefficient, but necessary, "evil" (Richey et al. 2005b). The challenge for an efficient RL management is thus to identify costs which have the highest impact on revenues (Stuart et al., 2005). Accordingly, literature has focused on addressing: (i) how to measure efficiency of RL systems; (ii) how to improve productivity and efficiency of RL; and (iii) how to select the most profitable action to manage reverse flows. As far as point (i) is concerned, many authors acknowledge a substantial lack of specific performance metrics for RL (Ravi and Shankar 2005) as well as the inadequacy of common forward logistics measures in assessing RL objectives of economic efficiency and environmental protection. An excess index is proposed in Blanchard (2005) to evaluate the performance of disposition decision-making system as a function of period costs, capital cost and a price erosion factor depending on the company and the products considered. Environmental performance indicators have also been proposed in literature; among others, percentage of waste recovered/recycled/sold/disposed, energy consumption ecological footprint per unit of product and environmental performance measures provided in ISO 14031 are suggested as viable indicators (Geyer and Jackson 2004). Hervani et al. (2005) apply the Balanced Score Card (BSC) tool to find out more metrics and measures for RL.

Improving productivity and efficiency of RL systems basically means finding strategies to minimize the total costs of RL. Guide and Wassenhove (2002) mention the need to make disposition decisions as early as possible, since long time between collection and disposition may lead to decreased product value. Economies of scale are also recognised as a viable tool to implement efficient RL programs (Zieger 2003). Klausner and Hendrickson (2000) show how benefits

can be achieved from combining profitable remanufacturing programs with expensive recycling ones. Incorporating reprocessing costs in new/renewed products represents a viable means to recover some expenditure. Horvath et al. (2005) investigate liquidity implications of RL for retailers: since RL programs can generate periodic negative cash flows, they provide a Markov chain decision-making model, which can help retailers in assessing liquidity issues related to products flows from one return stage to another. To the same extent, Goldsby and Closs (2000) suggest the use of Activity-Based Costing (ABC) to better approximate the "true costs" of operations in the RL channel. ABC approach may allow to identify redundant activities and excessive resource consumption of RL activities, and to trace related costs. Hu et al. (2002) describe an analytical model for the treatment of hazardous wastes, aimed at minimizing the total operating cost of a multi-time-step, multi-type hazardous waste RL system. The model is successfully applied to a Taiwanese industrial area.

As regards to previous point (iii) it is known that disposition alternatives, from reuse to refurbishing, are not equivalent in terms of profitability and achievable savings. Guide and Pentico (2003) formulate a hierarchical decision model which allows companies to determine the most profitable recovery strategy. Savaskan et al. (2004) propose a CLSC model with product remanufacturing, addressing the issue of choosing the appropriate RL structure for the products collection between direct collection, collection through a retailer, and collection by a third party. They provide three decision-making models to evaluate costs and profits related to each collection option. Chouinard et al. (2005) propose a push-pull approach for the recovery and processing of products, employed in a rehabilitation centre recovery programme: the hybrid model grounds on long-term planning for certain stages of the operational processes (push) and on launching of some activities in reply to an order (pull). Stuart et al. (2005) study return processes of clothing industry selling through catalogue: to reduce inefficiency and excess material handling, they provide a disposition decision algorithm which takes into account several decisional factors, such as products conditions, fashion obsolescence, back-order status, inventory level, demand pattern, cost and lead-time. The approach reallocates tasks to fewer work-stations so that the returns processing time decreases and service level and customer satisfaction, improves. Bautista and Pereira (2006) propose a mathematical model to locate a minimum set of collection points for urban waste in population centres; from the application in the metropolitan area of Barcelona, they found that the resulting collection system leads to cost reduction and service improvement.

### **EMERGING TECHNOLOGIES FOR REVERSE LOGISTICS**

The application of Radio Frequency Identification (RFID) technology to the RL context is a recently emerged topic both in scientific literature and in several European research projects. Hou and Huang (2006) study the application of RFID to different logistics activities of the printing industry, to assess related costs and benefits. Due to the relevance of RL for the printing supply chain, item tagging is suggested as a solution to overcome the issue of tracing the transaction history of returned goods. The pilot project INTELLARETURN (INTELLigence At the point of RETURN) was launched in 2002 with the aim to

explore the use RFID technology to improve RL activities, also providing companies with a way to supply value added services (RFID Journal, 2002); a trial to explore RFID application in RL was also launched in 2006 by Dutch telecom carrier KPN (RFID Journal, 2005). Finally, the PROMISE (PROduct lifecycle Management and Information tracking using Smart Embedded systems) project, funded by the European Union under the VI framework programme, focuses on exploiting product embedded information devices to track and manage information during the complete lifecycle of a product (European Commission, 2004).

## CONCLUSIONS

This work contributes to the literature in that it provides a review of recent papers related to RL issues, which were not examined in previous studies. The review performed shows that several three main RL issues still need addressing. First, little research exists which assesses the effect of environmental issues on long-term decision making related to RL activities. Moreover, although some optimization and costs minimization models are proposed to optimise the total costs of RL systems, no unified approaches are currently available. Conversely, models proposed in literature investigate very specific industrial segments and are hardly suitable to be adopted in different contexts. Finally, further research should explore the opportunities of applying new technologies to the RL function, to make it more competitive and profitable.

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## **THE WAY IN WHICH CURRENT EUROPEAN PACKAGING REGULATIONS AFFECT THE ENVIRONMENT**

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### **ABSTRACT**

This research focuses on the packaging sector in the global logistics market. It seeks to evaluate the problems arising from trade barriers generated by the implementation of regulations concerning packaging and reverse logistics. The investigation includes an in-depth literature review relevant to the subject, an analysis of current packaging laws and an evaluation of the trade barriers resultant from their implementation. Personal interviews of multiple packaging manufacturers and packaging users supported and strengthened this research. The paper also includes the investigation of a specific supply chain, where packaging acts as a significant factor for the individual companies that participate within it.

### **INTRODUCTION**

The 20<sup>th</sup> century was a period when there were very high levels of global economic growth due to the rapid development of new technologies, transportation methods and new international trade opportunities. However, this growth was not successful without serious environmental implications. Pollution of air and water, depletion of the ozone layer, rapid disappearance of rain forests, scarcity of landfills are just some of the most important factors affecting the environment (Wu and Dunn, 1994). Nevertheless, all these changes were not unpredictable. Thirty years ago many scientists supported the view that economic growth would lead to the over exploitation of natural resources and the decay of the natural environment (ESRC Global Environmental Change Programme, 2000).

In the late 1980's the environment emerged as an important factor. With the attention of media and the efforts of various environmental groups, consumers began to give more attention in this subject and forced companies to improve their environmental performance and meet consumer concerns. At the same time the environment became an increasingly important political issue (Livingstone and Sparks, 1994). Many countries considering the significance of the problem, tried to create a framework in order to determine companies to operate in a more sustainable way.

The European Union as a bloc of different countries has become involved in environmental legislation. However, despite the fact that until the end of the 1980's there were nearly 200 EC/EU directives concerning environmental areas, by 1990 more than 50% of these directives had not been implemented (Prendergast and Leyland, 1996).

### **PACKAGING ISSUE**

Packaging became a significant issue for the whole of Europe since the last years of the 1980's according to the Economist (1990, cited by Livingstone and Sparks, 1994). The European Community was generating approximately 50 million tonnes of packaging every year. Of these, only 9 million tonnes were recycled. It is obvious that further measures were necessary.

For this reason, in 1994 the European Union adopted the Packaging and Packaging Waste Directive (94/62/EU). This directive aimed to harmonise national packaging waste management measures, in order to reduce its impact on the environment and at the same time ensure that packaging laws do not create any obstacles to trade or restrictions to competition within the Community (The European Organization for Packaging and the Environment, 2000 and EUROPA, European Commission, Environment, 2005).

The specific Packaging and Packaging Waste Directive and the individual laws enacted by other countries (e.g. Green Dot in Germany – trade mark protected in ~170 countries (Duales System Deutschland AG, 2005)) were generated aiming to reduce packaging impact on the environment and at the same time address any obstacles to trade or restrictions to competition within the Community. Since then, there are many complaints that the Directives create trade barriers. For example, groups like Industry Council for Packaging and the Environment (INCPEN) and Alliance for Beverage Cartons and the Environment (ACE), at the end of 90's demanded that the EC take measures against Germany's refill quota, "*which put a 28% ceiling on drinks in single use packaging*" (Packaging Magazine, 1999). Due to the fact that the German system promotes the use of refillable containers, the system of deposits for non-reusable bottles is thought to be unfair to foreign companies who in order to avoid these extra charges have not only to change their bottles transforming them into refillable but also to organise reverse, longer and expensive channels of transportation (as compared with the local manufacturers) in order to take back the empty bottles (UKEN Archive, 2001).

The expansion of many companies to foreign and many times to bigger markets (compared with the domestic markets where they used to trade), have increased the distances between the place of production and the point of consumption (Jahre and Hatteland, 2003). This fact forces companies to redesign or totally change their packages in order to make the transportation, the warehousing and the handling of the products easier and at the same time improve their environmental performance. Redesign of packaging in terms of shape and size and many improvements in the easiness of handling and opening are some of the changes of the recent years' concerning packaging sector. In many cases (where possible), packaging materials are substituted with more environmentally friendly materials such as: recycled glass or paper, use of non – toxic colours, reusable plastic containers and so on.

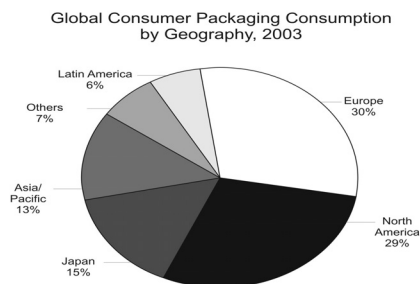


Figure 1. Source: Adapted from Packaging Strategies (2003)

Although the reduction of packaging became one of the most important issues considering the EC's Packaging and Packaging Waste Directive, the substitution of packaging or generally packaging materials is not always an easy matter, since not all materials are appropriate for all kinds of products (e.g. food) and in addition, some products need special treatment and further packaging in order to avoid further waste which might derived from the destruction of the product itself.

A general view of the global consumer packaging consumption by geography is shown in the Figure 1.

There is a view that packaging has developed, to a large extent, in response to social and economic changes affecting consumers. The continuous economic growth in the Western World that is translated into an on-going increase in consumer goods consumption and the demand for more, new and innovative products have boosted packaging operations and transformed them into a vital factor for the whole supply chain. It is obvious that packaging concerns not only consumers but also intermediaries since it is designed to facilitate the movement and handling of goods, the easy identification of the contained product, the various instructions for the careful handling of the product through labels etc.

### THE 94/62 EU PACKAGING AND PACKAGING WASTE DIRECTIVE

The specific directive describes and integrates the European Union's strategy on packaging waste. It mainly aims to harmonise national management measures concerning packaging and packaging waste in order to reduce its impact on the environment and to efface any obstacles to trade or restrictions to competition across European Union member states, caused by the individual packaging laws (EUROPA, European Commission, Environment, 2005). It covers all packaging and packaging waste placed on the market in the EU, regardless of the materials used. The measure involves packaging manufacturers and importers and includes all packaging used or released at any level (industrial, commercial, service, household etc).

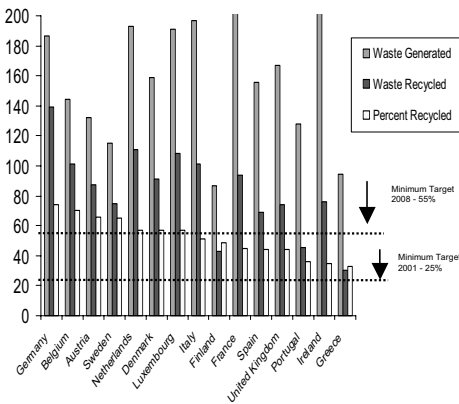


Figure 2. Source: Adapted from European Environment Agency (2005)

Member states are also required to: Create those facilities that ensure the return and collection of used packaging and packaging waste from the consumer, other final user, or from the waste stream, in order to channel it to the most appropriate waste management alternatives. Create those facilities that ensure the reuse or recovery of the packaging and packaging waste collected, in order to meet the objectives laid down in the specific directive. Encourage the use of materials obtained from recycled packaging waste from the manufacturing of packaging and other products (FOE, 1999).

The targets that the directive set for the recovery and recycling of packaging and packaging waste by June 2001, were:

- 50 – 65% by weight of packaging waste should be recovered.
- 25 – 45% by weight of all packaging waste should be recycled with at least 15% of each packaging material being recycled.

The above data (Figure 2) illustrates the 2002 situation but is also indicative of the present conditions in the European Union. It is clear that the targets for 2001 have been achieved by all the European Union member states. The new targets for the year 2008 are now expected to be published.

## RESEARCH METHODOLOGY

Explanatory research has been used in the first part of the investigation to:

- Explain current practices in the packaging sector concerning packaging materials that are in use, reverse logistics issues such as methods of operation and costs, relevant legislation and in what proportion the packaging industry is affected by packaging laws.
- Investigate the recycling and recovery methods and operations that are in use in the European Union and to assess the extent to which they are appropriate from an environmental protection standpoint.

Semi structured interviews were conducted to a part of our sample (mainly in Greece), including suppliers of raw materials, packaging manufacturers, industrial customers, wholesalers and retailers and the following can be concluded: 65% of the respondents were not aware of the Packaging and Packaging Waste Directive, 78% believe that the use of take-back programs is not affordable and is financially prohibitive for the individual companies, while 98% of respondents admitted that after the implementation of the Packaging and Packaging Waste Directive and the taxes that are going to be generated, -if they are allowed- they will try to push the cost to their customers through their prices.

## BARRIERS AND PROBLEMS

We already mentioned the trade barriers that Germany's legislation created in the European market. The activities which take place in a packaging manufacturer's supply chain can be illustrated as follows (see Figure 3).

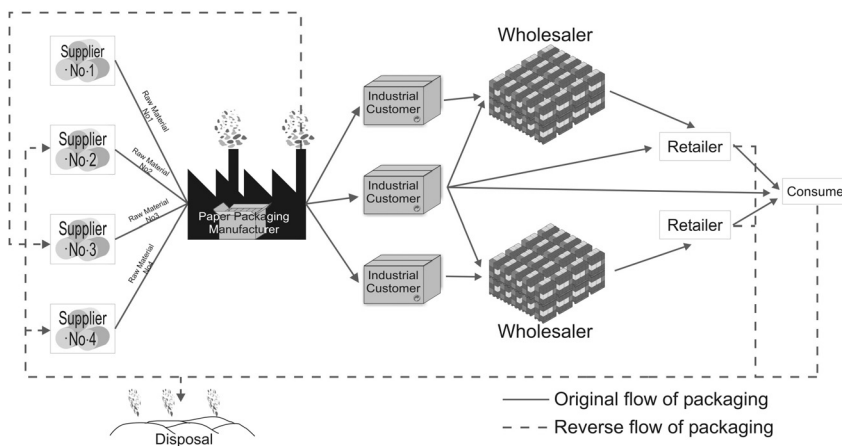


Figure 3. Paper Packaging Supply Chain

The flat lines indicate the original flow of packaging: 1) the raw materials (paper) are sent to the corrugated packaging manufacturer, 2) where they are transformed into final product (packaging), 3) packaging is then sent to the industrial customer who uses it filling it with its products, 4) and then passes it to the i)'wholesaler' or ii) retailer, 5) who in turn unpacks the products to sales unit level (in most of the cases) for the purpose of selling products to the final

user. The dotted lines indicate the reverse flow of packaging to the disposal or further to recycling centres. As shown there are at least 5 stages through which packaging moves in order to reach the final consumer. Each one of the above 5 stages is involved in some proportion in the whole process. The question is in what proportion each link of the supply chain impacts on the environment and what are the optimum deposits that they have to pay? Another important question is who pays for the extra costs that the legislation creates? Is it the manufacturer, his customer or the final consumer? What is the overall cost that the legislation has created in the European packaging manufacturers and to what level has this cost impacted on the prices of their products.

## **CONCLUSION AND FURTHER WORK**

1. Since most of the fee systems are weight based, the manufacturers seek to find ways to reduce the overall weight of their packaging. However, it has been observed that this drives the selection of lighter but more difficult to recycle packaging materials. What happens in the case where the above manufacturer exports his products? The country who imports them, is then affected.
2. Since the Packaging Directive tries to *"assist and harmonize national packaging waste management measures and at the same time ensure that packaging laws do not create any obstacles to trade or restrictions to competition within the Community"* (EUROPA, European Commission, Environment, 2005) the measures taken by the individual European countries are different.
3. In conclusion the regulations allow the generation of situations that do not clearly describe the framework to which the various involved parts of the market are allowed to operate.
4. There is not a clear distinction giving evidence of the proportion that each link of the supply chain is involved in this situation and what are the optimum deposits that they have to pay.
5. A matter of great importance concerning the question: "Who pays for the extra costs that the legislation creates?" is still unanswered. Is it the manufacturer, his customer or the final consumer?
6. How do the retailers return the used packaging for recycling, reusing or disposing?
7. The overall cost impact of the legislation on European packaging manufacturers and the impact on product prices has not yet been assessed.
8. There is not a buffer -concerning the local laws- that will undertake to equalise the differences between different countries e.g. If the taxes (concerning the legislation) for corrugated packaging are higher in country A comparing to country B, what happens to the final price of the product in these two countries?
9. The use of take - back programs can result in source reduction since it puts a direct link to the producer. However, in cases of long distances, for example export, the more the link is separated from the producer, the more the incentive or informal obligations to the source is decreased.
10. At this stage it is assumed that the existing packaging regulations do have some weaknesses in that they force the substitution of some kind of packaging without examining the environmental friendliness of the new material and furthermore do not restrain "exported" waste.
11. In addition, although there is no doubt that the consumer should have its share of responsibility, it is expected that further investigation using the above mentioned case study will reveal that the consumer will also pay for the share of the other participants of the supply chain.

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## **REVERSE LOGISTICS OF THE EMPTY PACKINGS OF AGRICULTURAL PESTICIDES IN BRAZIL**

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### **ABSTRACT**

This paper presents an understanding of RLSs in Brazil for empty packings of pesticide. It describes and analyzes these RLSs, in order to identify the processes of return and recycling and the market viability for recycled products. The work described in this paper studied the connections or relationships with focus on the recycler of 1st level, decomposing the studied RLS into two subsystems or stages: collection and post-collection system

Keywords: Reverse Logistics System, Packings of Pesticides, Brazil.

### **INTRODUCTION**

Traditionally, reverse logistics has been viewed primarily as the process of recycling products. Today, definitions vary depending on the company or segment of industry defining it. Retailers see reverse logistics as a way to get products that have been returned by a consumer back to the vendor, manufacturers tend to view reverse logistics as the process of receiving defective products or reusable containers back from the user (Buxbaum, 1998).

RLEC (Reverse Logistics Council) defines reverse logistics as "The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal" (Rogers and Tibben-Lembke, 1999).

As it has been previously stated, reverse logistics deals with recycling aspects. At the beginning of the nineties, Pohlen and Farris (1992) paid attention to the problem of reverse logistics applied to plastic recycling. A decade later, Brodin (2002) explored the concept of reverse logistics related to reverse logistics systems. She declares that "reverse logistics today refers not only to the retro-movement of goods, but also to the whole system, which reuses or recycles them".

Reverse Logistics Systems (RLSs) are systems that include all actors, their activities and relationships involved in the process of recovering goods or the value of end of life products. The interest for RLSs is partly due to the pressure of new legislation, which has forced the producers to be responsible for the collection and final use of their products. This creates more complex challenges for supply chain management. Pesticides are among these products. In Brazil, environmental legislation has distributed responsibilities for all the actors involved in the supply chain of pesticides.

This paper presents an understanding of RLSs in Brazil for empty packings of pesticide. More specifically, it describes and analyzes these RLSs, in order to identify the processes of return and recycling and the market viability for recycled products.

### **THE PROBLEM OF PACKINGS OF PESTICIDES**

The "green revolution model" has raised the overall productivity of the Brazilian agricultural sector during the last decade. At the same time that productivity of the 15 larger cultures has increased in 16.8%, the use of insecticides, fungicides and herbicides increased by 233.6%, 584.5% and 5414.2% respectively. The intensive use of pesticides (a tonic in this productive model) has caused countless negative impacts, from natural enemies of insects' elimination as well as the resistance development to pesticides for insects and herbs (Ferraz, 2000).

Brazil produces seven times the world average of poison per inhabitant. Within this context, Brazil is the fifth largest user of pesticides in the planet, consuming a total of 300 tons/year. The national demand for those substances grows, according to several Brazilian scientists by a rate of 6, 5%, being larger than the combined volumes of the 4 countries that precede it. The indiscriminate use of pesticides affects not only the soil, but also rivers and oceans, to where 25% of these residues are drained. Besides the toxicity of the pesticides, inadequate use of equipments and lack of protection for workers result in harmful effects to the workers' health and population in general (Pinheiro & Adissi, 2004).

Another serious environmental/health problem is generated by the reuse of discarded packings of pesticide by small farmers. Some types of empty packings, due to its size and resistance, are attractive for being reused as deposit of water, grains, manioc flour, among other uses (Ferraz, 2000).

### **LEGISLATION ABOUT FINAL DESTINATION OF EMPTY PACKINGS OF PESTICIDES**

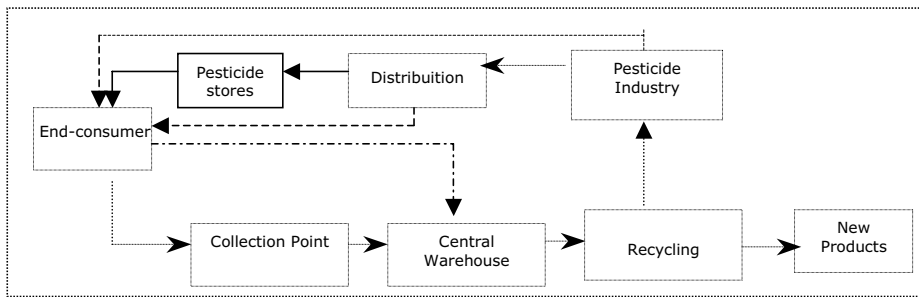
In 1984 the state of São Paulo edited the 1st Law on Pesticides (Law Nº 4.002 in 01/05/84), revoked by the Law 5.032 (11/04/86) and regulated by the Ordinances 30.5645 (10/10/89) and 31.132 (05/01/90). A mark in relation to pesticides' legislation was Federal Law 7.802 (11/7/89) and the Ordinance 98.816 (11/1/90), which created the compulsory nature of Agronomic Receipt for the sale and use of all classes of pesticides (Brasil, 2007).

In June 2000, the law 9.974 (law of pesticides) was amended to Law 7.802. This law determines that producers and distributors of pesticides are responsible for the correct destination of empty packings after the devolution by the users. It also determines that the users of pesticides should make the devolution of the empty packings in commercial establishments where they have acquired the pesticides, until one year after the purchase date. The devolution can be intermediated by collection centres that hold these packings before sending to a central warehouse or recycling plant.

### **THE RLS OF EMPTY PACKINGS OF PESTICIDES**

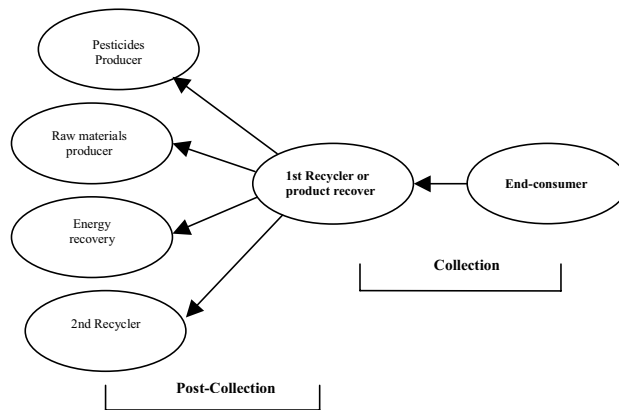
Before the legislation previously mentioned, every sold product arrived to the farmer's hands with a simple guide that mentioned ways of conditioning the packings in rural areas. The most common "treatment" was to bury (following a

series of technical procedures applied by the farmers) and incineration. At the present time, the logistics process of destination and treatment of empty packings of pesticides follows the flow presented in the figure 1.



**FIGURE 1:** Reverse Logistics for empty packings of pesticides.

This system avoids that chemical residues return to nature, as well as the inadequate reuse of the packings' material. Without the recovery process, the packings are dangerous sources of environmental pollution, contaminating the soil and impacting human health directly (InpEV, 2007). The scheme presented above can be dismembered in several actors and their relationships, creating a RLS. The work described in this paper studied the connections or relationships with focus on the recycler of 1st level, decomposing RLS into two subsystems or stages: collection and post-collection system (figure 2).



**Figure 2:** The studied RLS and its subsystems: collection and post-collection.

At the collection, the RLS uses the same truck that takes the filled packings of pesticides for the distributors to collect the empty packings (in bulk or compacted). These empty packings are inspected and stored in the collection points. Before this process, the truck that distributed the filled packings returned empty, which represented an increase in the logistics costs involved in the system. That process presents advantages in terms of safety for the environment and health, since it is conducted by a qualified haulier to accomplish such specific transport. It also represents economy for the global RLS, once the truck has part of its costs paid when it took filled packings.

The post-collection system begins after the selection, decontamination and disassembly of the empty packings to be recycled. The post-collection system is concluded with a producer of raw material, a manufacturer of final product (in case parts of empty packings are reused), an energy recoverer (uses fractions of empty packings as fuel) or other recycler.

Since June of 2002 (when it became obligatory), the devolution of empty packings of pesticides is growing all over the country. For this reason, Brazil is already the country that most collects packings of pesticides in the world. Nowadays, the RLS of empty packings is represented by 380 collection points managed by 185 associations of resellers and more than 2.200 distributors in 23 states of the federation. Brazil has achieved the world's leadership in collection and final destination of empty packings of pesticides, overcoming the 30 larger countries that possess similar systems, among them: Germany, Australia, USA, Canada and France (InpEV, 2007).

### **THE MANAGEMENT OF RLS FOR EMPTY PACKINGS OF PESTICIDES IN BRAZIL**

In the 90's the Brazilian industry began to seek a solution for the problem of empty packings of pesticides. By that time a partnership among ANDEF (the General office of Agriculture of the state of Sao Paulo), AEASP (the Association of the Agricultural Engineers of the State of São Paulo) and COPLANA (the Association of Sugar Cane Producers of Guariba District) was created in order to study the flow of empty packings of pesticides. Through this initiative it was implemented the first unit of reception and primary treatment of packings of pesticide. Recycling alternatives were created through an agreement with a small company of the pesticide industry.

An important and critical step for conducting this project was the contribution of the Brazilian Association of Technical Standards (ABNT) for the development of standards and procedures for the treatment and washing process of empty packings of pesticides. The establishment of these procedures has permitted that the packings of pesticide could pass to a dangerous residue to be considered common dejections, which made possible its recycling.

On December of 2001 the National Institute of Processing of Empty Packings was founded (inpEV). In March of 2002 the inpEV started to operate with the support of 22 pioneering companies. By the end of 2002 inpEV has collected 3.700 tons of empty packings of pesticides. After 4 years of operation, inpEV already processed a total of 56.000 tons of empty packings of pesticides. Now the Brazilian system of final destination of empty packings of pesticides is world reference in the subject when destining more packings than the sum of 30 countries that possess similar programs. Nowadays, the institute operates with 66 companies and 7 associated entities. The structure of the RLS operated by inpEV is formed by 365 processing units (collection points, central warehouses and recycling plants), which meant 19.634 tons of packings by the end of 2006.

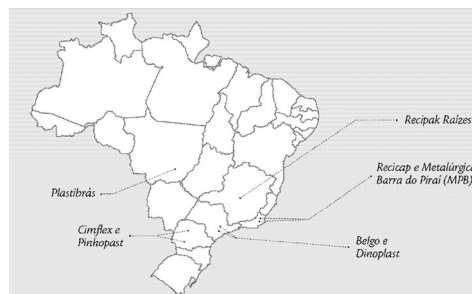
### **MARKET VIABILITY FOR RLS OF EMPTY PACKINGS OF PESTICIDES**

After four 5 years of operation of inpEV, some Brazilian states continue presenting significant growths in the indexes of devolution of packings, with

prominence for Mato Grosso do Sul, that increased their devolution indexes in 49% (it passed of 646 tons in 2004 and 965 tons by the end of 2005), Rio Grande do Sul, increased 47% (it passed of 996 tons for 1.464 tons) and Bahia, increased 42% (it passed of 683 tons for 969 tons of returned packings).

States of Paraná and Mato Grosso continue in the leadership in the collection of the empty packings of pesticides in Brazil, since in 2005 it has been returned in these States 4.006 tons and 3.891 tons, respectively. The state of São Paulo occupies the third position, with the processing of 2.597 tons of empty packings, what represents 12% of growth in relation to the year of 2004 (inpEV, 2007).

Besides 2 companies that practice energy recovery, in terms of final destination, the RLS for packings of pesticide in Brazil has 8 companies certified by inpEV that receive and recycle these packings. Only those companies are capable to deal with the recycling of these packings. These companies are strategically located in 5 Brazilian States (figure 3).



**Figure 3.** Location of the recycling companies in Brazilian territory.

The products resulted from the recycling of the packings are: cardboard barrels, tubes for sewer, packings for lubricating oil, boxes of automotive battery, and covers for packings of defensive agricultural, among others. The covers of the packings of pesticides are the first products returned for original use through recycling. The final products are produced by consent of inpEV, which prioritizes products for industrial use.

Now the priority of the actors of this system is the search for mechanisms that make the program sustainable, since today it is integrally financed by farmers, distributors, cooperatives and manufacturing industries, each one of them with a quota of responsibility. The program does not seek profit but the execution of the legislation with benefits to the environment.

### **FINAL CONSIDERATIONS**

Besides contributing for the preservation of the atmosphere for future generations, the management of the RLS for packings of pesticide develops an important socioeconomic function in Brasil. It generates more than 2.500 direct jobs along the whole chain (associations of distributors, cooperatives, collection points, carriers, recycling companies and services providers).

One of the main goals of the legislation is to direct the material flows in packings

of pesticide chains in an economical way towards environmentally friendly disposal options. Therefore, it is necessary for legislators to understand the structure of the supply chains for packing sod pesticide, technologies and markets. The primary goal of a legislator is to develop competitive markets by turning the negative value of packings of pesticide into a positive one. This can be done by encouraging research and development for new products derived from packings of pesticide and for better methods to process those packings.

In line with this discussion, this paper has identified two research topics that are of importance for scrap tire supply chain management:

- How to set the budget for scrap tire management programs and how to allocate it to different markets?
- How to organize the collection of scrap tires?

These issues can also be applied to other industries for which landfilling poses a heavy environmental burden. For example, the End of Life Vehicle Directive of the EU stipulates that starting from January 2007 drivers will be able to leave ELVs at an authorized treatment facility without incurring a charge.

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## **CLOSED LOOP SUPPLY CHAINS: A RETAILER'S PERSPECTIVE**

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### **ABSTRACT**

This exploratory study focuses on the product return supply chains of two Australian retail groups. A case study approach has been taken to data collection incorporating interviews, site visits and content analysis of company documents. The guiding research question of the study was how the firms viewed the concept of value capture in their product return activities. Both firms have moved to a centralised return centre managed by third party service providers. For the retailers, value recovery focuses on the maximization of credit from the suppliers for returned goods. A second aspect of value capture relates to increasing the efficiency of processing product returns in the retail stores. Low cost high speed returns processing is the aim of their reverse logistics activities. In contrast to literature that suggests the products' marginal value of time should drive reverse logistics systems design and practice, reality suggests a more complex set of factors are involved for these retailers who focus on both efficiency and responsiveness in their reverse supply chains.

### **INTRODUCTION**

Sustainability issues are increasingly being incorporated into organizations' business activities. Environmental issues related to pollution, climate change, and depletion of non-renewable resources are but a few of the issues that firms are now confronting. Governments are leading the way by collating data highlighting the need for sustainable action (Australian Bureau of Statistics 2006; Environment Australia 2002). Whereas economic performance and environmental responsibility have often been seen as discrete and mutually exclusive options (Porter and Kramer 2006), firms are beginning to develop strategies that embrace environmental responsibility while maintaining a focus on economic performance (Willard 2005).

Within the supply chain realm, firms can undertake many environmentally responsible initiatives (Wu and Dunn 1995) such as optimized transportation decisions, packaging waste reduction, supplier selection and environmentally friendly procurement. Reverse logistics is increasingly being viewed within the broader realm of closed loop supply chains. Closed loop supply chains involve returns management and product recovery, the reverse logistics of physically moving acquired product up the supply chain for sortation, evaluation and disposition decisions (Blackburn et al. 2004). Refurbishment and remanufacturing of reclaimed product are being explored as ways to reduce the waste stream while simultaneously enabling firms to reduce operating costs and cost of goods sold expenses. When refurbishment/remanufacturing is not feasible, disassembly for parts and material recycling are advocated (Environment Australia 2002).

Much of the literature on closed loop supply chains addresses the important issues of value recovery from the perspective of the manufacturer (Blackburn et

al. 2004; Cargille and Fry 2006; Guide et al. 2003; Mollenkopf and Closs 2005). In short, the economic imperative of closed loop supply chains moves beyond cost reduction, to the recapturing or creation of value. Viewed in this way, the intersection of economic and environmental goals can be realized for many firms. However, the literature remains unclear as to the role of retailers within closed loop supply chains. The purpose of this paper is to address this issue, focusing on the nature of "value recapture" initiatives from a retailer's perspective.

## **BACKGROUND LITERATURE**

Fisher (1997) advocates that not all supply chains should be designed for efficiency, and makes the case that for certain types of products supply chains should be designed to be responsive. Blackburn et al (2004) apply this logic to the closed loop supply chain context, arguing that reverse supply chains can either be efficient or responsive. The determinant is not product type, as in Fisher's (1997) distinction between functional and innovative products, but rather the product's marginal value of time. Return products lose value as they make their way up the supply chain. Some products lose value faster than others, suggesting that in order to maximize the value recovery firms need to develop responsive reverse supply chains for products with a high marginal value of time. For products with low marginal values of time, efficient supply chains are more appropriate. To maximize the value of recovered assets in the return stream, firms should position the evaluation and sortation activity appropriately. That is, centralized return centres are appropriate for creating efficient reverse supply chains, and decentralized evaluation decision points are more appropriate for supply chains that need to respond to product returns which exhibit high marginal values of time.

## **METHODOLOGY**

A case study approach is taken within the Australian retail sector. Two of Australia's leading retail groups participated in the exploratory phase of the research initiative. These retailers supply products across the spectrum of consumer fast moving goods and consumer durable products. Exploratory case study methodology is appropriate when study of a complex phenomenon that is poorly understood is undertaken. This is particularly appropriate when the phenomenon represents contemporary events over which researchers have little control (Yin 2003).

In-depth interviews and on-site visits to the retailers' returns facilities were conducted by both members of the research team. Interviews with distribution centre managers, supply chain managers and managers from the third party logistics provider were conducted. The same third party logistics provider operates the returns centres for both retailers, although the management at each facility is different.

The research is exploratory in nature, trying to reconcile the supply chain design advocated by Blackburn et al (2004) with the reality of the retail environment in Australia. The guiding research question related to how each retailer views and manages 'value recapture' for their firms, within the supply chains in which they operate. The in-depth interviews were open ended and discovery oriented, starting with a grand tour technique borrowed from ethnography (McCracken 1988). An interview protocol guide that broadly identified topics of interest was



used to follow up the grand tour technique. These topics were identified from the framework presented by Blackburn et al (2004) relating to the structure of reverse supply chains. Beyond the interview protocol guide, questions were not specifically pre-determined, so as to allow the participants to divulge issues that they felt were important within the research context. Verbatim transcripts of the recorded interviews and photographs taken at the facilities were used as data for analysis purposes. Content analysis of documentation provided by the companies and their on-line websites was used to compare stated corporate strategies with the practical realities at the return centres. Content analysis is a structured approach to the investigation of texts used in a variety of studies (Spens and Kovacs 2006).

### **KEY FINDINGS**

Both retailers employ a centralized returns centre, managed by the same third party reverse logistics firm. Discussions with participants suggest that recovery of product value is not the driving issue for these retailers, as suggested in much of the supply chain literature. This is not surprising, given that the products recovered through customer returns or stock adjustments are ultimately destined to be returned to the manufacturers or suppliers who provided the products to the retailers initially. Thus, for the two retailers, value recovery relates strictly to maximizing the credit allowances from the supplier for the returned product as quickly as possible, for the lowest cost.

A second priority in moving to the centralized returns centres relates to improved customer service within the retail stores. The retailers prefer their sales associates to spend as much time interacting with customer as possible. Before the centralized returns centres were employed, significant time was required of store personnel to place claims with suppliers, organize shipments, and monitor the claims payment from suppliers. The centralized processing centres enable the retailers' employees to spend more time on the sales floor, thus enhancing the relationships with its own customers. Thus, value recovery for the retailers relates to the recovery of time for employees to spend with customers.

Whereas Blackburn et al (2004) advocate a reverse supply chain that is either efficient or speedy (responsive), it appears that in the case of these two retailers, the centralized returns centres provide both efficiency and speed. When compared to the past practice of having returns sent directly from retail stores to the various suppliers, product now reaches the supplier much more quickly when processed through the central processing centre. Because economies of scale in processing and transport are now achieved, the central processing system is also much less costly for the retailer and its suppliers.

The two retailers have broad product lines, suggesting that some products might have a higher marginal value of time than others. According to Blackburn et al (2004), manufacturers should be interested in recovering these products more quickly than the lower marginal value of time products. But both retailers indicated that return schedules to the suppliers are consistently based on volume criteria alone, usually the use full truck loads to the return centre. This suggests that marginal value of time may not be the determining factor in these supply chains.

One of the benefits that both retailers feel they provide to their suppliers through their centralized processing centres is availability of in-depth information related to product returns—quantity, retail origin, return reason/defect type. This information allows suppliers to understand earlier why products are being returned, and to identify product quality issues that would remain invisible without the information provided by the retailers. By having the information early, the retailers report that their suppliers are becoming more proactive in product (re)design activities that work to minimize future returns. In considering the trade-off between speed and efficiency, it appears that speed of information exchange may be more important than product speed. Thus, the retailer can be efficient with product movement, but achieve responsiveness through speedy information exchange.

Another benefit realized by the retailers through the centralized returns process is improved relationships with their suppliers. Suppliers had been initially suspect of the retailers' motives in moving to centralized processing centres. While the suppliers now grant higher levels of credit to the retailers than had been the case when individual stores tried to claim credits, they also acknowledge to the retailers that they value the additional information provided to them by the retailers. The exchange of information and early indications of quality issues enable the retailers to work more cooperatively with the suppliers in resolving product issues. Both retailers and their suppliers recognize that the efforts of the returns centres enable the suppliers to avoid future returns, thus providing higher sales revenues for both parties.

Sustainability issues were not a significant focus of these retailers' reverse supply chains, although participants at each retailer acknowledged that improvements to their processes are now being considered, with respect to environmentally responsible activities. In each case, the closed loop supply chain for these retailers has been developed to achieve economic goals, in the first instance. Now that the operations are running smoothly and successfully, it seems that the next stage of evolution is to seek more environmentally responsible means of disposal for products that are not returned to suppliers. Additionally, these retailers recognize that further value can be extracted from non-returnable products through disassembly and materials recycling. Some suppliers request the retailer to dispose of their unwanted products rather than incur the cost of transporting them back to the supplier locations. As the retailers and their 3PL explore further recycling options, they recognize the opportunity of creating additional value for themselves and talk of sharing the financial benefits with their suppliers. Instead of being charged for the disposal costs, suppliers may actually receive some revenue from the recycling process, providing further incentive to enhance their collaborative relationships with the retailers. In this instance the retailers are taking opportunities to join with the suppliers on product stewardship initiatives related to the suppliers' products.

While sustainability goals were not the primary driver of the closed loop supply chains being developed by the two retailers in the study, the strategic benefits of sustainability initiatives related to product disposal and materials recycling are becoming more apparent to the retailers. For these retailers, the intersection of supply chain strategy and sustainability seems to be an evolving concept. If sustainability initiatives continue to evolve within these retailers' supply chain

activities, supply chain strategy will become increasingly a part of the firms' stated sustainability strategies.

## **CONCLUSIONS**

This exploratory research has been conducted with two leading Australian retailers to identify issues related to supply chains and sustainability within the Australian business context. Although no final conclusions can be drawn at this point, the research enables further research questions to be elucidated and helps establish a research agenda for supply chain sustainability research.

First, further research needs to address a broader view of the retailing sector within Australia to more fully understand the role of retailers within their supply chains, as firms grapple with issues of sustainability. How do retailers create value through sustainable supply chain initiatives? Does this value accrue to the retailers alone, or does the value extend to other supply chain members? What types of collaborative supply chain relationships best facilitate sustainable business practices and the (re)capture of value?

Second, in the industry sectors represented by the two retailers, it did not appear that the manufacturers supplying them were taking the lead on supply chain sustainability issues. Contrary to the expectations promulgated by Blackburn et al (2004) the manufacturers do not appear to be focused on value recovery opportunities presented by return products. Further research needs to investigate several possible explanations for this apparent phenomenon. Is it an artefact of the industry and product type, or does it suggest that sustainability has not yet pervaded the supply chain mindset of Australian firms? It may be an artefact of globalization. Many of the manufacturers providing product to the retailers have outsourced or offshored the manufacture of Australian consumer goods (primarily to China); these firms are essentially distributors of imported product. Since manufacturing takes place overseas, the economics of product recovery are such that return to overseas suppliers for refurbishment and/or remanufacturing is not viable. The most economical path at this stage is to dump the products in landfill.

Finally, longitudinal research needs to address the evolving nature of firms' sustainability initiatives within Australia. Public dialogue and regulatory pressures continue to change the business landscape for Australian firms. While sustainability and corporate social responsibility reporting is becoming more common for Australian firms, supply chain strategy in the two firms studied appears in its infancy with respect to sustainability initiatives. The factors that drive sustainability and supply chain strategy need to be understood over time as the sustainability imperative continues to evolve within Australian firms.

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## **A SURVEY ON THE CUSTOMER'S SENSE TOWARDS ENVIRONMENTAL LOGISTICS AND ITS APPLICATION TO THE SALES AND DELIVERY SYSTEM**

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### **ABSTRACT**

The purpose of this research is to consider the structure of environmental logistics from the viewpoint of environmental marketing. The research technique employed a survey in the form of a questionnaire to customers of the co-operative society. In order to prove the coexistence of "expansion of sales", and the "increase of environmental efficiency", we verified the results in two ways; the delivery form and the environmental activity.

**KEY WORDS:** Environmental Logistics, Environmental Efficiency, CO<sub>2</sub> Emission

### **INTRODUCTION**

Carbon-dioxide (CO<sub>2</sub>) emissions reduction has become the center of attention as a battle against global warming these days. In Japan, CO<sub>2</sub> emissions from transportation are reported to contribute 20% of the total amount of discharge. In an attempt to reduce emissions, it is important to have a clear understanding of how to attain a balance among the environment, costs, and services from the viewpoint of the company, which sets its priority for service and cost rather than for the environment. As for actual business conditions at the moment in Japan, there is a gradual need for the multi-frequency delivery of small-sized goods for the improvement in service, retail inventory control and sales management correspondence. The reason is that the consumer's need is more highly valued for the company's profit than the health of the environment. Various research and proposals for realizing maintainable environmental logistics are performed in response to the above background. For example, the evaluation index for maintaining physical distribution in a supply chain (key performance indicators: KPIs) was proposed by Potter et al. (2002), and the concept of "lean thinking" and added value was proposed and the index for maximizing both sides of CO<sub>2</sub> emissions and the rate of added value was presented by Simons et al. (2002). However, it is desirable for the physical distribution industry to incorporate methodology where the measure, which is influenced strongly and raises a consumer's degree of satisfaction by the demand from a market, can also lead to the reduction of environmental impact. According to this research, initially, the consumer's awareness regarding an eco-friendly physical distribution is investigated, and the obtained result is considered. Furthermore, the relationship between a green physical distribution and physical distribution information is clarified, and the validity is described, while how to visualize the amount of environmental impacts in connection with delivery at various ends is shown.

### **CUSTOMER SURVEY QUESTIONNAIRE**

Before outlining questionnaire of customer survey, an investigation was carried out about the actual condition of transportation, storage, cargo work, delivery, recovery of materials, and sale from the order having received relevant to the logistics of a life cooperative society (COOP) in Japan, and its supply. As a result, we have identified the environmental impact discharged from the all logistics processes. To construct a system realizing the synergy effect between environmental logistics and marketing,

it is necessary to analyze the behavior and awareness of consumers. The customer survey is carried out by following the result of this investigation for logistics process in order to clarify the possibility of environmental marketing by using the information of environmental logistics. The outline of our survey is as follows:

- (Time) November 20, 2006 questionnaire distribution beginning December 9, 2006 recovery deadline
- (Object number) 500 persons (random distribution)
- (Object region) The whole region of Tama; the whole region of Inagi; Hachioji-shi and Machida-shi
- (The distribution method) by handing it at the time of the delivery of goods
- (The recovery method) Mailing
- (Total result) The number of recoveries: 241 sheets

## THE RESULTS OF SURVEY

### ○ Delivery form

#### i) Resident status and delivery form.

Fig1-1 and 1-2 show the difference of resident statuses between consumers using group purchase (group delivery) and individual door-to-door delivery. Comparing the user's resident status, the rate of a collective housing (i.e. apartment, condominium, etc.) in group delivery users are larger than that in the individual door-to-door delivery group. From the viewpoint of environmental logistics, a group delivery system is easy to be installed in a collective housing situation compared to a single housing situation.

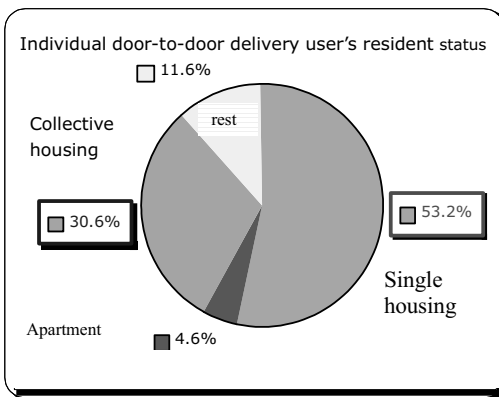


Fig. 1-1: Individual door-to-door delivery user's resident status

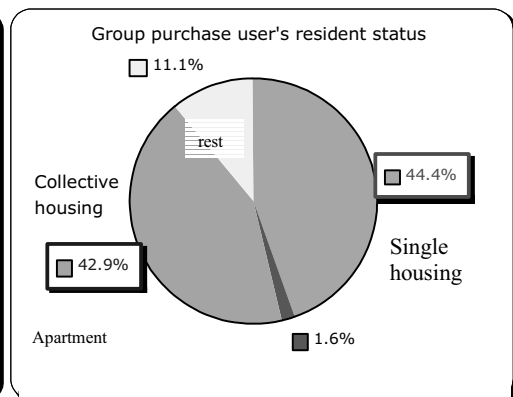


Fig.1-2: Group purchase user's resident status

According to this questionnaire, it can be surmised that collective housing is the reason for "the ease of carrying a parcel" and "the ease of ordering a group delivery within neighborhoods", compared with a single-family house. However, the people living in a single-family house tend to stay in the same house for long time. If they can make a local community in the area and realize "the abundance in exchanging with the neighborhood", the group delivery can be installed for single housing users. From the viewpoint of the impact on the environment, the group delivery for single housing users is relatively effective because of the necessity of long drive distances and many stops by the delivery trucks.

## ii) Delivery form and employment status

The proportion of customers whose employment status was employed and not employed were 47% and 53% respectively. According to the survey, 73% of all customers chose individual deliveries, while only 27% of consumers used the method of group delivery. In this case, we investigated the relevance of "work status" and "delivery form" (Refer to Fig. 2). As a result, there is no relation in the meaning of statistical significance between "employment status" and "delivery form". However, since the rate of "not employed" customers using group delivery is a little higher than that of employed people, it is necessary to consider the measure for busy persons. For example, it can be effective to install a "full-time locker", where individuals in a collective housing situation can collect their goods using a secure card operated system.

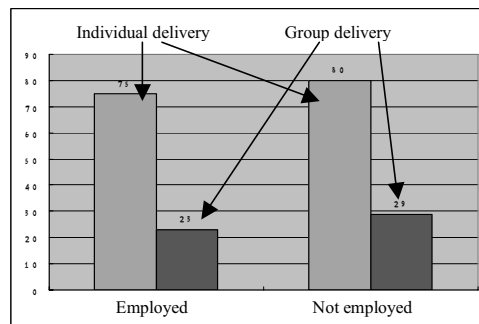


Fig. 2: Existence and delivery form of work

## oEnvironmental Activity

### i) Environmental consciousness

Fig.3-1 shows the frequencies of "number of activities" which consumers actually carried out in a list of eco-activities conducted by COOP. Fig.3-2 shows the number of consumer requests for COOP connected to the eco-activities. Although many people accept the proposed activities, they have few ideas of their own about the eco-activities.

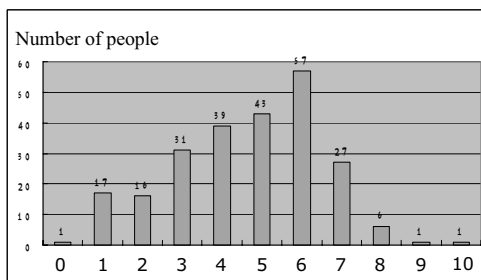


Fig.3-1: Number of activities in which consumers actually participated.

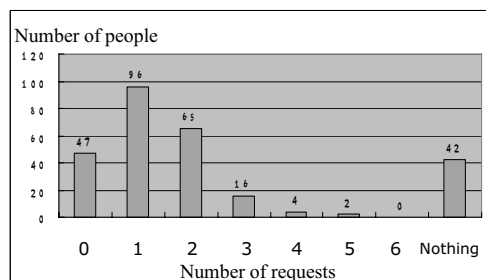


Fig.3-2: Number of requests from consumers with respect to environment.

According to this result, although co-operation on environmental activities was carried out, such activities were still viewed defensively. That is, a company should propose and promote environmental activities which can be tackled by its customers easily.

## ii) The environmental catalog according to age

Fig.4 shows the rate of people who want to use an eco-catalog if the environmental catalog was created in future. The rates stratified by consumer's age are shown.

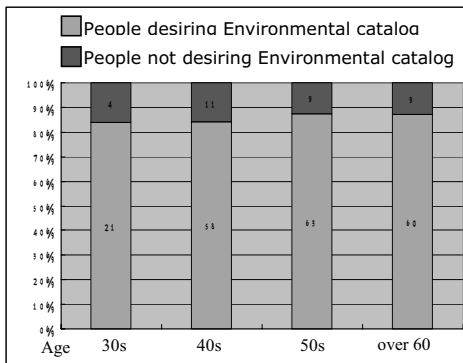


Fig.4: Environmental catalog hope according to age

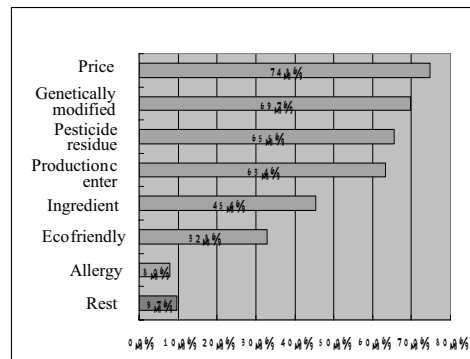


Fig.5: Criteria for goods selection of customers when purchasing.

As can be seen in Fig.4, more than 80 percent of people in all age groups answered that they desire the introduction of the environmental catalog. Specifically, we suppose that people desiring an eco-catalog have awareness about environmental issues. According to the result, putting CO<sub>2</sub> emissions data of goods in an environmental catalog is effective to increase customer consciousness about the environment and is also attractive to consumers.

## iii) The reason for goods selection

Fig.5 shows the result for the question "What kind of criteria is important to select goods for your purchase?" When creating a catalog using this result, it is most likely that price will be considered as the most important point. However, a criterion of "eco-friendly" is illustrated in 6th place on the chart. That is, an expensive eco-friendly good cannot be accepted by customers. It is hard for companies to discriminate the prices between environmentally-friendly goods and the existing goods.

## iv) Collection of plastic

During the "environmental activity" which is tackled, people who experienced "collecting plastics bags" was 65.3% (156 persons out of 239 persons). According to the statistics of "resource plastic collection transition of business in the fiscal years 2000-2005" in Japan, the collected rate is about 46% every year in the fiscal years 2001- 2005. Although the amount of supply of plastic is increasing every year, the amount of collection is not expanding. Although 65.3% of the questionnaire result is high compared with 45.3% of the collection rate of the whole in the 2005 fiscal year, the majority of respondents may be motivated people with awareness about the environmental issues. Possibilities of not continuing to collect now are also an idea. It is necessary to take the measure against collection.

## v) Soap promotion activities

"Soap promotion activities" are one of the environmental activities into which the company is putting energy. However, experienced persons are at a very low rate of 23.4% (56 persons out of 239 persons). Because the merits of soap are written with brevity in the present catalog, it is difficult for customers to find and understand the



explanation of soap promotion activities. This may result in few motivated customers. Soap is one of the ingredients of a product of nature, and soap is disassembled into water and carbon dioxide in a natural purification function. On the other hand, as for synthetic detergent, it takes a very long time to dissolve, and there is a possibility of destroying the purification function. It is necessary to advertise the environmental predominance of the soap compared with synthetic detergent.

#### vi) Collection of reusable bottles

According to the "activity which is tackled", there is a large population who is putting an effort into the "collection of reusable bottles". The rate of experienced people is 83.7% (200 people). By the collection track record of "reuse recycling article: According to the ability to set to 1999 - the recycle bottle collection transition [in the 2005 fiscal year]", although the amount is growing, the increase after 2002 fiscal year, the collection rate is decreasing. Moreover, all bottles collected by self-governing bodies are usually crushed and used as material for glass. All the reusable bottles collected by COOP are reused not being crushed, and those can be reused from 20 to 30 times to sell beverage products. As a result, there is very little environmental impact. 83.7% of the questionnaire results in our survey are of high value compared with 59.5% of the reuse bottle collection rate of the whole in 2005 fiscal year. Moreover, the reply to the free entry column had "I want you to collect all bottles" and the request of "wanting you to take through a deposit system."

#### vii) Catalog and Flier

By the request about the environment to a company, there were many replies "there are many catalog fliers" (9 persons out of 24 persons). Moreover, people who were asked the reason for "not wishing to have the catalog centering on the information about environment", replied that there were "already too many catalogs" for asking its reason (6 persons out of 13 persons). From this result, although the recycling of paper is possible, since it leads to environmental impact mitigation only by reducing the amount of the paper used, there is plenty of room for reexamine about the amount of distribution of a catalog flier.

#### o A request to business

The request to business was investigated. 99 persons (43.2%) out of 229 respondents were "to teach what a partner can do about the environment". 19.2% (44 persons) were "to report intelligibly about environmental activity". It showed that consumers are hoping for clarification of environmental activities that they can tackle and expecting the environmental report of business. Moreover, what was tackled as environmental activity was reported. Two hundred persons (83.7%) out of 239 respondents had actively participated in the "reusable bottle collection", 194 persons (81.2%) had a "catalog flier collection", 192 persons (80.3%) participated in the "egg pack collection", 178 persons (74.5%) participated in the milk carton collection", 156 persons (65.3%) participated in the "recovery of the plastic bags".

From this result, respondents prefer environmental activity of "collection of waste for recycle and reuse" to the other activities, for example, a partner participation type of activity which they act by themselves at the community level. The collection of waste for recycle can be done without any cooperation in the neighborhood and is an easy activity in Japan. However, the rate of collection activity of waste is not yet nearing 100% and should be raised. The page only for environment should be made into a

catalog (at least 1 time per month), and a method, a meaning, and a result of reuse and recycle activities should be announced to consumers. It is necessary to continue this effort in order to raise customer's environmental consciousness.

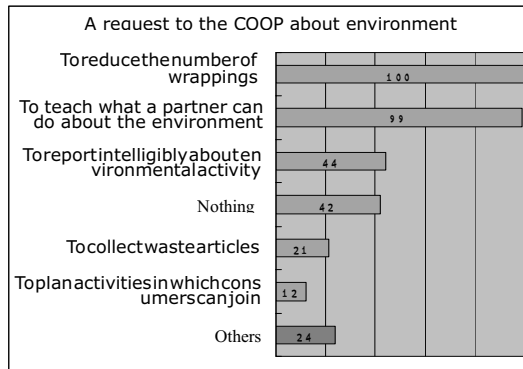


Fig.6: A request to the PAL system (COOP) about environment

**THE AMOUNT OF THE FUEL USED IN GROUP DELIVERY AND INDIVIDUAL DELIVERY**

It is clear that, on delivery activities, the fuel gauge was actually attached to run vehicles, so proven experiment was conducted to find out about a more efficient delivery method between group delivery and individual delivery. Setting condition: -- the case where mileage is set constant -- contents of verification: -- comparisons using the number method: calculating the arithmetic average and the amount of the fuel used, gross weight, and distance delivered place. The numerical value of a table is the number of cases.

Table 1: The comparison result classified by item of having set mileage constant

		Fuel consumption	Weight	Number of people
0.1	Group delivery(24)	0.0134167	2496.506	2.541667
	Individual (297)	0.0144337	2427.215	1.277027
0.2	Group delivery(26)	0.0283077	2476.525	2.730769
	Individual (243)	0.0286765	2380.874	1.231405
0.3	Group delivery (9)	0.0398444	2466.106	3.444444
	Individual (171)	0.0426737	2389.180	1.198830
0.4	Group delivery(11)	0.0498182	2572.782	3.272727
	Individual(103)	0.0702194	2369.472	1.320388

The result above shows that at the same distance delivered, group delivery required less fuel consumption than an individual delivery to serve the same number of customers. Therefore, group delivery should be strongly investigated.

In this survey, there is a possibility that respondents are having comparatively high environmental consciousness, because the majority of respondents were housewives having a greater interest in environmental issues. However, it was observed that the consciousness was not connected with concrete action in spite of the answers of motivated people with awareness. In other words, a consumer still tends to search for either convenience or economical efficiency, and does not necessarily purchase eco-friendly goods unconditionally. Therefore, it is necessary to consider how "a

consumer's increase of convenience" leads to "reduction of an environmental impact."

1) By the result of this research, it became clear from various cut ends for every delivery form exception or goods that CO<sub>2</sub> emissions can be measured and evaluated. Thus, it is proposed for utilizing positively for marketing the environmental impact information measured and computed according to the physical distribution system. The CO<sub>2</sub> emissions per each goods in physical distribution assumption are shown to a consumer, and it is made for environmental impact information to specifically go into a consumer's eyes in the case of merchandise selection. It can expect to rise in the consumer's environmental consciousness. Furthermore, it can promote the purchase of goods with low environmental impact by a physical distribution. Moreover, it is also possible to introduce the technique which accumulates the amount of reduction of the environmental impact by the consumer's goods selection by a point system, and is returned to a consumer in the same way as a mileage point card. By carrying out this a system can be built in whereby the mechanism in which the increase in a consumer's convenience (points) leads to the reduction of the environmental impact.

2) We can propose a system to maintain the convenience of individual delivery as it is for a consumer, and build a method equivalent to group delivery with respect of the physical distribution. That is, if delivery is possible to as many customers as possible in a small area where goods can be carried to the customers' doors by walking, the environmental impact reduction which is equivalent to group delivery can be realized with the advantage of individual delivery maintained, since it is greatly dependent on the number of times a truck stops in the case of orders from households who want individual door-to-door delivery can be concentrated in a small area, efficient delivery is realized. As concrete the part-timer who sends goods to each home is employed, for example, several neighboring affairs are collectively taken down to a delivery point, and how a part-timer sends it to a partner by hand can be considered. It is delivered by the customer to a space outside the front door by this, and can result in the reduction of CO<sub>2</sub> emissions. Since the burden of a driver is also eased, even if the wage is reduced for the part-timer, being connected with cost reduction it can be accepted.

3) By this part-timer, there is the possibility to offer information about the environmental harmony of goods, and to strive for a spread in the information. Moreover, the container recovery after use is begun and participation of various environmental activities is urged. By this, the canvass for sale and environmental activity depending on a catalog can be carried out more to spread the activity of the environmental impact. Moreover, it is also important to collect marketing information and to tie it to the development of environmental harmony of the goods. However, since various problems, such as a part-timer's reliability and a problem of privacy may arise, there is room for further examination. As mentioned above, while utilizing the advantage of the co-op which can grasp information over all the processes of circulation, sale, and recovery from supply from now on and aiming at improvement in the environmental consciousness of the consumer by presentation of environmental impact information. By working on the policy which can stimulate an environment-friendly delivery form should aim at coexistence of sales expansion and the improvement in environmental efficiency.

## **CONCLUSION**

By building the mechanism of utilizing the information about these environmental impacts for marketing activities positively, some measures were proposed that increased the consumer's convenience with the potential of reducing the environmental impact. In the future, the collection and dissemination of environmental impact information can be a valuable tool for raising customer awareness connected to the sales and delivery system.

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## **MATERIAL REQUIREMENT PLANNING IN REVERSE SUPPLY CHAINS: A CASE STUDY**

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### **ABSTRACT**

This study aims to evaluate how can material requirement planning system be used in refurbishing and remanufacturing facilities. A case study has been realized in an engine refurbishing facility in order to evaluate the application of material requirement planning system in reverse supply chains. In the case study, an algorithm has been suggested for planning the requirements of materials in an engine refurbishing facility.

### **INTRODUCTION**

Reverse supply chains are characterized with high uncertainties. In reverse supply chains, addition to the unknown demand, there are also significant uncertainties in the supply sides. According to time, quantity and quality, returned products are less homogeny than virgin raw materials. So, balancing the demand and supply in reverse supply chains becomes an important issue (Fleischmann, 2001). These uncertainties also make forecasting more difficult in reverse supply chains.

### **MATERIAL REQUIREMENT PLANNING IN REFURBISHING/ REMANUFACTURING FACILITIES**

Remanufacturing conditions are also appropriate for applying Material Requirement Planning (MRP) system (Ferrer and Whybark, 2001). However, there should be adjustments in MRP system when used in remanufacturing conditions (Inderfurth and Teunter, 2001). The main reason of these adjustments is related with the differences between disassembling activities and assembling activities. In assembling, the parts run to one source however in disassembling, the parts which will be disassembled are obtained from one source or different sources (Talep and Gupta, 1997). The fact that leaves may come from different cores or from same cores with different routes makes the process of determination of which cores should be disassembled difficult (Langella, 2007). The system should balance the demand of parts and supply of the cores. However, the probability of the similarity between components of remanufactured products which are sold and components which are returned back as an offset is very low and in some conditions the replacements can never be realized. In addition to this, the probability of matching with the components that are required to be disassembled in the next assembly is also very low (Ferrer and Whybark, 2001). As traditional MRP system, the approach of movement from top to bottom is not sufficient because of dependence between the components that have been obtained concurrency after disassembling and the requirement of obtaining from many supply sources (Fleischmann et al., 1997)

Fleischmann et al (1997) stated that, usually reverse material lists were used in existed approaches in literature. In literature, one of the early studies related with material planning in remanufacturing conditions has been realized by Krupp

(1988). Krupp (1988) and Krupp (1993) evaluated how will be material lists for remanufacture of automobile components. Krupp (1993) applied MRP system for planning remanufacturing activities in automotive sector. Gupta and Talep (1994) have developed reverse MRP algorithm that can be used in planning of disassembling activities. This algorithm can be used when there is a demand for the components of the products and when the quantity of the cores that have to be disassembled for meeting the demand of components have been known. The process goes through the leaves until reaching to the core and so the maximum quantity of components that is required determines the quantity of the cores to be disassembled. Gupta and Talep (1994) evaluated the MRP system as the demand of components instead of the demand of the products. According to the algorithm developed by Gupta and Talep (1994), disassembly of the product is realized to meet the demand of the components. With the algorithm they have developed, Talep and Gupta (1997) aimed to determine the disassembly plan of the products to meet the demand of the components while minimizing the disassembling costs and inventory costs. Ferrer and Whybark (2001) stated that the decision of the disassembly of cores are given according to the part and core inventory and material recover rate for cores. According to authors, the residue inventory of parts should be minimized, while deciding which cores will be disassembled. Inderfurth and Jense (1998) have developed the mathematical analysis of remanufacturing in MRP structure. Ferrer and Whybark (2001) suggested the algorithm where the demand is realized in the product level. They have used material lists for every component directly. The system determines the requirements for the parts and uses optimization rules for determining disassembly plans and purchase plans.

## RESEARCH METHOD

The aim of this study is to develop an algorithm for material requirement planning in refurbishing facilities. In the refurbishing facility which the case study has been realized, the engines of city buses of the municipality are refurbished according to the wear of camshafts of engines. There are two kinds of engines used in the buses. 250 engines are type I engines and 150 engines are type II engines. In this study, firstly, the parts that can be remanufactured were identified and the recovery rate of the parts were predicted. The common parts between two types of the engines were determined. The date of engines refurbished related to the wear of camshafts have been examined and according to these dates, at what kilometers are the engines and the dates of refurbishing of the engines related to the wear of camshafts were predicted.

According to analyzing these data, it was found that;

- the wear duration of the camshafts has normal distribution with mean 152.000 kilometer and standard deviation 26,35 kilometer,
- the way of a city bus takes in a week has normal distribution with mean 1945 kilometer and standard deviation 350 kilometer.

According to these findings, the engines that have to be refurbished for 12 weeks have been simulated. Parts that will be remanufactured and purchased arrive to the remanufacturing facility as orders. In order to meet the gross requirements of the refurbished engines, the gross requirements of the parts that will be remanufactured and purchased are determined as follows;

$$C_{ti} = \sum_{j=1}^m \sum_{i=1}^n S_{ji} \times A_{t+1j} \quad \forall t$$

The requirement of the parts has been determined as follows ;

Objective function ,

$$\text{Min } Z = \sum_{t=1}^k \sum_{i=1}^n E_i \times P_{ti} + B_i \times D_{ti} + K_i \times L_{ti}$$

Subject to ;

$$Z_{ti} = \sum_{t=1}^k \sum_{j=1}^m \sum_{i=1}^n Y_{tj} \times S_{ji} \times T_i \quad (\text{refers to the recovered type } i \text{ part after the disassembles in period } t)$$

$P_{ti} \geq 0 \quad \forall i, t$  (ensures no backorders for remanufactured type  $i$  part )

$P_{ti} = Z_{ti} + D_{ti} - C_{ti} + P_{t-1i} \quad \forall i, t$  (refers to the inventory of remanufactured type  $i$  part at the end of period  $t$ )

$L_{ti} = C_{ti} - P_{t-1i} - D_{ti} \quad \forall i, t$  (refers to the remanufactured type  $i$  part in period  $t$ )

$\sum_{t=1}^k \sum_{j=1}^m Y_{tj} \leq \text{capacity}$  (ensures that the amount of engines disassembled shouldn't be more than the amount of engines that can be refurbished), ( capacity subject)

$N_{tj} = N_{t-1j} - Y_{tj} + R_{tj} \quad \forall t, j$  (refers to the amount of engines that can be refurbished at the end of period  $t$ )

$Y_{tj} \leq N_{t-1j} + R_{tj} \quad \forall j, t$  (ensures that the amount of engines disassembled shouldn't be more than the amount of engines that can be refurbished), ( capacity subject)

$R_{tj} = A_{tj} \times X_j \quad \forall j, t$  (refers the amount of engines returned for refurbishing in period  $t$ )

$C_{ti}, L_{ti}, P_{ti}, D_{ti}, Z_{ti} \geq 0$  & integer,  $\forall i, t$

$Y_{tj}, N_{tj}, R_{tj} \geq 0$  & integer  $\forall j, t$

#### Parameter description for the model

$i$ -----{set of parts};  $j$ -----{set of engines (cores)};  $t$ -----{time period}

#### Description of input parameters

Capacity of the facility;  $A_{tj}$  : Forecast of type  $j$  engine that will be refurbished in period  $t$ ;  $S_{ji}$  : The amount of the type  $i$  part used in the type  $j$  engine;  $C_{ti}$  : Gross requirement of the type  $i$  part in period  $t$ ;  $K_i$  : remanufacturing cost of type  $i$  part ;  $E_i$  : inventory cost of remanufactured type  $i$  part;  $B_i$  : purchasing cost of type  $i$  part ;  $R_{tj}$  : the amount of returned type  $j$  core for refurbishing in period  $t$ ;  $T_i$  : recovery ratio of the type  $i$  part ;  $X_j$  : the returning ratio of the type  $j$  engine

$i = 1, 2, \dots, n$ , the parts index

$j = 1, 2, \dots, m$ , the core index

$t = 1, 2, \dots, k$ , the time index

#### Description of decision variables

$L_{ti}$  : the amount of the remanufactured type  $i$  part in period  $t$ ;  $P_{ti}$  : the inventory of the remanufactured type  $i$  part in period  $t$ ;  $D_{ti}$  : the amount of purchased type  $i$  part in period  $t$ ;  $Z_{ti}$  : the recovered type  $i$  part after the cores disassembled in period  $t$ ;  $N_{tj}$  : the amount of type  $j$  core for the refurbishing at the end of period  $t$ ;  $Y_{tj}$  : the amount of disassembled type  $j$  engine in period  $t$

## CONCLUSION and DISCUSSION

In this case, a model has been suggested for determining the requirements of the cores that have to be disassembled in an engine refurbishing facility. The adjustments in the material requirement planning system when used in the refurbishing and remanufacturing facilities has been evaluated according to the case study.

The uncertainties in reverse supply chains make the planning of materials more difficult. Seitz and Peattie (2004) stated that failure ratio of engines and strategies applied in the firms to let used engines return to firms affect these uncertainties such as return ratio of cores and time and quality of products' returns. As decreasing these uncertainties, the planning of materials' requirements in reverse supply chains will be easier.

In the case study, the ratio of the products' return has been estimated as a hundred percent and the time of the engines' return could be estimated. However, in remanufacturing facilities, estimating the products' return may be more difficult and match between the products' return and the remanufactured products' demand is not realized. The product which are returned may not match to the remanufactured product that the customer bought. This may cause the material planning more difficult in remanufacturing facilities. In the case, the product that will be refurbished can not be purchased from the outside of the facility. However, in remanufacturing facilities, the cores may be purchased from other facilities. In the case, the remanufactured parts can not be purchased from outside of the facility and only new products may be purchased from outside. However, in remanufacturing facilities the remanufactured parts may be purchased from outside and remanufactured products can also be sold. So, in remanufacturing facilities, while determining the gross requirements of the parts that will be remanufactured, the quantity of remanufactured parts should be estimated in addition to the quantity of the remanufactured products.

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**DECISION SUPPORT SYSTEMS AND  
COMMUNICATION TECHNOLOGIES  
INCLUDING RFID**



## REVISITING THE VALUE PROPOSITION OF E-MARKETPLACE CONNECTIVITY

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### ABSTRACT

In recent years there has been a broad shift towards the sophisticated adoption of supply chain integration and e-commerce (EC) techniques by leading logistics enterprises. A central element of this move has been the evolution of e-marketplaces or trading hubs and portals, which it is suggested, are able to provide effective enabling mechanisms for achieving synthesis between a wide range of collaborating partners and systems within value chains. To succeed in these contemporary environments enterprises, need not only to be highly capable of business excellence, but masters of process and systems integration. However, the problems associated with 'complexity and scope', undertaking 'cost/benefit analysis' and 'value proposition evaluation' remain. This paper describes and reports upon research and findings revealed during the implementation of an EC-based supply chain project by a leading international enterprise. General requirements for effective financial management within this area are considered and the industrial requirements for Information Technology (IT) system integration classified. Furthermore an analysis of an approach to e-marketplace connectivity and the implications of this are considered, prior to a choice of methodology for an industrial case study.

### INTRODUCTION

As the landscape for business has been amplified from local to global levels for many contemporary enterprises, the need to develop closer links between internal operations, customers and suppliers, has become an increasingly important key. High proportions of enterprises are now organised as networks of manufacturing, assembly and distribution sites, which may be scattered around the world. Together with customer and suppliers, these networks, which we refer to as 'Supply Chains' affect crucially both customer service and the total cost to the customer of products and services. Supply Chain Management (SCM) is now recognised as a pre-eminent concept by which enterprises can make instant improvements to their business strategies [1]. Moreover, enhancements to supply chains in terms of improved product quality, faster customer response and greater agility, can provide significant marketplace differentiation and increased levels of competitive advantage. Supply chain performance improvement initiatives strive to match supply and demand thereby driving down costs simultaneously with improving customer satisfaction levels. First step changes, to optimising enterprise logistic processes have relied upon concepts

such as BPR, JIT and TQM to become faster and more agile [2]. The implementation of SCM techniques externally, as a second step, should lead to enhanced cost saving opportunities as the whole supply chain can be considered and optimised. As we may see now, holistic mastery of process is one fundamental element of a successful supply chain, however the enactment of such process systems needs to be re-evaluated in the light of recent IT and communication technologies and in particular the rapid growth of Internet-based EC [3]. The adopted use of commercial ERP systems can facilitate some of the above capabilities. However, deployments of these all-encompassing business management applications have fallen short in delivering all of the various promises they make and may even place constraints on change [4]. Over the last few years, considerable efforts have been made, both by industrial and academic communities, to investigate and develop new holistic models of enterprise systems. These not only build upon previous internally focussed ERP systems, but also recognise outwardly facing SCM imperatives and address changing EC trends. Nowadays 'transactional' ERP systems are routinely implemented with additional Complementary IT Systems (CITS), such as CRM, APS, EC, Data Warehousing and Business Intelligence, to provide extra business support in terms of superior customer interaction, supply chain control and effective management reporting [5]. The problems of effective and latent SCM integration and collaboration often remain. As such additional emphasis is now being placed upon new Internet-based approaches designed to support low cost and improved supply chain partner integration, Figure 1.

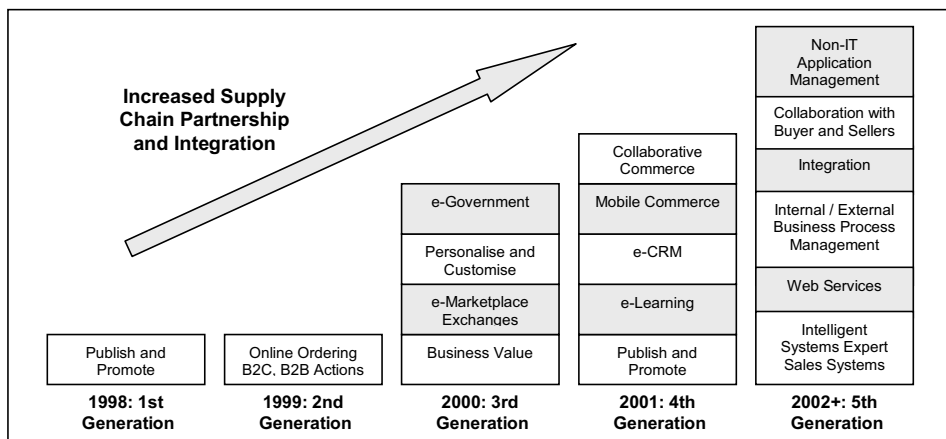


Figure 1: Key Drivers for B2B E-Commerce [6]

Within the context of a Business-to-Business (B2B) Internet software market estimated at \$7 to 10\$ Trillion in 2005 [6], there can now be seen to be a diverse range of business and software application models, which cover sell-side, buy-side, exchange, and collaborative commerce transactions. With the context of this paper, primary consideration is centred upon 'Vertical e-Marketplaces' or trading hubs, which facilitate the many-to-many exchange of goods between enterprises within a single industry or industrial segment. Whilst e-marketplaces have been around for over five years, it is only recently that the cycle of inflated expectations and trough of disillusionment; have been replaced by realistic evaluation and the potential plateau of profitability.

## **CHEMICALS ENTERPRISE BACKGROUND**

The case study enterprise is situated regionally throughout the UK and is one of only a handful of British companies that offer chemical marketing and distribution services to both industry and end consumers. It had developed a range of distributor agreements and a wide range of commodity and speciality products, with new areas being established continuously. Whilst its market share and profitability have suffered in recent years and as a consequence it had been subjected to Merger and Acquisition (M&A) activity, it holds a turnover of around \$700 Million. Recently, it had recognised that strategic partnership and supply chain issues must be considered further if the enterprise was to retain a competitive edge and high-share within its existing markets. The enterprise therefore embarked on an initiative to strengthen its key business partner relationships and implement new Internet-enabled supply chain systems to improve efficiency and reduce cost. This strategy was two-fold, i) to further improve its Internet sell-side channel to maintain its current competitive advantage, and ii) to rapidly provide supplier connectivity through an industry standard e-marketplace to reduce operational costs and safeguard its valuable distributor agreements. At the time, the enterprise employed approximately 1,500 staff across 18 sites, with its distribution depots organised within a hub and spoke configuration. Within the organisation, its IT capability was predominately in-house and based upon; a centralised Baan ERP system, and an integrated Internet-based shop front for a limited product range, EDI connectivity through standard EDI software, an IBM document management system, and a Cognos business intelligence suite. The programme was driven by the company's Commercial Director and held wide support from the enterprise's other board members. The enterprise had a long operational history of the Chemicals Industry and over time had established valuable relationships with its supply chain partners and industrial bodies. The initial phases of the project are now complete and further development work is in progress.

## **PROJECT APPROACH**

The enterprise embarked upon its strategy with the Commercial Director establishing a project team, led by a senior departmental IT manager, and comprising additional sales, distribution and procurement support. With a fixed budget and timeline in place the first phase of the project was to undertake an external business review and best practice analysis within the industry. Though the marketplace for Chemicals was valued at \$500 Billion in Western Europe, with a predicted growth of 1.9%, in recent years a downturn in UK manufacturing output was creating significant sales and financial pressures for the Industry. The Chemicals Industry was considered to be unique in its structure and operation, namely because of two facets; a) The Industry typically exhibits a high degree of intra-Industry buy and sell activity, with products being inputs to many processes, and b) Chemicals are used within 95% of all industries, including agriculture, aviation, electronics, manufacturing and service. From this initial review, Chemical Industry findings were reported and analysed internally (Table 1). With strategic importance now being placed upon service and supply chain differentiation the project team felt that large emphasis should be placed upon offering new and improved e-services for customers and forging closer links with key suppliers.

Industry Characterisation	Industry Issues
<ul style="list-style-type: none"> <li>• Mature European, North American and Japanese markets, with rapid growth potential in Asia and South America.</li> <li>• Highly capital intensive that can exaggerate economic cycles.</li> <li>• Exhibit a high local cost base through fragmentation, legislation, complexity and large plant size.</li> <li>• Structural shift from bulk to higher value-added products.</li> <li>• Internal focus is too high to the detriment of external customers.</li> <li>• Poor integration of IT systems and functional alignment.</li> <li>• Poor SCM understanding and activity is localised in one part of the value chain.</li> </ul>	<ul style="list-style-type: none"> <li>• Globalisation: Far East competition, elimination of trade barriers and overseas market development.</li> <li>• Overcapacity: Cyclical, cheap commodity competition and lower input costs.</li> <li>• Environmental: Changes to health and safety and environmental legislation.</li> <li>• Advances in technology: Changes in production technology.</li> <li>• Shareholder and customer demands: New quality and service requirements.</li> <li>• Diversification: More suppliers trying to ascend the value chain.</li> <li>• Portfolio concentration: Many enterprises have too many non-core businesses.</li> <li>• Cost Reduction: Far East competition.</li> </ul>

Table 1: Chemicals Industry Characterisation and Issues

At this stage only limited investment analysis was undertaken, as the risk of losing key supplier distributor agreements would easily outstrip the allocated \$200,000 budget and 10-month timescale. The key project elements comprised:

1. **Sell-side:** Expand the functionality of the enterprise's existing fully integrated Internet shop front capability to that of a partner self-service portal where clients could better manage their own accounts and access further value-added services such as Product Specifications, Technical Data, Manufacturing Safety Data Sheets (MSDS), Certificates of Analysis (CofA) and electronic formal business documents such as Sales Orders, Delivery Notes, Ship Notices and Invoices.
2. **Buy-side:** Electronically connect to the Internet-based Chemicals Industry Elemica e-marketplace for business document exchange to strengthen supply chain partnerships, reduce administration costs, improve cycle-times and establish a trading model which could be extended to many other key suppliers. Achieving connectivity in this way would assist in the maintenance of a global presence and recognition as a world-class enterprise.

Once the strategy had been formalised and approved by the board, the project was transferred to the project manager for implementation. The delivery of the two project phases would be sequential and involve the contracting of a technical Baan ERP integration specialist, due to internal resource and technical expertise limitations. Within the initial four months of the project the Sell-side development was nearing completion, at budget and on time. This phase now married together, user access functionality within the existing Internet shop front with Baan ERP product data and electronic documentation within the enterprise's IBM OnDemand documentation system. With pilot implementations now planned with the enterprise's internal business analyst team, development efforts were now centred upon the Buy-side phase. After industrial review, the chemical e-marketplace Elemica was chosen as the trading hub of preference due to its growing presence and existing number of major Chemical Industry company founders. Elemica was developed by 22 of the leading global chemical companies and provides real-time value to buyers, sellers and service providers in the chemical industry by establishing a single, global, neutral network for secure information sharing within pre-established chemical trading partnerships. Members electronically connect to the Elemica Network via a single connection, using established CIDX ChemXML industry standards or a series of proprietary translations designed around user specific ERP systems. Hence their adage 'Connect Once, Connect All'. Additional benefits to be acquired comprised; the removal of redundant inventory for improved forecasting, automation of slow and manual processing of many routine transactions, optimisation of complex

logistics networks, and the improved management of unwieldy documentation flows. The Sell-side phase was undertaken by the existing project team and formed three incremental parts: i) Purchase Order Management, ii) Direct Customer Deliveries and iii) Purchase Invoice Processing. Additionally, an Elemica e-Readiness Assessment was completed, Contractual Terms signed and a Technical Architecture Specification developed (Figure 2).

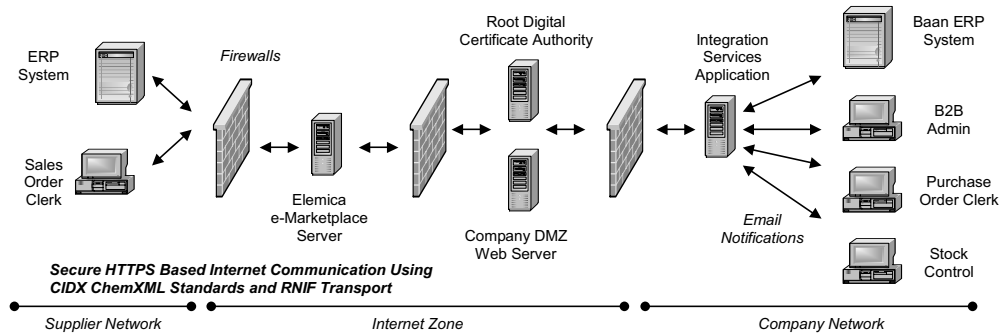


Figure 2: Elemica Technical Architecture Overview

Although Elemica provided advice upon infrastructure requirements, the location of suitable and scalable application software to undertake XML data translation and time-bound workflow management was problematic. Academic research [7] [8] and software vendor investigation, together with further supplier discussions, revealed only two appropriate applications to be suitable. These comprised Microsoft's BizTalk and WebMethods B2B Gateway software. Whilst the Microsoft offering was only in the early stages of development, at its list price it was considered cost effective, it already had availability of pre-defined ChemXML business document standards and an application development kit for implementing the RossettaNet Implementation Framework (RNIF) for Internet-based electronic transport. The WebMethods product set was much more established, but its modular nature and pricing structure was deemed to financially costly for the allocated budget. As such the BizTalk software solution was acquired, a test environment developed and a pilot trading partnership agreed with a mature Elemica and enterprise supplier. The initial pilot process comprised a number of agreed business scenarios for a set product range, delivering into a single distribution point rather than the option for direct customer deliveries as in part two. Initial work comprised developing Baan ERP routines for integrating Purchase Order / Invoice data and, connecting the BizTalk development solution to Elemica's test environment. Whereas the Baan ERP work was completed successful, expertise limitations within the emergent BizTalk product set and the complex technical architecture quickly arose. After a project review, the contracted specialist was released and replaced by an external consultancy firm specialising in BizTalk integration. Whilst this change had wide implications upon cost and time, work was quick to start again and progress re-achieved. Now within the wide industrial landscape, pressure was building from other major suppliers to the enterprise, to plan for subsequent Elemica connectivity and e-marketplace expansion. Despite issues regarding the procurement of suitable and secure digital certificates, internal firewall safety, and investigations to confirm the legality of electronic invoices, testing was



scheduled with a delay of three months. Structured testing was undertaken with the pilot supplier's European Headquarters, working through the range of previously agreed business scenarios. After internal training was delivered, the new application finally went live, four months late and at one and one-half times the budget. Despite the delay and the additional incurred cost, the enterprise was considered to be the first to market within this integration field and had gone a long way to maintaining the future of its established supply chain alliances.

### SUPPLY CHAIN ENABLEMENT

The revised supply chain model was considered to offer a holistic approach with greater speed of execution, reduced administration costs and improved value-added services. From the initial placement of an online order and automatic email confirmation, daily Distribution Requirements Planning (DRP) requirements would generate firm purchase order requirements. Purchase and stock control staff would then release the orders through the Baan ERP, triggering the automatic transfer of appropriately assigned products through the Elemica network. With the service level agreement, defined with the Elemica contract, a confirmation response or changes to delivery date, quantity or price would be returned within eight working hours. Internally to the enterprise, this response would be converted into internal email notifications and distributed to appropriate staff. Once the goods had been despatched, the supplier would transfer ship notice and invoices through Elemica and in turn the enterprise would then make its own available, together with further product information for the customer, within the Internet-based portal (Figure 3).

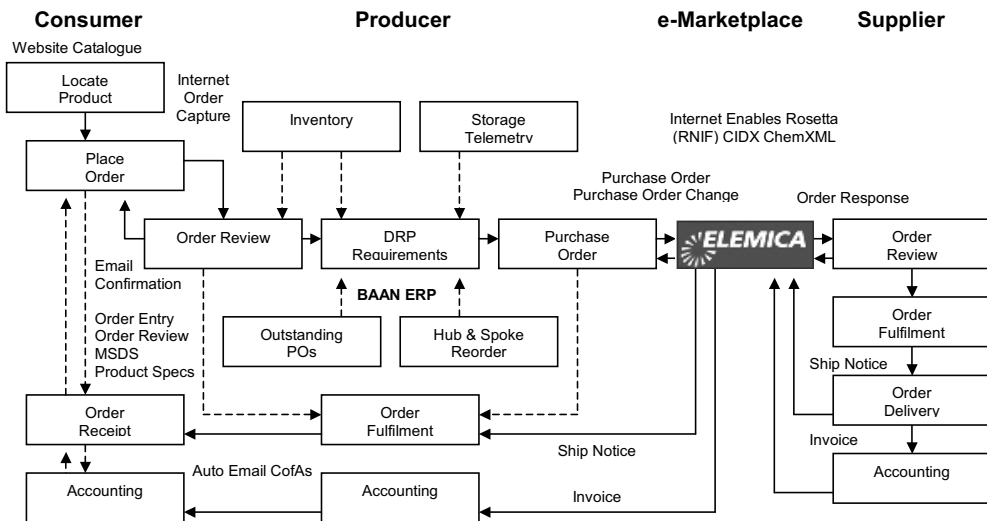


Figure 3: E-Marketplace Solution Architecture Overview

The developed solution had successfully implemented the concept of paperless order processing, while at the same time dramatically reducing the administrative burden for paperwork and error potential. Through automatic invoice reconciliation personnel requirements had been significantly reduced. The whole project had been a significant challenge for the organisation, but it had created a platform for future development and consolidation.

## SUMMARY AND CONCLUSIONS

The case study briefly presented within this paper, highlights a favourable implementation example of how contemporary business requirements were outpacing available supply chain research and software tools. At the time the enterprise had to balance a high degree of supply chain partner pressure with that of technical uncertainty and first-to-market risk. While it is difficult to fully quantify the financials of the project and estimate the cost of undertaking no improvement actions, the real cost of investment per initial transaction may be considered in hard financial terms. Within the first six months of operation, approximately 500 transactions were completed between 200 customers and 2 Elemica connected suppliers. This required an investment of around \$300,000 and \$20,000 operational costs per year for an annual return of \$40,000. Despite the issue of implementing complex, technically uncertain and business critical applications, the enterprise managed to satisfy supply chain partner expectations and acquire many lessons:

- New solution prowess can be achieved, but always at a substantial cost.
- Emergent technology carries a high-degree of inherent risk. Despite vendor claims, not all requirements can be met through new applications software.
- Effective Internet security can be beyond the means of even large international enterprises.
- No system or trading partnership is standard. The second supplier connection had differences.
- Whilst the drive to connectivity was problematic, once achieved it allowed for more equal partnerships to develop and financial gain to be shared.

Today, Elemica has 1,250 connected companies with 10 Million transactions totalling \$30 Billion per annum ([www.elemica.com](http://www.elemica.com)). It is now moved to simpler web connectivity and online Collaborative Planning Forecasting and Replenishment (CPFR) system provision. In summary, enterprises should conform to tactical business imperatives until they can develop their infrastructures to achieve firm business benefit from more strategic efforts. To do so, enterprises should focus upon reviewing strategic priorities, balancing supply chain pressures and addressing any opportunity to radically reduce cost.

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## **RFID ON ITEM LEVEL TAGGING IN SUPPLY CHAIN WITH HIGH-VALUED PRODUCTS**

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### **ABSTRACT**

In this paper we take a look at the use of RFID for tagging high-value objects on item level in Finnish Red Cross Blood Transfusion Service -environment. We consider the possibilities of automatic identification and tracking of blood products from the manufacturing to the end use of the product. In the field of blood banks, donation and transfusions we have divided the beneficiaries in two parts. First of all, some added value for the use of the product can be offered by making the handling at transfusion point more secure. RFID technology may also be a competitive advantage if there are competitors in the market.

Secondly the supply and logistics chains can get more efficient by reducing time and effort required for handling and identifying the products. This is however more challenging of the two possibilities. Therefore we have examined the usability of RFID separately in each parts of the supply chain of blood products. Some additional functions, such as temperature measurement can also be used to control and to ease up the process to keep the correct circumstances and by this way guarantee that every product used has been treated correctly.

The target for this paper is to define the factors that are typical for blood products and have an affect and limitations for RFID technology. We consider both the transportation and warehousing as a part of supply chain but also the point when the product is used and the advantages that it gives.

### **INTRODUCTION**

RFID containing additional read/write memory offers a possibility to store more exact information of the product into the tag and ease the updating of information. Automatic identification of single objects opens up many possibilities for product management through the whole product life-cycle. Not only all the information that is contained in a bar-code or RFID tag needs to deal with the product itself but it can be linked to the events and other products that are somehow connected to it. Actually, because of the security and privacy issues, it is demanded that in most cases the information cannot be stored in an easily accessible tag, but only the unclassified information can be shared for anyone. Confidential information is stored in information systems that have limited access.

Pharmaceutical products are generally considered to be among the most promising applications for RFID-based item level tagging applications because of their high value and counterfeiting [Koh03]. Blood transfusion operates in the same field of healthcare as the pharmaceuticals do. We can expect that RFID

becoming common in the healthcare will also clear the way for blood products. Later on with more mature technologies, common utilization and existing equipments in hospitals that can be used for varying purposes, shared resources for multiple applications may have a chance to work side by side.

RFID technology has already been used also among blood products. Italian hospital in Milan, San Raffaele, has carried out a pilot in association with a few hardware and software suppliers during year 2004. RFID was utilized to check that the correct product ended up to the correct patient. In this case the blood was originally donated by the same patient (autologous transfusion). [Dal05] Same kinds of pilots have also been run in other hospitals, such as in Saarbrücken, Germany [Bes06]. These pilots have been successful, and in Milan the system has been adopted in use. In this case each of the patients had an RFID-wristband that was read before the donation was committed. Later on also some microchip implants could also be used for identifying the patients. VeriChip Corporation already provides this type of a solution.

In this case we take a closer look into the blood supply system and how RFID could be used efficiently as a part in the current systems. Many interesting applications can be and have been implemented but there are also lots of challenges ahead before the implementations can go on to the next stages and all the benefits of RFID can be utilized.

### **RFID-TECHNOLOGY AND RFID IN A SUPPLY CHAIN**

RFID is expected to produce significant benefits for the supply chain in the future. The major benefits include inventory reduction, out-of-stock reduction, and labour reduction. Additional advantages include a reduction in theft and improved warehouse management. This helps to improve visibility into inventory stock levels and improves forecasting accuracy and significantly reduces order cycle times. [Jil05]

Shipments and pallets have been traced using different solutions for some time. Many delivery companies offer the status and some information about the product shipment for their customers through their website. All the shipments are marked with a serial identification number that is sent for the customer after the order has been handled. On different stages of the delivery chain the code is read and the location is updated into the shipment log. User has a chance to track the item and make assumptions of arrival. In other environments exact tracking of items is only used for remarkably high valued products that may be spoiled expeditiously or the need for them is urgent and critical. All these parameters fit perfectly for blood preparations and transfer process.

RFID should never be thought just as a replacement for the bar codes. In many cases where RFID-tagging is considered to replace or to give some added value compared to bar codes, the first step will be using both the methods side by side. Both of them have their own advantages. The RFID applications have to offer some added value, not just work as a replacement, to give some added value.

If RFID is considered as a total replacement for bar codes, RFID is often more usable in extreme environments where it may offer longer life time and better

durability. However, in some cases the information has to be also human readable. Another obstacle might be the reliability of a tag. Therefore currently RFID cannot be used without a backup in many cases.

While using RFID attached into products, numerous variables can be listed that have an effect on the success of reading of one single tag:

- Location of tag in the package
- Tag type
- Number of objects to be read
- Antenna position and direction
- Packaging of the items in the transport case

Each of these parameters has to be evaluated before taking RFID in use.

### **ANALYZING THE USABILITY OF RFID IN FINNISH RED CROSS BLOOD TRANSFUSION SERVICE**

The need and benefits for RFID-based system can be observed from two different perspectives. In the first case blood products would be tagged in manufacturing site and then controlled at the end-use point to verify that the correct product is being used. This is what is currently being piloted and can be considered to give added value for the customers, whether they are hospitals or patients.

Another approach in this case is the supply chain system and inventory management. In addition to automatic identification in warehouses, valuable information and functions of semipassive tags, such as temperature logs, can be gathered during the shipment and warehousing and this information can be accessed to verify the usability of the product. Efficient use of RFID however requires investments into the information systems and equipment and this does not necessarily come for cheap.

Handling of donated blood sets some requirements that have to be considered while looking for the challenges and limitations as well as making plans of implementation. Depending on the final product, these characteristics may include features such as:

- High value. Because of the high value of each tagged product, there is no space for errors that are caused by the failed tagging or marking of the product.
- Liquid or liquid like. Storing liquid like material sets some requirements for packaging. These materials may have an influence for penetration of radio waves and may cause problems.
- Short time of getting perishable. The logistics chain must be effective and there is no time for additional delays. Ready made products should be used in right order to prevent spoilage.
- Special requirements for storage and transportation circumstances. The material has to be stored in certain temperature.
- Critical. Right product has to be in a right place at a right time. There has to be also those products available that are rarely used.
- Demand is random. Inventories have to be large enough or there has to be a possibility to manufacture a right kind of product in a short time.

- Identifiable and traceable. Materials of each product and manufacturing process have to be traceable.

Another interesting aspect is the order cycle times with blood products. According to Karen Spens [Spe98], doctors have been ordering the blood products just in time based on the demand not necessarily considering the well defined needs in near future. This has caused the fact, that products may be shipped into the hospital on each flight. If this can be made more effective in some means, there can be savings in logistics costs.

### THE STRUCTURE OF BLOOD SUPPLY SYSTEM AND USABILITY OF RFID

The supply chain presented in figure 1 can be divided in two major parts. Before the production the blood is un-handled and this phase lasts no more than one day. The second phase is the processed blood. This cycle may last for even more than a year depending on the product type. Because of the different phases and longer lifetime, this phase seems to be more useful for using RFID. But to get more accurate idea how RFID could be put to use we have to take a look at the blood supply system more precisely. [Spe98], [Spe02]

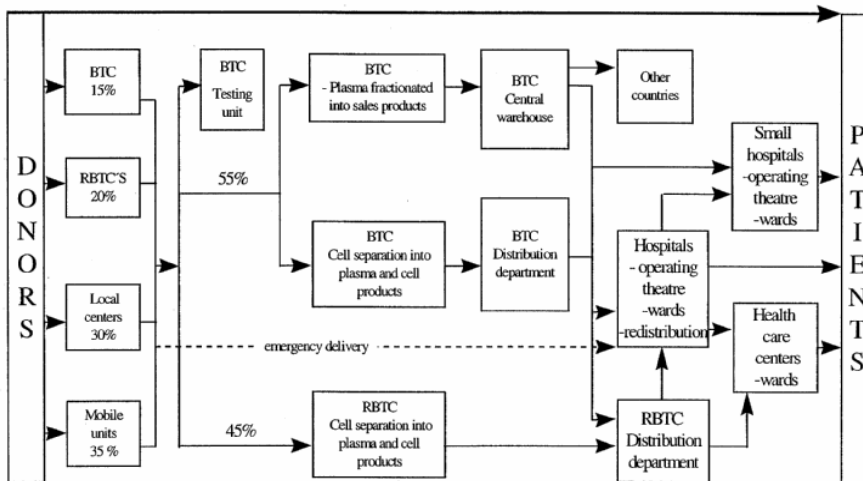


Figure 1: Blood supply system in Finland. [Spe98]

Blood is donated in stationary places or mobile units into disposable bags after donor's personal information has been registered. Already in this phase the bags could be tagged, but since the life cycle is short and anyhow there is a need for manual handling, the targets of applications are rather limited.

Donated blood will be transported into one of the three Regional Blood Transfusion Centres during the following night. Demands have to be considered before making decisions over manufacturing. Different particles of blood are separated of each other and the final products will be manufactured by combining the samples of four different donors. [Häk06] In Transfusion centres bags would be tagged and all the same information as in the label would be stored into the tag memory. Since the information of a single bag may be updated up to six times in this process [Häk06], easy updateability of an RFID tag would be a notable benefit.

From the Transfusion Centres the products are transported to the five Distribution Departments. Information about the inventories is stored in centrally managed information system. Inventories are controlled daily on preparation and blood type -levels. From the Distribution departments products are transferred to the hospitals in deliveries that contain several bags. The boxes are currently included with a follow-up code provided by the transport company. In this phase RFID could be used just like the current bar codes. Identifying of each single object from a delivery box is very challenging. Therefore the information of each particle has to be bound into the transportation. Even though unpacking and re-packing are currently human-made processes, the identification could be made more accurate and rapid by this means.

Larger hospitals have local warehouses of their own for the blood. At the moment Blood Transfusion Service does not have access to the local inventories. These warehouses are also used to distribute the products for the smaller health centres. RFID can be used to make the warehousing and follow-up more efficient with less human work needed. For maintaining the inventories in larger hospitals, RFID offers an effective way for controlling the inventory.

At the hospitals and smaller health centres the most important thing is to verify that the patient gets the correct product. Therefore doctors or laboratory personnel do tests with the patients and donated cross-match [Häk06]. Therefore there is not only a need to check that the blood type is correct but the product is just the one that is meant for the patient. In this point RFID could be very useful as a double-check for controlling and verifying that everything goes as planned. If the patient is also identified with an RFID technology, more safety can be added, decreasing also the stress that nurses live through [Dal05].

Transportation is an other issue in the defined supply chain. Tracking and tracing on item level is one of the benefits that RFID has to offer for the supply chain. This however requires integrated information systems for those points where the controlling is done. The transportation can be done with flights, train, bus, taxi or by mail [Häk06] which all have different factors such as speed, cost and consistency. The requirements for these factors can be influenced by sufficient warehouse and order management.

The other aspect related to transportation is the control of circumstances. Certain products require precise storage circumstances, such as defined temperature. Since blood supply system may include various different transportation companies and vehicles, there has to be a way for controlling the environment variables that have existed during transportations. Currently temperature is controlled with a logger that stores the information in its memory. This information is read while the delivery is received by connecting the logger into a personal computer and checked that the circumstances have been acceptable during the whole transportation. Using RFID would enable this control either for the delivery package as now or even for each single object. Controlling the appropriate heat conditions would happen automatically meanwhile identifying the product without a need for opening the box or couple devices to each others. The collation of temperatures would not have to be used just during the transportation but could also be used to control the whole history from manufacturing until the use of the product. This information can also be

transferred to a centralized server during any of the tag-reading operation (supporting the IT-system interface). Because the information also remains locally stored in a tag, the last control may even be performed at the point-of-use, without a need of connection to the centralized system.

## CONCLUSIONS

Having a great potential of growth, RFID also provides technical challenges for the developers. The immature technology, huge amounts of data being stored in databases and different kinds of software applications will require a lot of work. The right information has to be found efficiently and easily from the end-user's point of view. In most RFID cases it is a fact that in the beginning it is not reasonable to try to utilize the technology in all the possible nodes. Instead, after a research and testing, it is most profitable to all the pay attention to one case. After the technology has been successfully adopted in use, then new solutions and applications can be considered and added to the chain.

Based on the results from researches at the hospitals, RFID seems to give added value for the supplier. Offering new technological services for the customers the supplier may be able to push their own solutions on the markets and tie the customers and by this way protect their market share from the competitors.

Utilization in supply chains is more challenging. Technology is not yet mature enough to guarantee 100% functionality in demanding conditions. Since blood products are already identified uniquely and some additional information is also required to be stored by the legislation, utilization if RFID really has to offer new possibilities to be accepted in use.

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## **MANAGEMENT SUPPORT SYSTEM REALIZING DIRECT SALES OF AGRICULTURAL PRODUCT**

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### **ABSTRACT**

In a farmer's fresh store, farmers organize an agricultural union and manage the store by themselves. We have developed a Management Support System supporting direct sales at the store and we describe the way of farmer's utilizing the system effectively. The System provides the following functions: 1) the information utilization by the farmers and 2) presentation of crops information to increase efficiency of the support and the promotion of the farm management activities. The System makes it possible to reinforce the differentiation and competitiveness of the shop, to provide fresher crops according to the demand, and to expand the business opportunity. Moreover, providing the crop information gives the customers a sense of security to the crops and increases convenience of the store.

**Key Words:** Information system, Inventory Management

### **INTRODUCTION**

In the farmer's fresh store, a farmer sells his crops such as fresh greens, vegetables, fruit and other agricultural foods to final customers directly. At the store, price and kinds of crops to sell are determined by him selves. The store becomes an important distribution channel for non-standardized and less volume crops of their region. Price is often set lower than that of general distribution channel through intermediate suppliers. Therefore, the shop is preferred by small-scale farmers to earn their profit (Ose 2003).

Recently, the number of such stores has been increased and, therefore, farmers have to compete with not only the traditional distribution channel but also other farmers' fresh stores (Kidachi 2003). Furthermore, type and amount of crops to be cultivated are determined on their experience and intuition. As farmers are working at their farming place, they can't go frequently to the shop to see the inventory adjusting to appropriate amount. Stock shortage or excess stocks are often observed in the stores and this causes the reduction of not only farmers' profit but also quality standard of the whole farmers' store. Therefore, certain solution for inventory management focusing on safety and freshness of the products, which are based on information for the customer demands, has to be considered (MAFF 2005).

The purpose of this paper is to propose an ICT solution to overcome the problems

of the farmer's stores. We construct the farmer's business model form shipping management process in a medium-size store. We develop a management support system including following features: "inquiries of product inventory/sale status", "E-mail notification of the inventory/the sales", "Arrival notice to customers" and "cultivation record".

In this paper, we summarize current situation and the problems at farmer's fresh store in chapter 2. Proposing management system is presented in chapter 3. Chapter 4 shows the implemented information system. Finally, we give conclusion in Chapter 5.

### **PRODUCT SUPPLY IN FARMER'S FRESH STORE**

We define a product in farmer's fresh store as a packed crop to be sold. Farmers rent certain areas on the shelves and sell their products to the customers. Fig.1 shows traditional method of replenishing products in the store. Before opening the store, a farmer estimates quantity of his products to be demanded and delivers them. He prices his products on his shelf as stock for selling. Customers come to the store and purchase them. After several hours later, farmers go to the store again and check the amount of stock. If little inventory occurs, he returns to get additional crops from his farming field, and replenishes the store with them. If certain product exceeds consumption date, farmers have to collect them for disposal. However, it is difficult for them to check inventory as often as it should be as they spend most of their working time at the farming field.

We propose a revised business model for shipping management process at the farmer's fresh store. In the model, Point of Sales, refereed to POS registers, are utilized not only to summarize total sales of the day but also to get inventory control of products at the shelves. We have prepared a server in the store. The server manages sale status, inventory and cultivating record of each product. Fig.2 shows this procedure. At present, the computing of the sales is by the batch processing.

- (1) A farmer cultivates his crop at the farming place and issues cultivating records including used chemicals.
- (2) The farmer estimates quantity to be demanded based on the sales result sorted in the server and delivers products. Amount of the supplied products is recorded in the server when price tag is issued.
- (3) Amount of the products is observed through POS register. If a product is sold, then the number of theoretical stock in the server is reduced.
- (4) The farmer can inquire current sales status as if he is in the farming place.
- (5) When the crops exceed a storefront exposure deadline, the server sends a message to the farmer for disposal.
- (6) If inventory is reaching to a reorder point which farmer sets in advance, the server

sends E-mail to the farmer.

(7) If the farmer receives shipment order, he collects crops from his farming field and replenishes them on the shelf of the store.

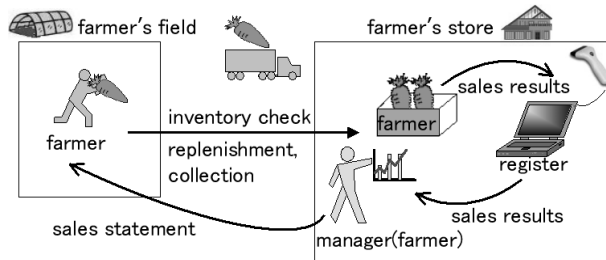


Fig.1 Shipping process currently

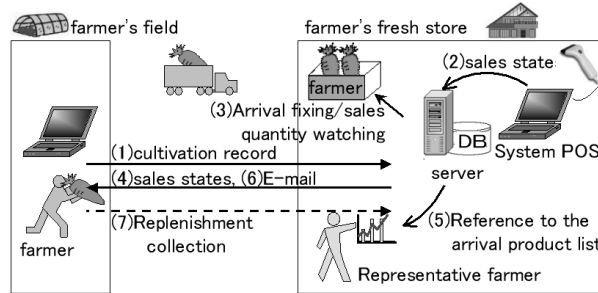


Fig.2 Shipping management process

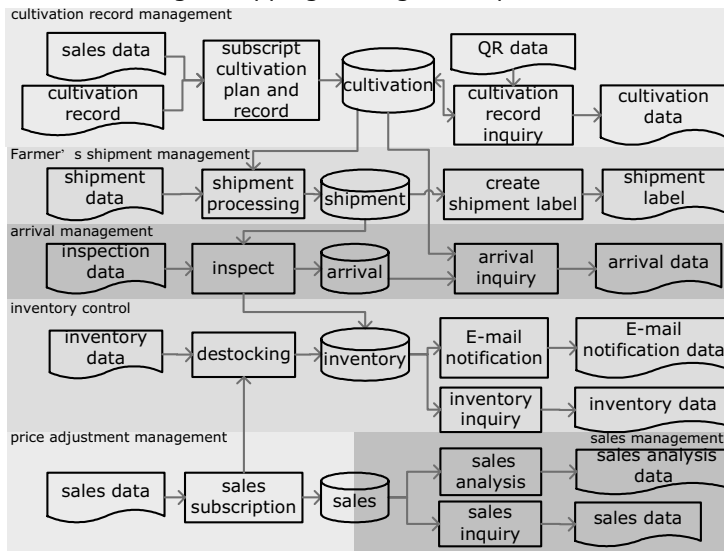


Fig.3 The relation of process and information

**MANAGEMENT SUPPORT SYSTEM**

The System consists of following six functions: cultivation record management, farmer's shipment management, arrival management, inventory control, price adjustment management and sales management (Fig.3).

"Cultivation record management" manages information on productions, farming fields, the diary of the cultivation, cultivation planning and information inquiry. "Farmer's shipment management" creates a product label with the two dimensions bar code. On the Web page, the code provide the product information which contains cultivation record. The code on the label is also used to see records from the terminal of the information on the inside of store and the cell phone. "Arrived product management" inspects the quantity arrived product on the store. It is used to see the product information in the store. "Inventory control" receives the inventory inquiry to respond: notification of the storefront products status, notification of the storefront total stock and delivery order by E-mail. "Price adjustment management" is used for accounting with POS register. "Sales management" calculates the number of sales and individual proceeds. According to the sales statement, this function analyzes and reports the purchase record analysis, the sale ranking tabulation, the creating of the sale transition table, the creating of the inventory transition table, the creating of the sale in measurement table and the product sales.

### **IMPLEMENTED MANAGEMENT SUPPORT SYSTEM**

The development environment of the system is shown in Table 1, and system requirements are shown in Fig.5. We prepare a server which provides three functions: an application server, a database server and a mail server. We also use client computer, a bar code scanner, a product label printer and a cell phone. With this setup, we construct the prototype of the management support system.

We checked on a certain Windows client computer and the cell phone. We used Internet explorer 6.0 to test Web application. The following is the example of the operation test. Fig.6 shows an example of sales information on the cell phone display. We verify we can see current status, status of sales products, the arrival date and etc. in the shop through the cell phone. Fig.7 shows us receiving messages from the system. Fig.8 is the screen capture of information of the products on the shelf. Farmer's name, cultivation way and shipped-date of product are shown on a terminal.

Table 1 Specification of the prototype system

Server	type	IBM XSERIES_206
	CPU	Intel Pentium 4 CPU 3.00GHz
	OS	Windows2003 Server
	DB	MS SQL Server
	Software	ASP.net .NET framework
Client	type	EPSON DIRECT Endeavor

	CPU	Intel Celeron 2.00GHz
	OS	Windows XP
	DB	ACCESS2000 POS system
Scanner	type	2 dimensions bar code scanner GT10Q-SU
Printer	type	EPSON TM-L90 Label
Cell Phone	type	Vodafone802N by NEC

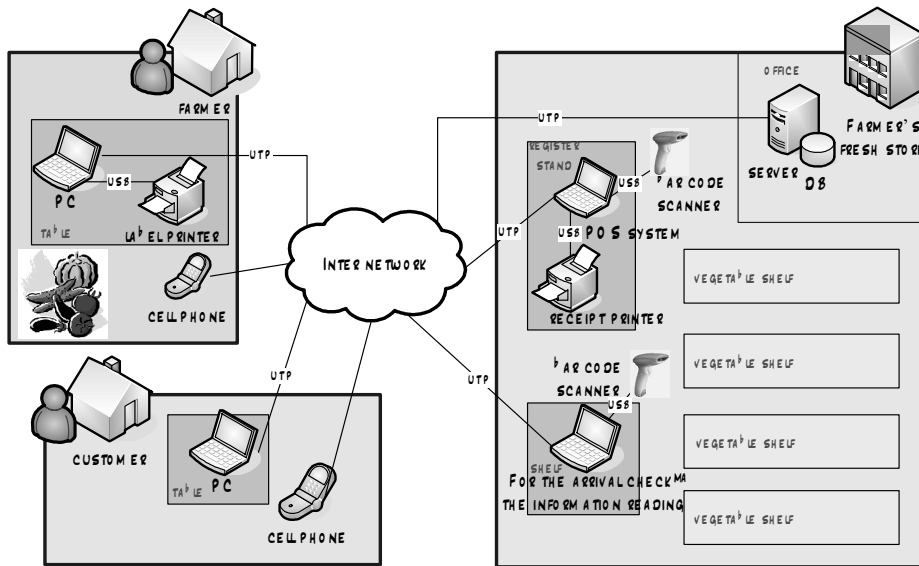


Fig.5 Setup of Prototype system

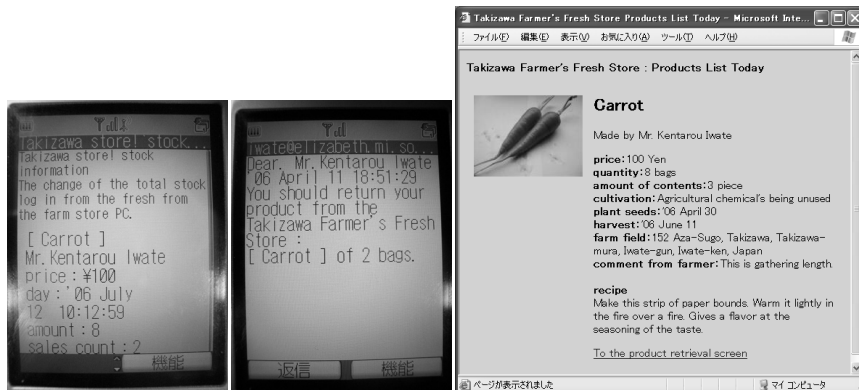


Fig.6 sale status Fig7. E-mail Fig.8 products information

**CONCLUSION**

In this paper, we have developed a management support system for farmer's fresh store. With the system, farmers can grasp current sales status and they can replenish

their product to the store appropriate inventory level. Customers can refer the cultivation record which improves product's quality. These functions provide advantage of the store to another stores.

A part of the system is experimentally introduced a farmer's fresh store for evaluation. We are going to introduce remained function to the store to complete the system. We also evaluate the system according to the actual records. Using the cultivate record of the farmer, we attempt efforts to the management improvement including the reconsideration between cultivation planning and the production activities.

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## **ENABLING COLLABORATION IN GLOBAL SUPPLY CHAINS THROUGH SERVICE ORIENTED ARCHITECTURE (SOA)**

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### **ABSTRACT**

Agility, responsiveness, and flexibility are what business users need from their supply chains today. With companies going global, supply chains are transforming from a traditional linear model to a complex networked one. There is an increased dependency on external partners leading to need of strong business collaboration.

Companies are adopting Service Oriented Architecture (SOA) (Fig1) for their IT infrastructure design to overcome integration complexity and achieve business flexibility at a less cost. The immediate benefit of SAO is to significantly reduce the cost and complexity of application integration, which can be as high as 40% of a company's typical IT budget. Aberdeen's survey shows that 63% of all the responding companies have SOA projects underway, while almost 80% of large companies (revenues more than \$1 billion) do<sup>1</sup>. SOA allows to leverage (re-use) the existing IT investments and existing applications available within the supply chain partners. It allows companies achieve effective collaboration by encapsulating the integration challenges of diverse set of supply chain applications, which are built over different technologies, platforms and data structures. In our article we endeavor to provide an overview of SOA (without being too technical) and then explore utility of this architecture in the context of business collaboration.

### **WHAT IS SERVICE ORIENTED ARCHITECTURE (SOA)**

Service-oriented architecture is a design philosophy for IT architecture. It evolved from distributed computing and object-oriented programming. It is based on 'request-reply' principle of application interaction. The basic premise of this architecture is that functionalities of applications are encapsulated and exposed as services within strict specification of standards. These service interfaces (application's functionalities) can be utilized from another application independent of the underlying technology implementation. So an application developer or system integrator can develop a 'composite application', which is aligned with company's business imperatives to achieve competitive advantage. This 'composite application' can connect to required functionalities (exposed as services) that are available in diverse set of applications and are distributed over the enterprise or even with suppliers or customers or any other players (like 3PL providers, transporters, agents etc.). These diverse set of applications can be in different platforms, different operating systems or may be written in different software languages. SOA makes it possible to create shared information infrastructure for serving multiple players in the supply chain. SOA thus allows companies to create collaborative environment in their supply chain and allows applications to access data from a heterogeneous infrastructure in real time. For example, a manufacturer can make its MES (manufacturing execution system) and planning systems available direct to the order management system of their suppliers. This allows these two systems to share/integrate data in real time without manual hands off. As a result the relationship between enterprise

partners can be transformed and responsiveness of supply chain can be improved dramatically. As these application connections made in SOA architecture are loosely coupled, it is easily possible to change or add business services within the application landscape of a supply chain. Thus business achieves agility and any future changes in process are easy to implement.

### **IT SYSTEM CHALLENGES FOR SUPPLY CHAIN COLLABORATION**

The supply chain IT infrastructure is disparate with multiple players (suppliers, OEM, distributors, customers, logistics providers etc.) having different application infrastructure. The landscape has various software platforms that do not integrate with each other in a simple way and multiple standards among themselves makes things worse. But business demands high responsiveness in operation, glass-pipe visibility in supply chain and seamless co-ordination among value-chain partners. On one side, customer demands access options through multiple channels (store, web, PDA, call centre) and get seamless experience across all these channels. On the other side suppliers need demand visibility, alerts on manufacturing changes, information sharing and design collaboration platform.

The situation is further aggravated as there is more M&A activity in the industry and companies get into a complex web of supply chains. Overall, the entire supply chain length and breadth is continuously increasing. Managing it without an effective IT system is unthinkable. Companies have been, therefore, investing heavily in deploying robust IT systems to suit its business needs. This has led to a plethora of applications and services running within the company that might be different from the ones being used by its supply chain partners. In fact, companies use either heavily customized or internally built software that allows them to offer differentiated services.

As businesses grow exponentially, it becomes critical to provide complete transparency into the full range of activities across the business process. The business undergoes changes on a continual basis. Every time there is a change in business process, the changes in technology supporting it would call for heavy investment in terms of time, cost and effort. Companies also face integration issues due to multiple platforms and applications available within its enterprise supply chain. In a survey done by Aberdeen group, 75% of companies mentioned that their legacy supply chain software limited the amount of services that can be offered to customers<sup>1</sup>. More than 60% of companies with annual revenues of more than \$1 billion have or are in the process of standardizing on common platforms for supply chain management<sup>1</sup>.

Companies are realizing now, that with growing business complexities, they need flexibility in IT systems that business changes can be embrace business changes easily. Supply Chain managers understand that the need of the hour is create an IT infrastructure that can be flexibly aligned to business changes of today and future so that they can implement their business decisions and process changes much faster and easier. The questions making rounds in the minds of Supply Chain managers and IT managers are –

- How do we get better control over the processes and their changes?
- How do we create support systems for new, agile business processes?



- How can we increase re-usability of application's functionalities?
- How do we enable of one common view of data and information for users within all parts of enterprise and outside partners?
- How do we minimize hands-off in data and integrate applications within enterprise and with supply chain partners?
- How do we realize collaboration in such a disparate supply chain?

### HOW SOA ENABLES COLLABORATION IN SUPPLY CHAIN

SOA enables companies to overcome these challenges confronted by business managers due to disparate IT landscape in the supply chain. It allows to leverage (re-use) the existing IT investments and existing applications available within the supply chain. The legacy applications can be linked through SOA with another legacy or new generation applications so that business requirements of data availability from different supply chain entities can be resolved.

SOA allows designing the IT architecture in a networked supply chain in a way that permits to break up functionalities available in diverse applications into small granular components. These components can then provide required business services or allows implementation of in-built business rules across different part of supply chain as and when required. SOA allows abstracting the underlying technology so that the integration efforts are focussed on business imperatives and not on solving technology complexities. These components are orchestrated (connected) by a workflow management tool.

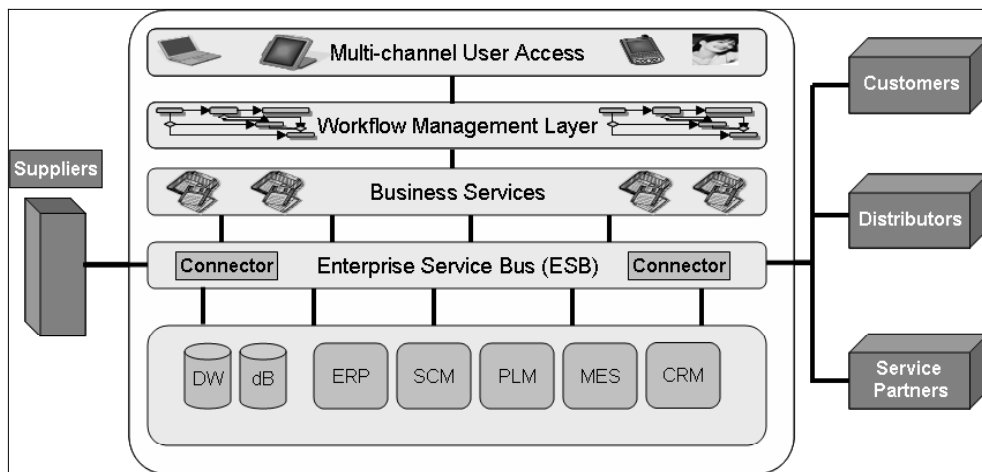


Fig:1 Supply Chain Collaboration through Service Oriented Architecture

### BUSINESS BENEFITS OF SOA FOR SUPPLY CHAIN COLLABORATION

The design approach of SOA allows multiple benefits to supply chain players. Going elaborate on them is beyond the scope of this article. Those benefits summarily includes the following but not limited to –

- Companies in the supply chain network easily collaborate on real time through an integrated and automated workflow.
- Business processes within and outside enterprises that needs integration and data sharing from remote applications can be managed easily.

- If there is a need for new business processes due to changes in market requirement, new components implementing the new business rule can be developed. The new component's services are then exposed to relevant applications through the workflow management tool. So time-to-market for IT change can be greatly reduced for companies to adapt to market changes.
- If there is a change in existing business process, the workflow can be modified suitably providing agility in the supply chain.
- Supply Chain intelligence can be achieved through integration of systems that allows better decision support and collaboration framework.
- Developments of exception event management framework, which can enhance responsiveness in the entire supply chain, there by, improve customer experience.

## **CONCLUSION**

Service Oriented Architecture results in changing the way business partners manage application portfolios for seamless collaboration across supply chain. It represents the next breakthrough in software design methodology with much faster and cheaper integration. SOA allows flexible business processes that are needed for a networked value chain and supports structural changes happening in the market place. However, SOA philosophy like all other design approaches has its specific requirement and this is not magic wand. Companies, therefore, should understand their current systems and application landscape before deciding to go SOA way. Then they should consider creating an infrastructure that supports SOA and exploit its potential to the maximum possible extent.

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**"easyRFID"**  
**PLANNING OF RFID SYSTEMS BY MEANS OF INTERNET-BASED  
PLANNING SYSTEMS**

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**ABSTRACT**

"easyRFID" is a cooperative research project of the Professorship of Factory Planning and Factory Operation of the Technical University of Chemnitz and the SIGMA Chemnitz GmbH. The research project will be supported through the European Union's EFRE-funds and the Free State of Saxony. The project's objective is the development of a planning software for the projection of RFID systems. An intelligent tool will be developed, which lowers the planning time and will be especially useful for small and medium-sized companies due to facilitating their entrance into the seminal technology "RFID".

**INTRODUCTION**

The four letters RFID and the technology associated with it have been an issue in the field of logistics as well as other economic sectors for several years. In general this stands for the identification and tracing of objects by means of radio-tags, so called transponders. The realtime detection of these objects helps to connect the virtual world of data to the real world of goods. The reasons and motivation for the rollout of this technology are wide-ranging. Not only the need for a higher efficiency of logistics processes and production controlling but also the suppliers or rather the costumers put necessary pressure on many enterprises to create an own RFID-competence. The reaction of particularly small and medium sized enterprises to these requirements will be exceedingly decisive for their competitiveness.

**INITIAL SITUATION**

The enormous variety of publications and predictions about the state of development and the benefits of the technology can easily cause confusion. Explanations about the technology, functional principles and particularly the so called „Best Cases“ are waiting for inquisitive clients. Especially during the first planning steps, at the stage of little knowledge of the technology, this variety overburdens the user. Even if the provided information is well-structured, it takes a lot of time to effectively integrate this knowledge into the planning. But time is often a relevant factor for the success of integration projects.

Choosing a suitable RFID-system is a very complex problem. Main questions to be answered are:

1. Which objectives can be pursued with RFID and which application scenarios are promising?

As illustrated in the introductory description of the research project, a lot of textual support exists regarding the issue of RFID or, more precisely, the planning of RFID applications. To adjust existing deficits in the business processes of the enterprise with the possibilities of the RFID-technology, a scenario is to be developed which is oriented towards problem solving but also economically feasi-

ble. This task requires both profound knowledge of the business processes as well as extensive know-how of the potentials of the RFID. The knowledge about the internal processes of the company is provided by the company itself. The solution approaches, which can be realised with RFID, will soon be available for research through a branch-specific application database at [www.easy-rfid.de](http://www.easy-rfid.de).

## 2. Which requirements does an application scenario put on an RFID-system?

If the implementation of an RFID-project is planned, the technical realisation has to be checked within a short time framework. The purpose is to choose an RFID-system that meets all requirements of the target-application and has the required functionality. These requirements can be:

- minimum or maximum distances of the operation range between the RFID-tag and the reading/ writing unit
- memory requirements
- data transfer rate
- structural shape and application surface
- influence of disturbance variables etc.

These and other requirements are important input variables for the planning of an RFID-system. They have to be identified and considered for the target-application in the course of choosing a system.

## 3. How do these requirements affect the technical data of an RFID-system?

With the number of input variables raises the complexity of the decision making process. However, not only the amount of input variables is decisive but also the interrelations among the variables. Some of these variables have a direct others have an indirect influence (in combination with another variable) on the technical data of the system. In turn, these technical data can not be combined freely since the existence of one variable can require or prevent the existence of another. The quality of the decision making process depends significantly on the correct consideration of the input variables. Failures during this step can possibly cause extensive modulations of the production and logistics processes for which the RFID-system is planned for.

## 4. Which RFID-system meets the requirements?

After the variables are identified and considered properly, requirement specifications, or rather a catalogue of technical requirement regarding the RFID-system, is created.

Afterwards, a likewise time-consuming investigation into the current market situation as well as a search for RFID-providers follows. The providers' product portfolios have to be searched through for products that meet the technical requirements.

## 5. Which data have to be analysed and how?

An RFID-system improves the acquisition of information. The additional information shall help to control, regulate and automatise processes. Therefore, the information deficit has to be recognized and a solution has to be found before an

RFID-project starts. The solution should include both the data storage as well as the analysis scenarios for your operational information systems.

6. How are the data generated by the RFID-system to be filtered and aggregated with regard to the target of the analysis?

RFID-tags are not „smart“; only under certain conditions, they provide information that were saved on them previously. This information usually consists of numbers (EPC, UIN) but they can also include process-state data or any other requested information. To optimise the data traffic in your backend systems, it is useful to aggregate data packets into suitable events or alarms.

7. Which interfaces are relevant with the enterprise-IT?

To transfer the information into data, interfaces and mechanisms have to be defined, via which way the operational information systems (ERP, PPS, MIS, etc.) receive the data of the RFID-system. Special attention has to be paid to this task because the value pursued by this project has to be made apparent at this point.

### **METHODICAL APPROACH**

At the beginning of the project four main focuses have been identified.

1. Adaptation of established planning methodologies for the use of RFID-system-planning

In general, a range of several approaches exists for planning projects. The Systems Engineering procedure [1] model is deemed to be established for assignments of tasks in the field of system planning. The application of the underlying phase conception for the planning of RFID-systems has proved to be functional.

2. Identification of important planning topics of the RFID project planning

A further focal point consisted of the identification of which planning topics are necessary to RFID-system-planning for the requirement of an integrative approach. Seven main topics could be found, which had to be created with the help of the developed planning methodology.

- definition of the goal
- hardware determination
- RFID data integration
- cost-benefit analysis
- data security
- safety at work
- simulation

Within the research project "easyRFID" the planning topics hardware selection and RFID data integration are focussed.

3. Identification of all parameters of the planning topics as input variables into the planning process

The basis of the adaptation of focus 3 consists of a substantial search for the parameters on a technical operating RFID system. The initially formulated central issues two to seven are to be answered in this project phase.

#### 4. Development of the planning tool

For the chosen planning topics, the final task of the project is to develop a question catalogue, its processing logic on basis of the parameters, and an Internet portal for utilization.

#### **BENEFIT OF THE PLANNING TOOL**

The use of the planning tool resolves the described complexity of the decision-making process into questions about the use case that can be easily answered by the planner. In this way, all necessary input variables are registered into the planning and transferred into a recommendation. With this, the quality of the decision-making process reduces the extra time of the system integration. Thus, excluded restrictions that arise from the application case could possibly lead to complex modulations of the production and logistics processes for which the RFID is planned. The user can save a considerable amount of planning time, which directly influences the pilot or rather the project costs.

#### **THE PLANNING TOOL "easyRFID"**

The planning tool itself consists of two modules. Module 1 is concerned with the system selection. At this, all needed hardware components of the system are identified. Module 2 plans the integration of the RFID data in the operational information systems (OIS), such as ERP-, PPS-, or PLM systems. The division of this task is illustrated in the following figure.

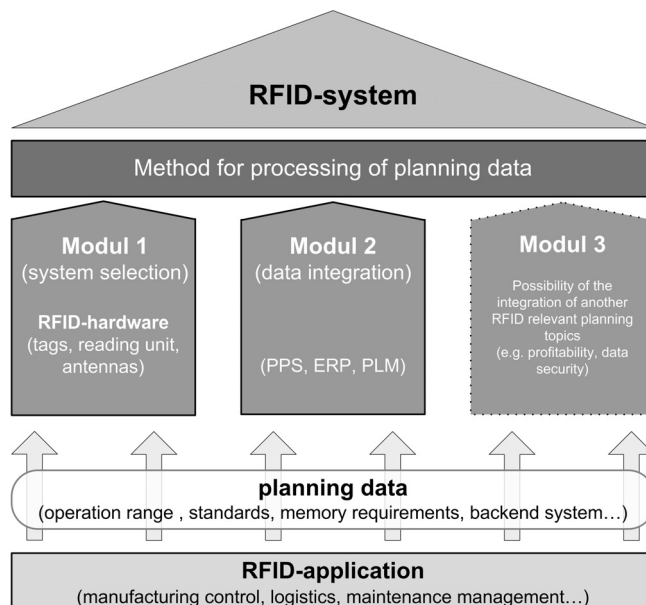


figure 1: The easyRFID structure

The Module 1 gives the planner a fast and dependable instruction of an RFID-application about which RFID-system is adequate for the application. The base of this operating mode is an extensive research and systematization of the input variables into the planning of an RFID-system. The planning method which derived from it as well as a questionnaire ensure that during the planning process all relevant variables are considered in regard to the decision making process. The application-specific data are entered by the planner in form of different request scenarios and are processed by the program. At the end of the planning cycle, the saved data are displayed in form of requirement specifications for the RFID-system. These requirement specifications already reduce the number of applicable systems to a great extent, which facilitates choosing the system. In a further step, the technical data that are required for the application are compared to the datasets of an RFID-product database. Depending on the extent of consistency, concrete recommendations can now be made for the use of an RFID-system.

Analogue to Module 1, in Module 2 a questionnaire is developed which considers all influences on the processing of the RFID-data. At the end of the planning cycle, an instruction is given which provides information about the necessary software and hardware modifications of the enterprise IT. At this, the main focus is on the transfer of the RFID-data to an ERP-system as well as on the implementation of the RFID-data into the ERP-modules. For this purpose, our network partner SIGMA Chemnitz GmbH is developing a universal connector which combines the data flows of different RFID-systems and makes them available to the ERP-systems. In the research project the exemplary realisation of this operating mode is carried out for the ERP-system INFOR ERP LN.

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## **INTEGRATION OF LEAN ENTERPRISE AND ERP IMPLEMENTATION**

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### **ABSTRACT**

Lean thinking extols the virtues of responsive pull based production, whilst enterprise resource planning works to build a push based forecast; much of the academic literature suggests a conflict (Bartholomew, 1999). However, in an extended supply chain, there is clearly a need for Enterprise Resource Planning in the broadest sense, and IT tools and techniques in a more narrow sense, alongside Lean and responsive supply chain design. This paper argues that the key barrier to successful use of information technology in supporting a lean system is the integration of process insight with IT expertise. In approaching any business need, the IT manager of a business will look at the problems posed by an IT legacy system, and a lean improvement team from the process legacy they have inherited; however, both perspectives are agreed that business need is not best served by the current state, whether due to IT systems legacy, or process legacy or both. This paper examines the issues involved in changing IT to support a lean enterprise, and how managers from both the process side and technology sides of the enterprise can collaborate to design better solutions.

### **INTRODUCTION: USING ERP IN A LEAN ENTERPRISE**

There has been a long standing conflict between the use of IT systems and lean manufacturing and many cite ERP and its predecessor, MRP, as an obstacle to lean manufacturing. The term Enterprise Resource Planning was coined by Gartner Group in the early 1990s to describe emerging IT systems that were capable of "managing a company's resources" (Stephens and Ramos, 2002). The criticisms of early ERP systems from a lean perspective centred upon five main problems:

1. Whilst they offered the possibility of integrating once disparate systems and databases, ERP were limited to integrating the internal functions of an enterprise; finance, order management, human resources, database management, scheduling and capacity planning. This meant that they managed the flow of information only within an organisation, and therefore information was not shared effectively with business partners, suppliers and customers (Taking the Pulse of ERP, 2001).

However, the trend is inexorably to cheap web based inter-enterprise integration of information flows, with levels of access granted to users outside the corporate 'walls'.

2. Lean thinking extols the virtues of responsive pull based production, whilst enterprise resource planning works to build a push based forecast (Bartholomew, 1999). This is the key criticism of the use of IT systems from a lean perspective. In traditional resource planning systems, orders, inventory, forecasts and production plans determine activity in production execution. In a lean enterprise, the flow of product determines the execution and event management, with simple management techniques such as use of takt time and kanban. In fact,



the problems created here leads Bartholomew to state "To do both ERP and lean jeopardizes the success rate of either".

Planning and Execution Item	ERP	Lean
Process Focus	• Planning and Execution Control	• Continuous Improvement and Flow
Production Volume	• Sales Forecasts	• Customer Demand (Pull)
Execution Tracking	• Transaction and data intensive • Focus on tracking all material movements and process operations	• Simply visual cues • Focus on maintaining flow • Action Oriented
Implementation	• Top-down	• Bottom-up

Figure 1: A traditional comparison of Planning and Execution Schemes between ERP and Lean (Bartholomew, 1999).

3. ERP systems ran on a closed architecture which was hard to adapt to changes in business process. The result was that the IT system determined business process rather than the other way round. This lack of flexibility was inherent because ERP installation tends to want to fix sub-processes into rather than stimulate process improvements.

4. ERP systems tended to encourage silo thinking in processes, with delays for intervention in order handling, production planning. Despite the possibility of a clear flow of information, data tended to be kept within organisational boundaries. Overnight batching of information exacerbates this problem.

5. Quality of information was a major concern, as the information management and databases often contained out of date information that did not reconcile with real time changes.

However, many of these criticisms have been addressed by subsequent generations of ERP systems. Furthermore, in an extended supply chain, there is clearly a need for Enterprise Resource Planning in the broadest sense, and IT tools and techniques in a more narrow sense, alongside Lean and responsive supply chain design. And in the most practical sense, most businesses will employ some form of enterprise wide architecture. The more open minded view is that advanced planning systems can support a lean exercise "so long as they support rather than direct the structure of a lean system" (Liker, 1999). In recent years, systems developers such as Oracle and Peoplesoft have responded to conflicts within earlier ERP systems and lean thinking by developing new ERP tools for 'flow manufacturing' (Bradford, Mayfield, Toney, 2001). Furthermore, if ERP is redefined as *flow* of information, then there is no conflict with the basic principles of lean thinking, and modern enterprise wide systems are intended to be designed to be adaptive, flexible, and scalable; indeed, through instantaneous and selective sharing of information, the various bottlenecks and buffers in an

extended supply chain can be synchronised to real demand, for example to allow a new vehicle supply chain to respond and flow to build to order demand (Waller, Howard, Graves and Williams, 2002).

However, research into build to order manufacturing has demonstrated that information flows are largely invisible relative to the physical process, but often make up the bulk of delays and problems within a system (Holweg and Pil, 2002). In fact, current ERP systems are not as integrated as they might be from a responsiveness perspective; sales and marketing demand management decisions and supply decisions could be better integrated to allow a single market response (Waller, 2004). This paper argues that the key barrier to successful use of information technology in supporting a lean system is the integration of process insight with IT expertise.

### OVERCOMING LEGACY

Lean thinking and IT systems management share a key obstacle in the path to improvement, and that is legacy systems. A large enterprise, such as a car manufacturer, often contends with five or more generations of systems. Many of these systems were designed and implemented in isolation of others systems, as they were designed to automate existing management processes, such as order collection to an order bank, rather than be part of an integrated enterprise system. However this legacy of IT architecture is no different to any other capital constraints that the business must accommodate in the short to medium term, such as the built factory space. Living with certain legacy issues is part of all change management, and rarely does a company get the chance to start with complete freedom of process or business design.

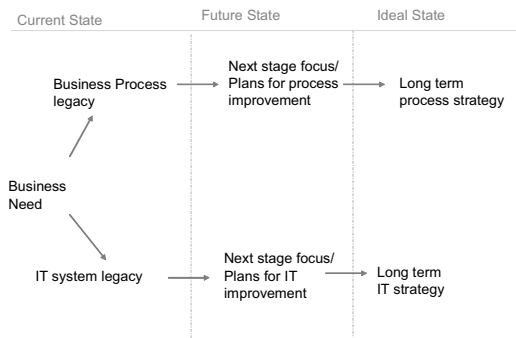


Figure 2: Implementing future states

In approaching any business need, the IT manager of a business will look at the problems posed by an IT legacy system, and a lean improvement team from the process legacy they have inherited; however, both perspectives are agreed that business need is not best served by the current state, whether due to IT systems legacy, or process legacy or both. Each IT improvement director and lean programme director will have a long term strategy for their systems, and the more open minded of both backgrounds will see the benefits provided by consultation to involve the other party.

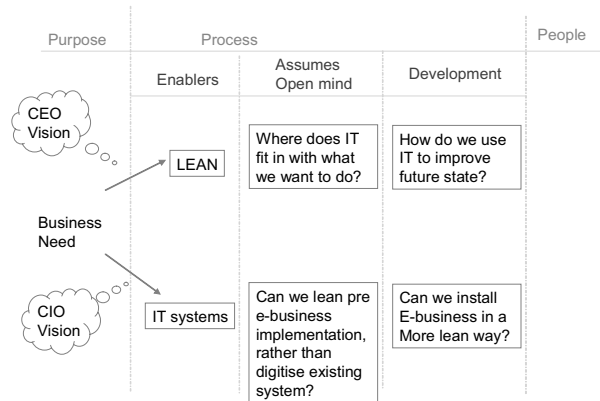


Figure 3: Combining IT and Lean change

What is required is a strategy for implementing both lean process change and IT change in an integrated way, which means an integrated road map as shown below. Leading edge enterprises do not operate in functional silos. The research involved examining the approach to lean improvement in three large corporations. For example, at GE Oil and Gas, one company visited to examine approaches to lean and IT implementation, the management no longer talk of IT projects, but instead all projects involving business change are “Process Improvement projects”. Equally, projects are not run by functions but by process based teams, as the organisation focus is upon process not functions.

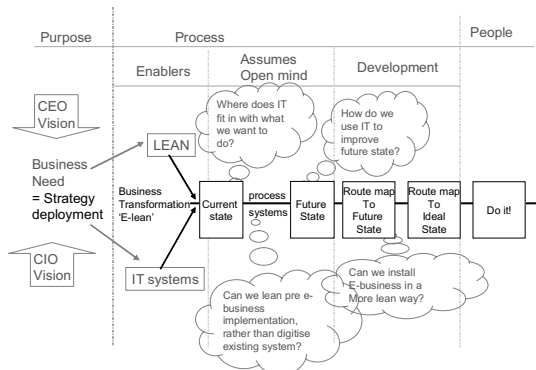


Figure 4: E-lean transformation

**INTEGRATING I.T. AND LEAN PROCESS CHANGE**

As such, at one company visited, value stream process leaders interact with more than one function. The role of lean leaders or champions within the IT function is to sell and manage project implementation internally, and coordinate the initiation of “Action work out events”. These events drive change strategy, rather than any IT driven agenda. These workshops are intended to initiate change projects, which will involve a holistic approach to process and IT systems

change. These workshops are designed to produce a series of process improvement projects, which are subsequently prioritised and project teams established. Any change which touches upon IT in any way, both currently or potentially, will necessitate an IT representative on the project team. This integrated team approach encourages process redesign, where the role of IT functionality is questioned, along with any assumptions behind the current process. The role of IT is critical here, in both highlighting possibilities and constraints. Once a new process has been designed, the IT will be delivered according to that new process design, and the IT department at this company have a defined change management to improve the quality of IT implementation. IT change is embedded throughout any process redesign;

- Unit testing (tests for the effective working of each IT program)
- System Integration Testing (testing of the interfaces between different components of the system)
- User Acceptance testing (test of functionality compared to the functional specifications).

The interviews with IT and lean change personnel identified common pitfalls to be avoided in IT and lean process change. Unsurprisingly, the main issues are cultural rather than technical;

The possible errors made in connection with changes are essentially connected with people:

- Communication to all parties which may be affected by any process change;
- Training of all the IT users (which is a perpetual project, best aided by training "super-users", which new users of the system can approach for advice);
- Resistance to change which results in 'passive resistance to the change process launch and the potential issues connected with the new system.
- Greediness of project teams. There is a temptation to engage in too many changes in one go, and every change plan must consider the impact upon processes, operating systems, and most importantly, people.

Key to continuous improvement is the use of tools and techniques to evaluate the efficiency and effectiveness of current processes and systems. A key output of this action research was to develop tools to assist a lean enterprise undertaken a process redesign that involved both IT systems change and process improvement.

### **DESIGNING A PROCESS CHANGE TOOL THAT INCORPORATES IT AND PROCESS CHANGE**

The research involved adapting big picture mapping and four field mapping approaches (Rother and Shook, 1998; Dimancescu, Hines, and Rich, 1997), to provide a starting point for integrating long term project plans for IT upgrades and lean improvement. By doing so demonstrates the need to involve not only all the stakeholders in the management of the process, but also those that understand the micro-level technical interaction of information flows and storage. By integrating the project management we also aim to remove sub-optimisation of processes and systems, and minimise disruption in business change. A key weakness identified in traditional approaches to value stream mapping is the focus upon physical process flow; this underestimates the impact of tackling information flow, whether due transmitted via IT systems or other media. As noted earlier, time after time information flow is cited as a major cause of process delay. For example, the 80% of the lead time for building a car to

customer order is actually taken up with order processing (3DayCar Summary report, 2003). In order to address this, both big picture value stream maps and four field maps were adapted to capture the flow of information in detail, in addition to the overall process. The tool which involved the integration of IT systems mapping with four field mapping is shown in appendix one, and a close up with detail is shown below. The follow on to this paper will detail the use of this tool as a case study.

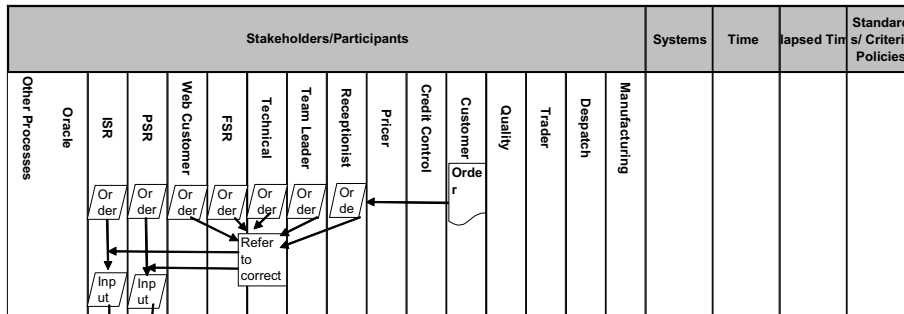


Figure 5: Integrating systems maps with four field process mapping

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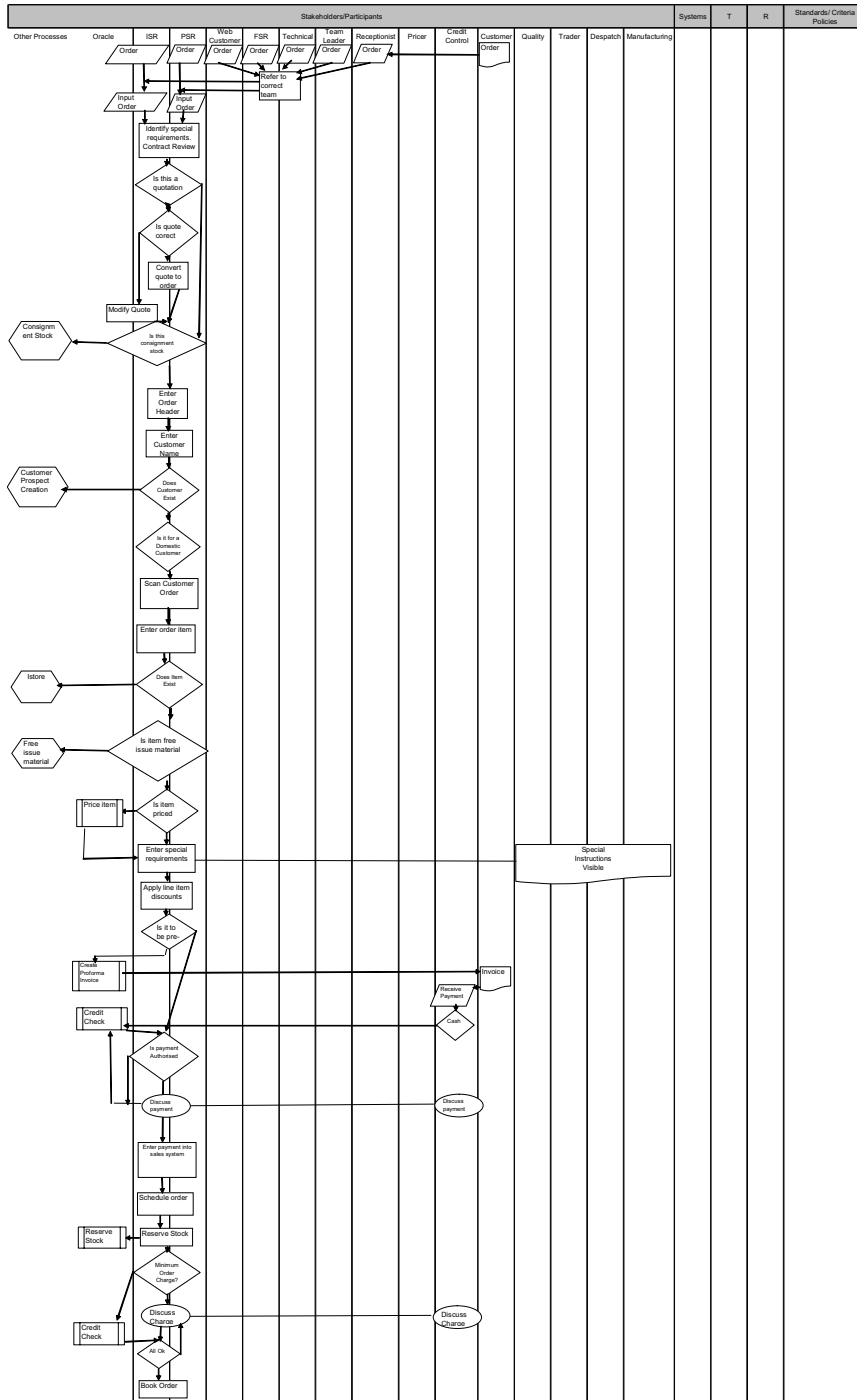
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# APPENDIX 1: INTEGRATED SYSTEMS AND FOUR FIELD PROCESS MAP



## **ENHANCED SUPPLY CHAIN VISIBILITY THROUGH ITEM-ATTENDANT ICT**

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### **ABSTRACT**

As supply chains become longer and more complex with fragmented business processes around the world and with numerous disparate sources of information, visibility of items, resources, costs and information becomes crucial to the effective running of the business. Currently, while information systems can enable a level of integration and encourage collaboration between members they present an incomplete and sometimes inaccurate view of the supply chain. This can be disastrous for companies in turbulent markets where responsiveness and agility is crucial. New technologies and methodologies are becoming available which can exploit implicit process information and knowledge to improve supply chain capability. One such approach is item-attendant ICT.

### **INTRODUCTION**

Accurate and up-to-date information regarding individual items in the supply chain together with visibility of process is crucial for companies to monitor business operations and to support management control and rapid decision-making. Lack of inclusive visibility, however, remains a frequently-expressed concern (Aberdeen Group, 2006). As supply chains become ever more complex and geographically dispersed, complete visibility and traceability become ever more elusive. Global information systems are available that purport to provide integrated supply chain visibility. However, in practice, such systems are often limited to parts of the supply chain, are extremely expensive, tend to offer generic solutions, suffer from latency and fail to provide sufficient resolution at individual process level (Davenport, 1998; Carr, 2004).

Automatic identification and data capture (AIDC) technologies, such as bar codes, have already played an important role in the transformation of supply chains by providing identification at various levels of item containment (from individual items, consumer units and so forth up to palletized and container loads). However, the process of identification is not a static event. It is often a part of dynamic item-defined processes. This paper proposes locating the emerging RFID technologies within the context of dynamic item-defined process management. Item-attendant ICT becomes a vehicle for carrying data and information through the supply chain and its constituent elements. Coupled to current systems it can provide a real-time and automated view of all supply chain activities i.e. inclusive supply chain visibility.



## **VISIBILITY AND TRACEABILITY**

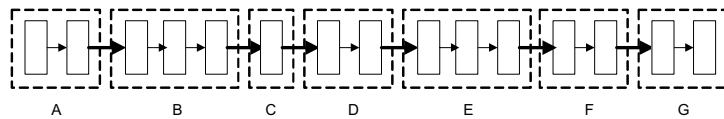
The meaning of visibility frequently changes according to context. Slack et al (2004) emphasizes the 'transactional' aspect as a measure of the amount of value added to the customer, while Blanchard (1998) suggests it is related to the time required to locate an asset that may be in use, in transit or in inventory. Kaipa et al (2006) focus on the information sharing aspects across supply chain partners. Gattorna (2003) adds a real-time dimension that can emerge from collaboration. Visibility of individual items is perhaps the most common aspect emphasized because the capacity to 'see', or know the location of, items is central to support the efficient flow of material (Sridharan et al, 2005). However, the process of identification is more than a static event. Product, resources and equipment usually change according to time, location and movement. Regarding identification as a nexus of item, process and of its environment yields a significantly fuller view of what is happening and of what has happened. Traceability adds an additional chronological aspect that inter-relates type and uniquely identifiable items, levels of containment and associated activities in a significant manner.

A major barrier to collaboration (internal as well as external), coordination of supply chain activities and process innovation is poor information/knowledge flow and sharing. This has frequently resulted from problems associated with geographical distance, different and incompatible systems, lack of resources, fear of new technology, and a lack of training. New ICT systems appear to offer a solution by providing management reach, information richness and connectivity, but have frequently failed to provide the real-time and integrated solutions envisaged (Phelan and Griffiths, 2002). The challenges (implicit and explicit) of managing complex supply chains may also be characterised by tensions between local and global management and information provision. Infrastructures must support dispersed yet highly interdependent management structures and process flow. At the same time, there must be local control and visibility (Rolland and Monteiro, 2002).

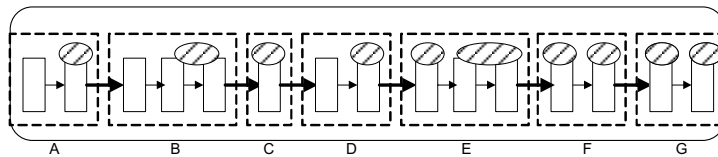
## **THE EVOLUTION OF ICT-SUPPORTED SUPPLY CHAIN VISIBILITY**

Figure 1 represents the evolution of ICT-supported visibility through various stages. To begin with, it is convenient to see the supply chain in a simplistic way as a series of processes from supply to the marketplace. Figure 1a shows a 7-stage supply chain comprised of companies A, B, C, D, E, F and G. (The dotted 'company' lines indicate that organisational boundaries are becoming less important in terms of material flow). Figure 1b shows the desired system, a complete envelope of supply chain visibility with an IT backbone from one end of the supply chain to the other. Currently IT systems (hatched areas) are implemented to support and manage processes. These are specific to an organisation, process or application (see figure 1c). Global IT systems such as MRP and ERP are designed to integrate these processes and resources, but this remains limited in terms of reach and resolution.

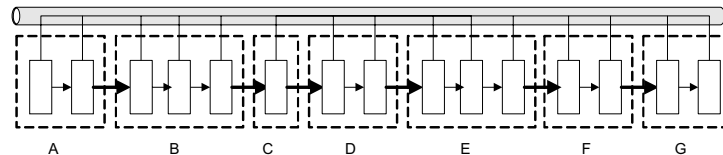
Hybrid systems (figure 1d) which show global information and planning systems combined with best of breed systems can offer supply chains the appearance of an end-to-end solution. However, they tend to be one-dimensional – for example, focused exclusively on the visibility of global management information at the expense of local item-level information. Figure 1d illustrates how this still gives an incomplete picture. It suggests that an additional level of visibility is required to obtain the comprehensive vision (predicted in 1b). This is the visibility of processes connected by visibility of items as they flow within and between processes – a form of environmental visibility. Figure 1e shows how both levels of visibility can combine to achieve the desired outcome.



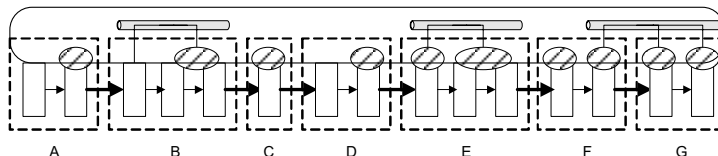
1a: The supply chain as a series of processes



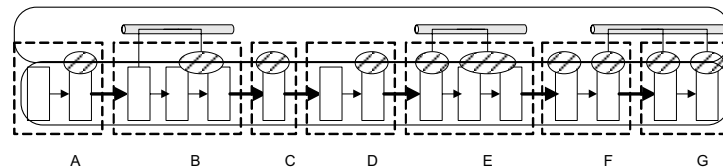
1b: IT systems supporting process management



1c: The global ICT structure



1d: The hybrid ICT structure (global plus local)



1e: End-to-end visibility: extending the concept

Figure 1: The evolution of supply chain visibility

The process-focused item (the basic unit of material flow) is the material link from one point to another across the entire supply chain. This additional level of visibility provides a capability based on integrated process knowledge together with sufficient levels of resolution. In terms of information system support, this may be modelled as the integration of a 'bottom-up,' item-led approach with the 'top-down' aspects of existing global or enterprise systems such as ERP. This extends 'end-to-end' supply chain visibility to one of 'inclusive' supply chain visibility (see Figure 2).

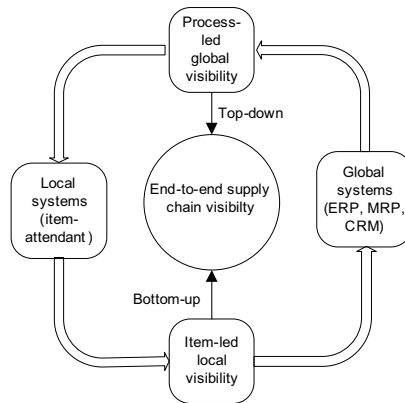


Figure 2: Inclusive supply chain visibility model

## ITEM-ATTENDANT ICT AND RFID

Technologies such as bar codes have already transformed the supply chain in terms of item identification and item management. However, the process of identification is often dynamic and determined by product, resources and equipment changes with respect to time, location and other process and operational impact. Viewing identification in this way gives a much more accurate interpretation of what is happening and what has happened over both time and location. While bar codes can be used in real-time applications, current systems find it difficult to share the information amongst the supply chain partners (Aberdeen Group, 2006). RFID-enhanced intelligent items coupled with the implementation of intelligent processes may result in better process management while maintaining the unique capabilities of local subunits.

Item-attendant ICT has been defined as:

the body of knowledge, techniques, principles, applications methodology and technologies used for automatic or semi-automatic identification, data capture and data transfer in management or other process support requirements with respect to tangible physical items, including assets, people and locations (Furness et al, 2002)

By extending this concept to embrace integration with wider area connectivity communications, global information systems and intelligent agent technologies, a paradigm emerges for an integrated, item intelligent world or  $i^3W$  (Furness et al, 2002), in which tangible items can be identified for business purposes, and linked to the supply chain through the communications platform to provide 'inclusive' supply chain visibility.

### **$I^3W$ AND PORTABLE DATA FILES**

Portable data files carry data that, when read at a process by a host, can provide immediate freestanding information. If the reader and data carriers have read/write capability the functionality of the process is dramatically increased. The data content of the file carried by the item can have three basic elements of identification (Furness et al, 2002):

- Item identity
- Location identity
- Time of event identity

Depending on the item application and data carrier technology this may be complemented with other data (related to the processes and environment) to be carried and explored. Furness et al (2002) refers to this composite identity as the State Variable of the item (Figure 3).

Identification of....	Item	Location	Time of event	....etc

Fig 3: Item identification - the State Variable

For example, a portable data file on a sub-assembly may be used to specify set-up and machining instructions when presented within suitably equipped machinery; a fire extinguisher may carry a file that records the maintenance history of the device; fruit transported from abroad may have its environmental metrics such as temperature and humidity recorded; and products at the end of their life may carry instructions detailing their disposal. Such examples may only require the read function where the data from source  $S_1$  is carried by data carrier  $dc_1$  to process or host reader  $h_1$ . Figure 4a illustrates how an item and its data carrier  $dc_1$  may be read many (n) times by the same host, with successive readings at times  $t_1, t_2, t_3$ .

Figure 4b shows in graphical short form how many items in a batch with carriers  $dc_1, dc_2, \dots, dc_n$  can be read at one host, and the data assembled or fused into a data package represented by  $f(dc_1 + dc_2 + \dots, dc_n)$  for decision support. All items in the batch are read and can be recorded as being present for stock control purposes or, in a manufacturing context, components ready for an assembly process. For example, Li et al (2005) show how the declining product quality value of perishable goods along the supply chain could lead to changes in product prices.

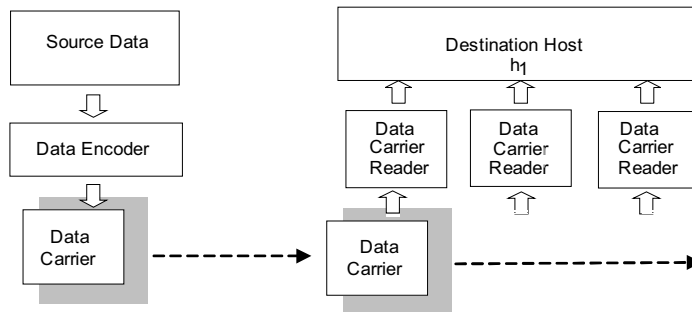
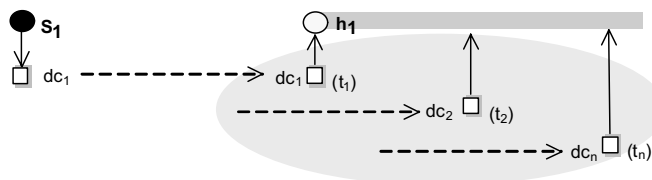


Figure 4a: Multiple data readers



where  $S_1$  represents a source of data encoded into a data carrier, here identified as  $dc_1$ , a host read or decoupling point here identified as  $h_1$ , and  $t_1$ ,  $t_2$  and  $t_3$  times at which the data carrier is read

Figure 4b: Multiple data readers in graphical short form

Figure 4: Capturing item history

## SUMMARY

Despite the promise of comprehensive supply chain visibility, there remains a significant limitation. This is visibility at an item level. Combined with process-led global visibility, it enables an 'inclusive supply chain visibility model' that gives real-time end-to-end visibility and knowledge. Therefore, effective management of modern supply chains demands systems that can link both local and global systems, and, at the same time, lever the individually of processes and capabilities for a supply chain that is innovative as well as responsive.

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## **STUDY ON EFFICIENT KIOSK AND TICKETING COUNTER OPERATION MODEL IN AIRPORT PASSENGER TERMINAL BY USING SIMULATION**

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### **ABSTRACT**

Due to unfavourable factors such as 911 terror in 2001, Iraqi war and SARS in 2003, airline industry has been plunging into recession. Because of recession, several big players filed for Chapter 11 bankruptcy protection in order to survive and this kind of situation worsen business in airline industry. Airline companies have been establishing strategy for restructuring their organization and making big efforts on achieving competitiveness by cost saving and throughout processing improvement. As a part of such efforts, electronic ticket (e-ticket) which enables fully automated ticketing process has been widely adopted.

In this research, we studied cases of 'K' airline which has introduced and operated e-ticketing with kiosk in many airports. Currently they are operating around 18 kiosks at the 20 check-in counters for domestic destinations. However due to limit service and other issues such as readiness of customers including high usage of cash when purchasing ticket, currently the utilization of kiosk is below 10%. In order to increase the utilization of kiosk, the company is planning to increase supporting personnel for assisting kiosk operation and give more benefit for e-ticketing and kiosk user (such as 100 mileages per kiosk usage).

In our research, we developed a simulation model which is closed to the real implementation model of "K" airline. Based on the boarding rate and service function of kiosk currently being operated, we analyzed efficient kiosk and check-in counter operation combination model.

We believe that our research will give a clear benefit to airline and eventually boost the adoption of e-ticketing service and kiosk.

### **INTRODUCTION**

The global airline industry has been in recession since 2001. Many airline companies have been establishing new strategy for restructuring their organization and making efforts on achieving competitiveness by cost saving and

throughout processing improvement. Among those efforts, fast and efficient check in process is very important in airline companies and airport. One of technologies for the reduction of passenger waiting time especially at the check-in desk is e-ticketing system. E-ticketing service enables remote processing for ticketing and has changed manual check-in process which was based on the paper ticket to computerized automated check-in process.

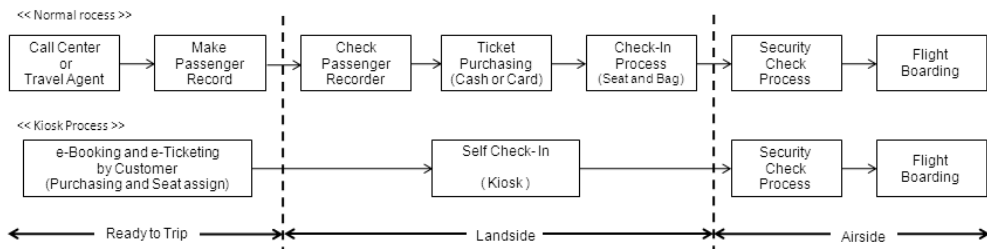
From airport perspective, it is more cost effective approach than expanding facilities to support check-in process. From airline perspective, airline companies can reduce resources to support check-in process, remove paper based ticket and improve customer service by simplifying ticketing process.

As a supporting idea for e-ticketing service, concept of self check-in is getting much attention and kiosk is considered as a key system for this. Kiosk has been developed and adopted in order to reduce waiting time at the check-in desk. Currently K airline is operating kiosk in domestic airport such as Gimpo, Busan, Jeju etc. in Korea. In this study, a simulation was constructed based on the boarding rate and service function of kiosk currently being operated. Our key objective was to find efficient kiosk and check-in counter operation combination models.

We believe that our research will help to understanding the benefit of e-ticketing service and kiosk.

### E-TICKETING SYSTEM

As in Figure 1, in the ordinary process, the passengers contact the 'travel agent' for reservation, ticketing, and payment. Then at the airport, check-in agent assigns seat for passenger after checking passenger's records, issues baggage tag and the passenger can be on board after that. This process results in long waiting time and could be a bottleneck, which causes customer's dissatisfaction.



**Figure 1. Passenger Process**

International Air Transport Association (IATA) encourages adopting E-ticketing because it is facilitating the movement of data via established protocols and standards to enable all transactions to take place. Airlines can send ticket data electronically rather than carrying a paper ticket and moving relevant ticket data between the different processes. Detail information of the ticket is stored in the computer system of issuing (validating) airline and it is available to all transactions.



#### Benefits of Customer using E-Ticket System:

- Various methods for reservation and purchase: The passenger can choose methods of getting a ticket. They can either ask a travel agent to issue a ticket at the airport or just tell the number at the check in desk or can issue the ticket using internet
- Easy to keep ticket: E-Ticket has much information about a ticket. Accordingly, it is easy to reissue in the case of unexpected condition.
- Time saving: E-Ticket supports 'Self check-in Machine'. Since passenger can process necessary procedure except boarding, they can save time in the terminal and all procedures become simplified

#### Benefits of Airline Company using E-Ticket System:

- Cost reduction: It is possible to reduce commission for travel agencies because E-Ticket system directly links with the customer.
- Improvement in procedure: This system can reduce cost. Changing the ordinary process with paper ticket to computerized process. And little physical space is required for keeping information on the ticket since it is not requiring any paper work.

### **CASE STUDY**

K airline operated domestic airport in Gimpo, Busan, Jeju and etc. Due to heavy queue at the check-in counter and operating cost for check-in counter, K airline has been researched to maximize the counter utilization and minimize passenger waiting time.

There are two parts of kiosk implementation cost: one is IT cost which is related to the hardware and software setting; the other is business cost which is related to the education of airline's agent and salary.

### **SIMULATION STUDY**

So far, there are many researches in the airport operation: queuing time analysis at the airport (Takakuwa and Oyama, 2003; Ray and Claramunt, 2003; Jim and Chang, 1998; Cao et al., 2003; Gatersleben and Weij, 2004; Pendergraft et al., 2004); baggage process and system at the airport (Yfantis, 1997; Jaroenpuntaruk and Miller, 1995; Pitt et al., 2002; Leon and Liu, 2005); and resource allocation at the check in counter (Chun and Mak, 1999).

The objectives of our study are:

- To analyze passengers' queuing time considering increased utilization of kiosk. In this paper 18 kiosks which are operated by K airline at Gimpo airport and 20 check-in counters (3 of Business Class, 17 of Economy Class) are studied.
- To compare kiosk counter with normal check in counter processing in terms of passenger waiting time which is directly linked with service level.
- To analyze efficient number of combination for kiosk and check-in counter operation based on the arrival rate of passengers at Gimpo airport To analyze the implementation cost of kiosk

In this study, a simulation model was developed by Extend Version6 (Extend, 2006).

### ASSUMPTION

- Each counter agent processing time is steady.
- All Passengers arrive at check-in counter before departure.
- All flights departure is in fix time.
- There is no break down at check-in counter by passenger.
- There is no limit in queue length and flight load factor is 90%.

### SIMULATION INPUT DATA

Generally there are various patters in passenger arrival time at the airport. Passenger arrival pattern is a key reason in airport congestion and it could cause flight delay. In this paper we classified the time as A.M (06:00~12:00) and P.M (12:00~21:00) because Gimpo airport has a curfew time from 22:00pm to 06:00 am.

Other input data such as processing time at check-in counter, aircraft types and classification of passengers are as in the following tables.

Contents	Time (sec/person)
Ticket Process Time	85
Baggage Handling	15/baggage
Reservation Passenger	40
Group passenger	45

**Table 1. Processing Time**

Contents		Rate	Contents		Rate
Payment	cash	26%	Class	Business	5%
	Card	74%		Economy	95%
Discount	Discount	30%	Trip Type	Individual	55%
	Non-Discount	70%		Group	45%
Number of Baggage	0 (EA)	60%	Reservation	Reservation	40%
	1 (EA)	30%		Airport Ticketing	60%
	2 (EA)	10%			

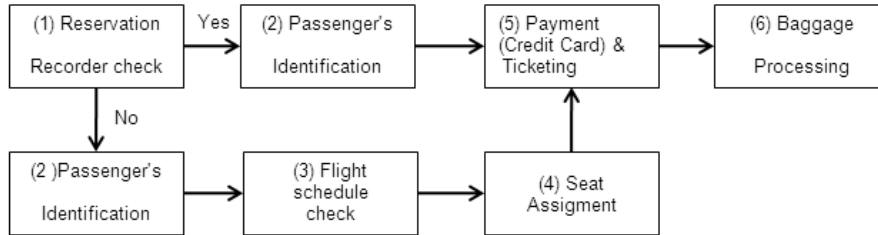
**Table 2. Passenger Classification**

### SIMULATION RESULT

Comparison between business class counter and economy class counter are analyzed. From our simulation, a business counter waiting time is smaller than economy counter due to business passenger small share of total passenger.

### COMBINATION OF KIOSK AND CHECK-IN COUNTER PROCESSING

In this case, queuing time for ticketing and operation rate of counter are important factors. We used different kiosk usage rate such as 10%, 20%, 30%. Generally kiosk process resembles a normal counter check-in process as in the figure. But currently K airline's kiosk system does not support a cash payment and group check-in, discount, and check-in process of baggage holding passenger. (Figure 2)



**Figure 2. Kiosk Check-in Process**

Process type	Processing	Time (sec/person)
kiosk Passenger (who has no reservation)	(1)->(2)->(3)->(4)->(5)	90
Baggage handling	(6)	20/1 baggage
kiosk passenger (who has reservation)	(1)-(2)-(3)	40

**Table 3. Processing Time (Kiosk) and Normal Check-in Counter**

The result of simulation was as the following (Table 4).

Kiosk usage	Reduction of economy counter	of class	Average waiting time	Utilization (%)
10%	1		10.5	73
20%	3		13.8	73

**Table 4. Using kiosk rate with reduction of economy counter**

Table 4 shows that we can reduce 3 economic check-in counters when kiosk rate is 20% with similar waiting time of kiosk rate 10%. Improvement of kiosk function and combination with normal counter

We assume that kiosk system supports group check-in and cash payment functions. Other assumptions remain the same.

Kiosk Rate	Reduction of Economy Class Counter	Average Waiting Time (min)	Utilization Rate(%)
40%	11ea	12.6	65.12%
50%	13ea	19.8	70.28%

**Table 5. Improvement of kiosk function case**

As in the Table 5, by increasing the kiosk usage rate to 40% we can reduce 11 economic check-in counters with similar performance with kiosk usage rate of 20%. Here we can guess that by increasing kiosk usage rate to 40%, we could reduce more economic class counter and even average waiting time.

Most airlines utilize check-in counter. Usually counter cost includes: labour cost; rental cost; and operation cost. However, kiosk system usually adds hardware and software cost. K airline's investment for kiosk development were 452,000 (USD). Gimpo domestic airport currently operates 18 kiosk counters. Each counter cost is USD1,662 and total cost for 18 kiosks is USD29,916 per month. By increasing kiosk counter usage rate to 35%, K air line can reach a breakeven point of kiosk implementation (K airline can remove 5.2 check-in desk reduction with this usage rate)

## CONCLUSION

Kiosk and e-Ticket are new trend in the airline market and many airline companies are rapidly adopting it. However, there has been not many researches on the benefit of its introduction so far. In this paper, we studied the impact of new system introduction using discrete event simulation. We analyzed normal counter and kiosk counter processes: how many counters can be reduced by increasing usage of kiosk counter. We believe that our research will bring a guideline to the airline industry before their introduction of new system.

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## DESIGN AND IMPLEMENTATION OF RFID ENABLED PACKING OPERATION

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### ABSTRACT

With the advance of information technologies, manufacturing companies today are applying various state-of-the art information technologies to their supply chains and manufacturing floor in order to improve manufacturing and logistics processes. Among those technologies, Radio Frequency Identification (RFID) is getting focused attention due to its strength such as real time data acquisition capability, non line of sight capability and etc.

In this paper, we introduce an RFID based packaging operation which has been implemented in a semiconductor manufacturing company, Advanced Semiconductor Engineering Korea (ASE Korea).

### INTRODUCTION

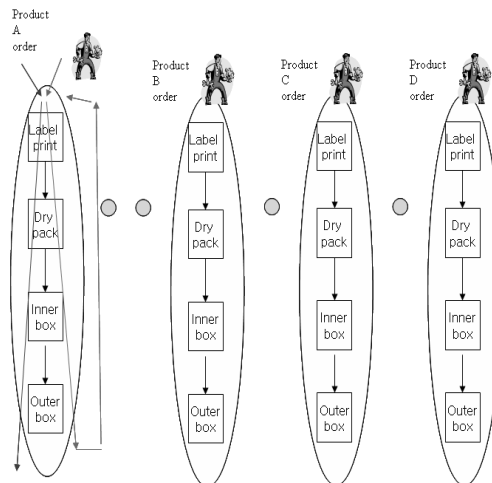
In some micro-electronics companies such as ASE, operators and equipment (i.e. layout and process) are assigned to specific product manufacturing line where each customer requires different packaging processes and packaging (e.g. inner box, outer box). Ideally when the mix of products is uniform, this type of assignment and layout may work well. However, due to dynamic characteristics of customer demands and factory physics, the layout and manufacturing practice could not cope with the real environment. With layout and manufacturing practice issues, there had also been difficulties in Work in Process (WIP) tracking and order sequencing due to manual input and dispatching decision.

In order to address such issues, we studied new layout and manufacturing practice, especially application of RFID. We developed simulation models considering operators, equipment (e.g. bar code printer, dry pack machine), working space, RFID system, raw materials for packing process (e.g. bar code, packaging box), mix change of goods and quantity of goods transported. Based on the simulation models developed, we designed and implemented a new layout which could improve manufacturing performances (i.e. throughput, utilization, cycle time) and optimal number of operators to accommodate the dynamic changes of demand.

## PACKAGING OPERATION

ASE KOREA was established by ASE Group, a Taiwan's flagship semiconductor company, as it acquired the semiconductor division of Motorola Korea Ltd. located in Paju, Gyeonggi-do, Republic of Korea in July 1999. ASE KOREA provides turn-key solutions - assembly and testing of a range of customer-specific semiconductors such as automotive power ICs, medical and industrial sensors and amplifiers for wireless telecommunications - and continuously invests in the development of high value-added and next-generation products.

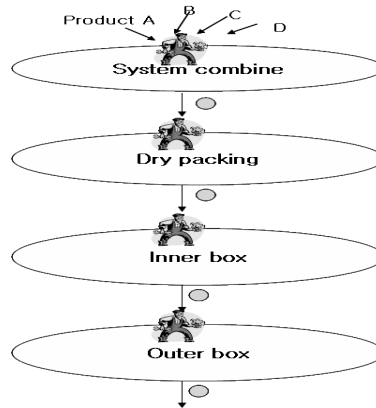
Packaging process in ASE was as in Figure 1. Once finished products were arrived in the packaging line, each operator who was assigned to individual product type was controlling the whole packaging process from label printing to outer boxing process. In this process, each product had different packaging requirement such as box size, label etc and each operator assigned to a product had to have all packaging processes knowledge for a specific product.



**Figure 1. Packaging process in ASE**

The old manufacturing concept might give better ownership to each operator and also provided better traceability for each product. However, due to the dynamic nature of customer demands, this manufacturing concept was not responsive enough when product mixes were frequently changing. In order to address responsiveness issue, we considered different manufacturing concept, as in Figure 2. As in the figure, each operator has responsibilities on each process not on each product. In order to implement this, each operator should have knowledge for each process of a product and has to be cross-trained for the specific process of each product. Important changes in function based cell packaging line (e.g. Figure 2) are application of RFID and use of conveyer belt. Once finished products are arrived at the operators' desk through conveyor belt, firstly they are processed at the system combine process. In combine process, RFID tag and product information are matched. Once matching is finished, printed reel labels are attached (In case of "S" company, 3 reels are grouped into one inner box, in case of "M" company, 2 trays are grouped into one inner box).

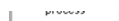
In the next process, which is dry pack process, RFID system identifies the option for labelling (e.g. either attaching bag label or not). In inner boxing process, RFID system also identifies options for labelling for inner box. As the same as inner box, in case of out box, RFID system identifies options for label.



**Figure 2. Function based cell manufacturing process**

### **PROCESS STUDY AND RFID BASED PACKAGING PROCESS**

In order to develop new manufacturing practice and layout, we analyzed the packaging process which was based on the barcode system and consisted of various checking procedures which were considered as inefficient and time consuming procedures. Figure 3 shows the old packaging processes.



**Figure 3. Activity diagram for old packaging process**



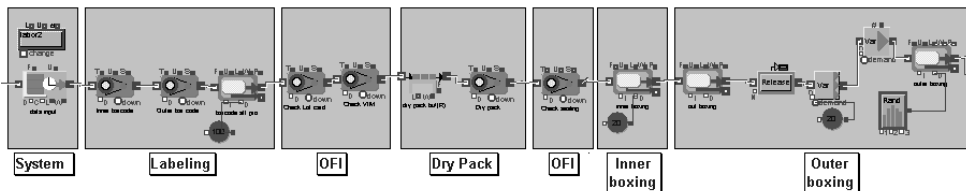
After reviewed the old packaging process, we changed the packaging process to cell based process which can accommodate RFID supported process. Instead of assigning each operator to specific product line, they are in charge of each process (such as system combine, dry packing, inner box, outer box).

In case of "S", 3  
reels in inner box  
In case of "M"  
2 trays in inner box

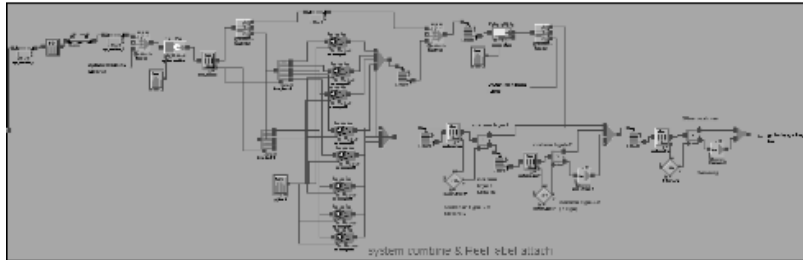
**Figure 4. Activity diagram for RFID based new packaging process**

### **SIMULATION**

Considering activity diagram developed, we developed simulation models for each case to compare. Simulation model was developed by using extend 6 (extend, 2006). Figure 5 and Figure 6 shows examples of simulations developed, respectively.



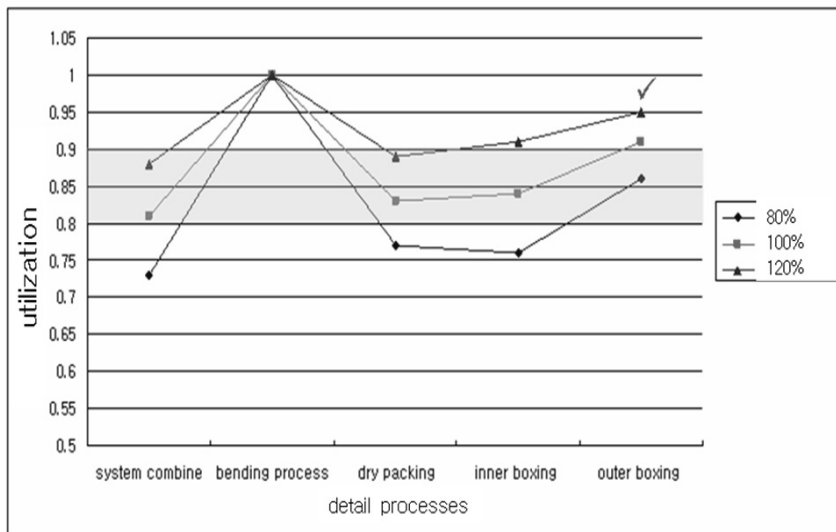
**Figure 5. Simulation model of existing manufacturing line (in case of A product)**



**Figure 6. Example of system combine and reel label attach process**

To analyze demand pattern, we used 12 weeks' assembly data which includes 17 customers. For example, for increasing pattern, we used demand type A, which is linear regression analysis, for constant pattern, we used demand type C, which is based on the average and standard division values, for periodic pattern, we used demand type R, which generates demand by average period. We have compared different options for operator assignment to find optimal number of operators (e.g. 10, 11, 12) considering different demand levels, operator utilization and queue levels.

Figure 7 shows case of 11 operators and was the best case from various scenarios. Compared to 10 operator case, in this case, most of operator utilizations were range between 80~90% and there were no big queues.



**Figure 7. In case of 11 operators**

Figure 8 shows outer box which is traced by RFID reader



**Figure 8. RFID System with outer box**

### **CONCLUSION**

From our study, by changing layout and resource assignment (e.g. operators, equipment), we could build a responsive manufacturing line against dynamic demand changes (i.e. demand quantity changes and product mix). To reduce errors due to manual process, we replaced manual input process by RFID based automated inputting process. By RFID based inputting process, we could also reduce the time to input data (e.g. time stamp of lot data) and the time for dispatching decision.

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# **INVENTORY MANAGEMENT**



**APPLICABILITY OF CPFR IN INVENTORY REPLENISHMENT OPERATION  
MODEL OF LOW-VALUE ITEMS IN FINNISH MACHINERY INDUSTRY: CASE  
STUDY.**

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**ABSTRACT**

The study focused on collaboration in the supply chain of low value items in the Finnish machinery industry. The research framework applied to this research target was the CPFR (Collaborative Planning, Forecasting and Replenishment) philosophy. The research aimed to establish the suitability of CPFR to the case supply chain and the CPFR principles currently applied to it. In addition, it was explored how CPFR could improve the future performance of the case supply chain. The study revealed that the case supply chain applied some collaborative processes. Collaborative principles were mainly utilised in operational level processes and in some tactical level processes. This kind of collaborative activity corresponds to a great extent to the CMI (Co-Managed Inventory) operations model, which is more limited than CPFR. Based on the results of this study, CPFR would be appropriate for the case supply chain. In the future, the supply chain should focus more on strategic and tactical collaboration in addition to operational collaboration. CPFR could at least be applied to provide the common concepts and framework for the partners to start collaboration.

Keywords: CPFR, collaboration, supply chain management

## **INTRODUCTION**

Different approaches to management have been tried out in supply chain development and management during the past few decades. The 1990s introduced the launch of philosophies based on collaboration and demand, such as CPFR (Collaborative Planning, Forecasting and Replenishment) and ECR (Efficient Consumer Response) (Frankel et al., 2002). The main drivers for these philosophies have been increased competition, reduced product life-cycles, the uncertainty of demand and more complex supply chains (Fisher, 1997; Fliedner, 2003). Demand-based philosophies have been applied in order to align demand and supply and thus reduce the storage turnover and inventory levels, respond more rapidly to customer demand (Cassivi et al., 2004) and decrease fluctuations in inventory levels of the supply chain (Lee et al., 1997). Deep long-term relationship between supply chain partners is considered a means to improve the performance of the supply chain as well as increase business (Ellram and Cooper, 1990; Lambert et al., 1999). In this paper, deep long-term relationship is referred to as collaboration. In a collaborative relationship, partners have shared goals and decision-making processes, which aim for mutual strategic advantages (Stank et al., 2001). At present, the food industry seems to have been the one to profit most from collaboration (Min et al., 2005). However, Sabath and Fontanella (2002) maintain that of all the different supply chain strategies throughout the times, the practical application of collaboration has been the weakest.

## **METHODOLOGY**

The research target of this study was collaboration in low-value items (e.g. screws) in the two-stage supply chain between a customer in the machinery industry and a technical wholesaler in Finland. In addition to production operations, part of the items within the scope of this study could also be used in maintenance operations. Items used solely in maintenance operations were, however, excluded from the study because their consumption differed significantly from that of items used in production.

A pragmatic systems approach was applied to this qualitative case study. This approach was chosen in order to achieve results that best describe the overall situation of analysis unit and support practical development in the future. The research data was collected during a two-year time span from 15 enterprises. The research methods consisted of thematic interviews, team work and observation. The interviews were conducted with employees from the strategic, tactical and operative levels of the businesses.

The CPFR philosophy was adopted as the framework for studying collaborative activity in the case supply chain. The research aimed to establish the suitability of CPFR to the case supply chain and the CPFR principles currently applied to it. In addition, it was explored how CPFR could improve the future performance of the supply chain.

The CPFR model was originally developed for consumer goods supply chains, and it is in this context that it has been applied and researched the most (Fliedner, 2003; Ireland and Bruce, 2000). CPFR has also been applied in other sectors, such as the electronics and chemical industries, which means it can be considered a generalisable framework (VICS, 2004). However, the application and research of CPFR in the machinery industry and low-value items has been minor. CPFR was selected as the framework of this study because technical wholesales and consumer goods sales have a number of common characteristics.

Furthermore, the choice of CPFR was affected by its comprehensiveness, which allowed us to study the case as an integrated system from the strategic level to the operative one.

#### CPFR reference model

The CPFR model offers a framework for collaborative planning, forecasting and replenishment processes with the aim to improve performance of the inter-company supply chain (VICS, 2004). The model was developed by the CPFR committee of VICS (Voluntary Interindustry Commerce Standards) together with industry representatives (VICS, 2006). It differs from the traditional approach where supply chain parties promote their own vested interests instead of the shared interests of the supply chain (Simatupaung and Sridharan, 2005).

In the CPFR model (Figure 1), the end customer is the centre of attention, to whose demands the supply chain (buyer and seller) endeavours to respond. The model consists of four main activities and eight tasks. The activities are strategy and planning, demand and supply management, execution, and analysis. Each activity comprehends two tasks. In strategy and planning, the tasks are collaboration arrangement and joint business plan, in demand and supply management they are sales forecasting and order planning/forecasting, in execution they are order generation and order fulfilment, and finally, in analysis they are exception management and performance assessment (VICS, 2004).

The practical application of CPFR has been explored in many different studies. CPFR is the most appropriate for in-depth business relationships, where there is a strong trust between the parties (Barrat & Oliviera, 2001) and where the product price is not the determining factor in choosing a partner, products are differentiated and supply sources are scarce (Noekkentved, 2000). Moreover, the application of CPFR requires a sufficiently high volume (Stank et al., 1999). According to Cassivi (2006), CPFR is at its most advantageous when it is applied to both the supplier and the customer.

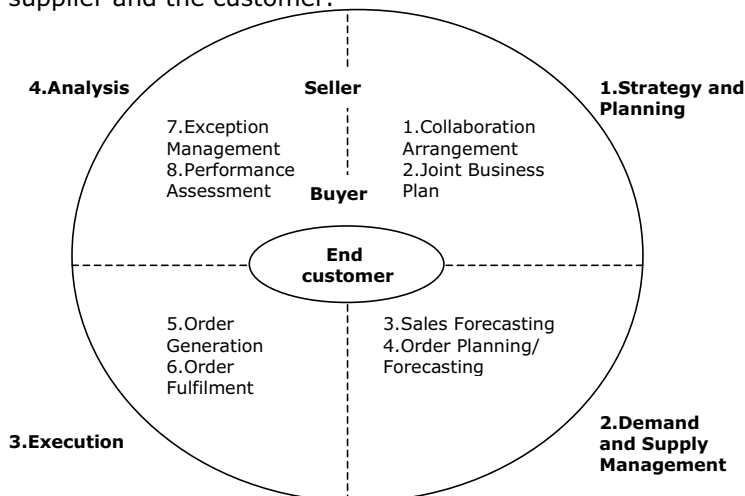


Figure 1. VICS CPFR Model – Top-level Diagram (VICS, 2004).

#### **DESCRIPTION OF STUDIED CASE ENVIRONMENT**

This section describes the Inventory Replenishment Operation Model (IROM) applied in the Finnish machinery industry and according to which the studied



businesses operate, on an average. In this research, the IROM refers to low-value items used in the machinery industry delivered by the supplier directly into the shelf space in the customer's production or storage facilities according to the agreed management model. Table 1 shows a typical IROM, categorised into processes according to the four main activities of CPFR. However, the table does not take a stand on inter-business collaboration in introduced processes. Table 2 compiles characteristics/problems in the case IROM in a Finnish business environment and characteristics of the case items. However, even though a large number of items falls under the average characteristics, some items may deviate from them considerably.

<b>CPFR activity</b>	<b>IROM processes</b>
Strategy and planning	<ul style="list-style-type: none"> <li>-locating supply sources</li> <li>-tender competition and negotiations</li> <li>-choice of supplier, conclusion of agreement</li> <li>-setting goals and performance indicators for service level and products</li> <li>-definition of management model</li> </ul>
Demand and supply management	<ul style="list-style-type: none"> <li>-definition of management parameters</li> <li>-communicating important upcoming changes in supply and demand</li> <li>-creating and updating inventory replenishment item documentation</li> </ul>
Execution	<ul style="list-style-type: none"> <li>-inspection of inventory levels</li> <li>-placing order and processing order</li> <li>-delivering material to shelves</li> <li>-invoicing and processing invoice</li> <li>-reporting delivery</li> </ul>
Analysis	<ul style="list-style-type: none"> <li>-analysis of delivery information and supplier performance</li> <li>-exception management (e.g. shortage)</li> </ul>

Table 1. Processes in case operation model.

<b>IROM characteristics in machinery industry in Finnish business environment</b>	<b>Characteristics of case items</b>
<ul style="list-style-type: none"> <li>-The IROM demands a great deal of work from the staff, which results in considerable costs</li> <li>-Despite a rather large safety stock, unexpected shortages occur from time to time, which consequently results in e.g. significant additional costs compared to the value of the material and normal operational process</li> <li>-Logistical distances are long</li> <li>-Volumes are small/medium-sized compared to e.g. Central Europe</li> <li>-Trust between business partners is at a high level</li> </ul>	<ul style="list-style-type: none"> <li>-The value of items is relatively low compared to their overall material costs</li> <li>-Some items are high-risk because their absence may stop the entire production line</li> <li>-Items are typically small and their volumes are large</li> <li>-Items can usually be used for different purposes because of their standardised characteristics</li> <li>-Usually the consumption of items is recurring and relatively constant</li> <li>-The life-cycle of items is usually much longer than that of e.g. components in the electronics industry</li> <li>-The lowest-value and smallest items are normally delivered in packages</li> <li>-The accurate inventory balance is not always known, because the quantity of items is not always recorded in the information system</li> </ul>

Table 2. Characteristics of research target.

In the management of the IROM items, customers consider it important that their availability is secured with total costs as low as possible. Suppliers aim to respond to the service level required by the customer as cost-efficiently as they can. Cost-efficiency can be achieved through large customer and item volumes because shelf inventory replenishment is a rather low-profit activity. Large

customer volumes are beneficial in the sense that the supplier may operate in a small area with short transportation distances. Large item volumes, on the other hand, mean that the supplier is able to complete an entire day's work in one production plant or plant area.

## RESULTS

This section presents the collected research data and generalised results with regard to the applicability of CPFR to the case supply chain, and the current application of the four CPFR activities.

### Applicability of CPFR to studied supply chain

Even though there were some collaborative processes between the companies in the case supply chain, the CPFR philosophy had not been applied to the development and management of collaboration in the supply chain. However, the CPFR is a suitable philosophy for the case supply chain. This is supported by the arguments presented in the right-hand column of Table 3.

<b>Theoretical arguments for applicability of CPFR (introduced earlier in the methodology section)</b>	<b>Applicability of CPFR to the case supply chain</b>
Strong trust between parties	In the studied cases, business relationships last 1-3 years. However, in a Finnish business environment trust is usually rather strong even in medium-term relationships.
Product price is not the deciding factor	Price is not (or should not be) the deciding factor – overall costs are.
Products are differentiated	Products are rarely differentiated, whereas services usually are.
Supply sources are scarce	Service differentiation has reduced the number of equivalent supply sources.
Volumes must be sufficiently large	In a Finnish environment volumes are not large, but they are sufficient when the customers' production plants are large and/or customers are located next to each other.
CPFR is applied to both suppliers and customers in the supply chain	This study was limited to two stages, but the following study will explore three. There is a clear need for this because the current trend involves a logistics operator between the customer and the supplier.

Table 3. Applicability of CPFR to the research case.

### Strategy and planning activity

Because the strategy and planning processes of the customer and the supplier have not been integrated in the studied cases, the different business goals of the parties lead to partial optimisation with regard to the supply chain. The differing goals created trade-off situations. For example, customers aimed to reduce costs by reducing storage space, which, in turn, increased the supplier's order processing and fulfilment costs because of smaller delivery lots.

### Demand and supply management activity

In the demand and supply management activity, collaboration between companies was minor. Some of the studied cases did, however, collaborate in adjusting inventory management parameters.

Demand and supply management processes were usually not properly standardised in the studied cases, which meant they were carried out in a variety of ways and irregularly. For example, forecasting based data on the history of material deliveries would be very suitable for the case items because their demand was mainly rather constant. However, existing data on the history was

not always analysed for updating the control parameters. The most important reasons for deficient parameter adjustment were the extensive working hours required for parameter adjustment and the absence of applicable information, such as actual balance-based consumption information. In addition to data on history, also data on the future demand would be needed. This would, for instance, include work the customer performed on weekends, which increased the demand considerably. However, the case customers did not forward information on changes in demand to their suppliers early enough.

Above mentioned deficiencies in the demand and supply management activity were usually compensated with a large reserve stock and frequent inventory inspections, which ensured the availability of material. Especially frequent inventory inspections required many man-hours, which incurred high costs. Furthermore, if the number of items on stock was not recorded in the inventory system, the visual inspection of inventory levels at shelves incurred additional costs. If the number of items was recorded in the inventory system, more efficient remote monitoring was usually applied.

#### Execution activity

Collaboration and integration principles were applied to the execution activity the most frequently. The studied IROM corresponded to a great extent to the CMI (Co-Managed Inventory) operations model, in which the inventory is co-managed between the customer and the supplier. In practice, this means that the order-delivery process was largely integrated between supply chain partners even though manual work was still required in the interfaces of some sub-processes.

#### Analysis activity

The analysis activity was not strongly integrated between supply chain partners. Typically, the case customers measured and analysed the performance of their suppliers, which had induced suppliers to develop their own processes. In contrast, shared performance was rarely measured and analysed. This was mainly due to the fact that the partners had not established shared strategies or goals, and had thus no shared indicators.

Exceptions caused problems in the studied cases. They were mainly managed by attempting to eliminate them by large safety stocks and frequent inventory inspections. Nonetheless, shortages occurred when changes in demand or other process exceptions (e.g. late delivery due to a human error) were great enough. The causes and consequences (e.g. total repair costs) of these changes and exceptions were analysed very little in the studied cases.

### **DISCUSSION AND MANAGERIAL IMPLICATIONS**

The case suppliers had enhanced their competitiveness by focusing on developing their services and making their processes more efficient. This had usually also led to improvement in the performance of the customers' supply chain because of cost savings and improved material availability. The following step towards further performance improvement and a more equitable distribution of benefits (as well as risks and development efforts) would be deeper collaboration between companies. CPFR is one possible collaboration tool, which could help to optimise the supply chain as a whole instead of the internal supply chains of individual companies. The CPFR philosophy would offer at least a shared set of concepts and guidelines for initiating collaboration.

*In the strategy and planning activity*, an important collaborative aim would be to reduce the overall costs of the inter-company supply chain (including e.g. item price, and transportation, shelving, transaction, storage and shortage costs).

Activity Based Costing could serve as a strategic tool in establishing the overall costs. The segmentation of items is also a potential development possibility. Even though a large number of the studied items closely corresponded to the average characteristics, some items showed considerable deviations in terms of characteristics. In practice, this entails the creation of different collaboration and management models for different segments. Furthermore, it would also be important to classify the factors affecting changes in demand and in products in more detail and negotiate about related information exchange. The business relationships in the studied cases were usually medium-term, and they are not likely to extend in the future. This may impede strategic collaboration. Active collaborative development efforts between the supplier and the customer would, however, be a good starting point for increasing trust between companies, which in turn would provide an excellent basis for concluding a new agreement when the previous one expires.

*Demand management* is an important target for future development. Development could be roughly divided into two parts – item segments of constant and fluctuate demand. For the item segments with a rather constant demand, the management parameters should be updated more frequently than nowadays with the help of delivery/consumption history. For the item segments with a fluctuate demand, suppliers could engage in proactive activities if they had access to information on changes in demand at an earlier stage. This would help the supplier to optimise its activity. Especially the optimisation of personnel and transportation resources could be improved. The quality of the demand data should be connected to performance indicators because the quality of the data has an impact on the efficiency of the material flow. One could thus state that the customer should concentrate on producing high-quality demand data, whereas the supplier should focus on utilising this data to improve material deliveries. Collaboration is needed between the customer and the supplier in order to determine which demand data (accuracy, format, timing, etc.) is useful for the supplier. *Supply management* is mainly related to the collaboration between wholesaler and its material supplier network, which was excluded from this study.

*The execution activity* could be improved by remote monitoring the inventory levels. As a solution, this study piloted the use of scales on the shelves and webcam monitoring. Their practical applicability will be further explored in parallel reports. In the future, however, collaboration in the execution activity will be least necessary because the current trend seems to be that customers want to outsource execution processes to their suppliers entirely.

The development of *the analysis activity* runs parallel with the development of the strategy and planning and demand and supply management activities. In the strategy and planning activity, the customer and the supplier should first decide on collaborative indicators. Values of the indicators could then be analysed in the analysis activity, laying a foundation for deciding on appropriate development activities. On the other hand, the analysis could also be related the demand and supply management process, analysing the history data, as mentioned earlier. The case supply chain should focus especially on proactive exception management because the exceptions that occur result in significant costs compared to the actual value of the item. The partners should concentrate on eliminating or decreasing the main causes of exceptions, which were human errors and poor communication about changes.

In a follow-up study, it will be examined how sub-processes of the eight CPFR tasks (collaboration arrangement, joint business plan, sales forecasting, order planning/forecasting, order generation, order fulfilment, exception management and performance assessment) could be applied to improve the case supply chain. In addition, the scope of the follow-up study will cover a larger field of business in order to improve the validity. Moreover, collaboration will be studied in a three-stage supply chain because the prevailing trend seems to involve a logistics operator connecting the customer and the supplier.

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## THE ROLE OF THE LOGISTICS SERVICE PROVIDER IN VMI OPERATIONS

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### ABSTRACT

Industrial manufacturers today are outsourcing their logistic functions to logistics service provider (LSP) companies. At the same time, LSPs are developing their services to add more value to customer processes. Recent research projects in Finland have focused on logistics outsourcing and especially on inbound logistics from the manufacturers' point of view. Development actions are focusing today on purchasing issues and inbound material flows. LSPs are assuming a more important role within traditional supplier-customer relationships. This paper concerns a research project focused on industrial Vendor Managed Inventory (VMI) in the case of low-cost items in manufacturing. We have analysed six material suppliers, how they use LSPs today, and the kind of potential they have to use LSPs in future. Logistics outsourcing to LSPs is not a simple topic. The paper discusses the LSPs' perspective and what role they could take in VMI operations in manufacturing industries.

### INTRODUCTION

Logistics Service Providers (LSPs) today have assumed an important role in industrial value chains (Naula et al. 2006; Stone, 2006). Logistics operator markets are growing and the demand for different logistics services is rising (Naula et al. 2006; Stone 2006). The market demand for logistics services consists of much more than mere transportation, and includes, for example, warehousing, material handling and quality control. LSPs are also required to provide information services, including demand and supply forecasting, item usage reporting as well as supplier performance monitoring and reporting. Manufacturing companies today use LSPs in every kind of logistics operation, covering inbound, in-house and outbound logistics.

This paper is based on a research project that aims to develop a new VMI operating model utilising LSP in the replenishment process within traditional supplier-customer collaboration. The paper discusses the role of LSPs in the manufacturing industry and in the case of low cost items, typically referred to as Class C products. There are many potential business opportunities for LSPs in VMI operations, not only in the replenishment process itself, but also in new kind of service functions that LSPs could provide to customers.

### METHODOLOGY

Our research project is based on a constructive research method and on Yin's multiple case study definition (Yin, 2003). We develop a new VMI operating model (a new construction) and evaluate our result in multiple case studies. We have carried out a literature survey and interviewed supply chain professionals working with VMI in Finnish industrial companies. We have also made two international benchmarking research visits to analyse different VMI operating

models and enabling technologies. The role of LSPs is one feature of our new operational concept and that feature is presented in this paper.

### VMI IN AN INDUSTRIAL CONTEXT

In the manufacturing industry, low cost items are mainly standard items, for example fastening and assembly materials. The common warehouse replenishment model in these cases is Vendor Managed Inventory, VMI (Hemilä et al. 2006). A number of articles have been published about VMI and other replenishment models (e.g. CMI, SMI, consignment stocks etc.). VMI has been successfully used in the retail sector (Cooke, 1998; Waller et al. 1999), but also in other industries (Kuk, 2004). Many papers analyse the effectiveness and outcomes of VMI partnerships, and also compare VMI with other replenishment models (e.g. Holmström 1998; Kuk 2004; Disney and Towill, 2003; Elvander 2006). In addition, there are research papers on the evaluation of VMI systems (e.g. Sarpola, 2006). Our study is about VMI in manufacturing industry's low-cost material flows, where suppliers operate with a VMI model, and about how LSPs could be utilised in replenishment. This kind of approach is not usually covered in academic papers.

### LSP IN THE SUPPLIER-CUSTOMER RELATIONSHIP

LSPs are not commonly used in industrial VMI. Excluding transport services, no case examples could be found in the academic literature of LSP utilisation in the VMI process. We have analysed four main categories for utilising LSPs in supplier-customer relationships, as presented in following figure.

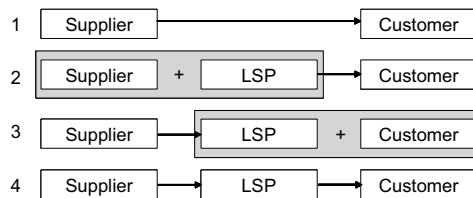


Figure 1. LSP in the supplier-customer relationship.

The first model is a traditional supplier-customer VMI model, where an LSP is not used. The supplier has full responsibility for replenishing the customer's warehouse as agreed.

In the second model, a supplier has chosen an LSP for the replenishment process, or for managing out-bound logistics as a whole. This kind of operating model is standard from a supplier point of view. The supplier produces the materials and the LSP takes those to its warehouse. The LSP is responsible for replenishing materials at the customer's site just as the supplier has agreed with customer. This is a good choice for suppliers that have geographically dispersed customers.

The third model is a co-operation model between the customer and the LSP. This is common for big customers when they want a standard inbound model. The customer does not need to do any kind of logistics operation; it is all done by the LSP. Suppliers supply as required by or agreed with customer, but through the LSP. The supplier is then not allowed to visit the customer site. This is a good operating model for multi-supplier businesses, as then only an LSP visits the customer site, not all of the suppliers.

The fourth model is a theoretical model and we have no practical examples of it. The idea is that the LSP could choose suppliers and provide both materials and logistics operations for customers. This kind of operating model might work only with standard items, like Class C screws and bolts etc. The LSP is acting like an independent material integrator. This model is really close to a wholesale business, but with a strong emphasis on logistics management and operations. The advantage of this model might be the option of choosing the best items from selected suppliers. Traditionally, the customer would choose the supplier who has the widest range of suitable items. There is scope for optimisation here, as there are differences between different suppliers' ranges of items. This fourth model makes it possible to have items from many suppliers, as a "one stop shop".

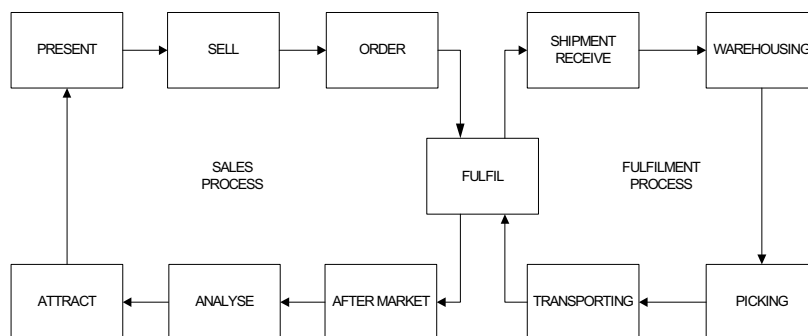
### WHEN IT IS REASONABLE TO USE AN LSP IN VMI?

Our research project encompassed four industrial material suppliers (A,B,C,E) and one Logistics Service Provider that also provided manufacturing services (D). Moreover, this paper includes ideas from LSPs who are developing their VMI services.

**Table 1. Case companies in our research project**

Case Company	Managed Replenishment	Managed Replenishment	Separated sales and replenishment processes
A - Fastening and assembly technology supplier	x		
B - Fastening equipment and industrial component supplier	x	x	x
C - Industrial component manufacturer and importer	x		x
D - Logistics and manufacturing service provider	x	x	x
E - Electrical wholesaler	x		x

The key decision for LSP usage is the separation of the sales and replenishment processes. If the replenishment process is integrated with the sales process, then the same personnel are involved in sales and marketing at the customer's premises (product demonstrations, future planning with customer, product shutdown decisions etc.) but also in replenishment logistics (materials management from delivery vehicle to customer's shelf, unpacking, waste management etc.). We have shared sales and replenishment processes, as shown in Figure 2. The idea is that the replenishment process could be done in parallel with the sales process by the supplier, or replenishment could be outsourced to an LSP.



**Figure 2. Sales and replenishment processes**



Replenishment is pure material logistics that has no value added features in it. This kind of activity could be managed cost-effectively by a logistics specialist (LSP). By using an LSP, an operational mass advantage could also be achieved if the LSP integrated all inbound material flows.

If the replenishment process is outsourced to an LSP, the supplier could focus on its core competencies. For suppliers the core business is sales, marketing and purchasing, or manufacturing new items. On the other hand, separated replenishment and sales make it possible to measure and monitor supplier and LSP performance more efficiently through the transparent cost structure of the VMI service (item and service costs separated).

When there are huge differences in organisational cultures, can the sales and replenishment processes be separated? However, when companies' processes are integrated, the idea is to have closer contact with the customer – it is possible to visit the customer's site regularly. We also noticed totally opposite views: an expensive sales specialist should not waste his time on logistics activities, for example unpacking, at the customer's site.

There are arguments in favour of separating sales and replenishment but also arguments in favour of integration. We consider that it is always case specific which is the competitive way to go. Our findings are that it is reasonable to use an LSP in a VMI partnership in the following cases:

- in a multi-supplier environment, an LSP integrates inbound material flows
- sales are separated from the replenishment process
- logistics cost should be separated from item costs
- core competence is not in logistics, or a company's own managed logistics does not bring a competitive advantage
- there is a long distance between supplier and customer

### **INFORMATION IN VMI OPERATIONS**

Demand information has lately been a hot topic in academic papers (e.g. Holweg et al. 2005; Vigtii, 2006), but operational management also requires other kinds of information. Based on our research, in the case of industrial Class C materials, there is no systematic information sharing between supplier and customer. Class C is not typically included in Materials Requirement Planning (MRP) but where Class A and B are concerned it is crucial. These materials are critical for the customer's production, so availability should always be ensured. The supplier needs information about consumption for the planning of manufacturing and replenishment. Cases of Class C materials are usually handled manually (during visits to the customer's site).

Our VMI concept includes a model for automated information collecting and sharing (Hemilä et al. 2006). The basic idea is that information should be a driver for operational change. If information from the customer's warehouse (stock level) is available, the supplier should change its operational model. Without this information, the supplier visits the customer site regularly according schedule. With this information, every visit should be planned, agreed and only done when needed. We can describe this change as one from "bus timetable" to "fleet management".

### **THE ADVANTAGES OF LSP SERVICES FOR VMI PARTNERSHIPS**

Many advantages of VMI can be found in the academic literature. Holmström (1998) has noticed that the focus of VMI is on lowering overall costs and

decreasing operational management. An LSP in the supplier-customer relationship does not always create an additional cost, because operational costs are decreased, particularly on the supplier side (replenishment efficiency). Ordering typically takes much time and effort, but in VMI it is not needed. The VMI contract will clarify common rules, like delivery quantity, frequency, min-max levels etc. In this way, VMI requires less management, with maximum availability. The contract could be similar with or without an LSP, only the material will be managed physically by the LSP or the supplier.

Our research project included LSPs who have developed VMI services. The main process is pure logistics: incoming materials, unpacking, labelling, storing and delivering for customer's self. Pure logistics does not include any valuable features. The advantage of LSP usage is the integration of material flows (multi-supplier environment). There is always a lack of warehouse space at the customer's site, and this is the main challenge for Class C materials. It would be best for supplier to have about a month's supply of materials at the customer's site. In many cases this is not possible, because of a lack of space. This means that the supplier has to increase replenishment frequency – and this increases costs. An LSP could be the solution for this, too. As an LSP's core business is warehousing and value-added logistics services, an LSP could provide safety stock near by the customer and replenish often. An LSP could provide a wide range of logistics services, not only VMI replenishment. That's why an LSP is much more cost effective than a VMI service provided by the material supplier.

## **CONCLUSIONS**

Logistics outsourcing has been one of the key actions of industrial companies, but in the case of industrial VMI operations, a competitive advantage through outsourcing is not always easy to identify. LSPs are focused on logistics, so they manage it better than suppliers or customers. Focusing on core competence is the best solution for every player in the supply chain, so outsourcing would be a good solution for a VMI operation. LSPs are developing their core business with value-added services. We consider that VMI could be a potential area of development for many industrial partnerships and that utilisation of LSP could make partnerships more competitive. There is still a need for research in the field of industrial logistics, VMI partnerships and the utilisation of LSPs.

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## QUANTIFYING THE BULLWHIP EFFECT IN INVENTORY MANAGEMENT POLICIES

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### ABSTRACT

We investigate the bullwhip effect (BE) resulting from order batching under EOQ inventory management policy. We first analytically derive the exact formulae to quantify the increased variability of orders due to batching for a two-echelon supply chain. Our model assesses BE as the variance ratio, that is the ratio between the demand variance at the downstream and at the upstream stages of the supply chain. Robustness and correctness of the model are validated by mean of a simulation tool properly developed to this extent. The comparison shows a good correspondence between analytical results and simulated ones.

*Keywords: Bullwhip Effect, reorder policies, lower bound, simulation model*

### INTRODUCTION

The bullwhip effect (BE) is a wasteful phenomenon that occurs due to a lack of information across the supply chain. According to Lee et al. (2004a), the bullwhip effect arises when orders to the supplier tend to have larger variance than sales to the buyer, and the distortion propagates upstream in an amplified form. BE thus involves both demand distortion and variance amplification moving upstream the supply chain. Both effects were first demonstrated by Forrester (1961) and are currently observed in many supply chains (see Lee et al. 2004b, Geary et al. 2006, for several examples), where they cause, among others, excessive inventory, poor forecasts, loss of revenue, excessive/insufficient production capacity, inaccurate production plans throughout the supply chain (Lee et al. 1997, 2004a).

Four major causes of the bullwhip effect have been investigated in literature (Lee et al. 1997), such as (i) "demand signal processing" (also called "demand forecast updating" by Geary et al. 2006), (ii) "order batching", (iii) "price fluctuations", and (iv) "rationing and shortage gaming".

In this paper, we focus on the second factor causing the BE, and, in particular, we provide an analytical model to quantitatively assess the increase in demand variability as a function of batching caused by common inventory management policies, such as EOQ or EOI. The paper is organised as follows. To illustrate the contribution of our study to the existing literature, we first review previous works discussing quantitative models for the BE, with a particular focus on those investigating order batching. Then, we introduce the model developed to quantify the bullwhip effect generated by order batching. The model is tested through a numerical simulation, which is detailed in section 4, together with the comparison between analytical and numerical results. Concluding remarks and future research directions are finally presented.

## LITERATURE REVIEW

The bullwhip effect has been debated in literature from many different perspectives. In particular, scientific papers related to the BE can be categorised into the following groups:

- a first group of papers deals with a description of the phenomenon, related triggering factors, consequences on the supply chain, and theoretical issues (Lee et al. 1997a,b, Geary et al. 2006);
- several scientific works provide quantitative assessments of BE generated by one or more of the above causes (Chatfield et al. 2004, Chen et al. 2000);
- finally, many papers suggest remedies to the BE, such as the adoption of proper inventory management policies (Boute et al. 2007, Lin and Lin 2006), or the introduction of advanced demand information in order processing (Ouyang and Daganzo 2006).

Since we provide an analytical assessment of BE, our review of the literature has been particularly focused on the second group of works. Among such papers, a further taxonomy can be made, based on the methodological approach followed to quantitatively assess the BE and the cause of BE examined.

Methodological approaches to investigate the BE mainly refer to statistical inventory control and control system engineering models. Chen et al. (2000) made one of the first attempts to quantify the BE based on statistical inventory control models. They investigated the impact of demand forecasting, lead time and information sharing on BE in a three-echelon supply chain, by quantifying the increase in demand variance due to these factors, separately examined. The ratio between the demand variance at the downstream and at the upstream stages of the supply chain ("variance ratio"), is derived as a viable BE measure for each factor investigated. Similarly, Lee et al. (2004a) have analytically computed the increased demand variability as a consequence of demand signal processing, rationing and shortage gaming and order batching. Through a simulation model, Chatfield et al. (2004) have examined the effect of stochastic lead time, information sharing and the level of information quality on the demand variance amplification in a multi-echelon supply chain. They find that lead-time variability exacerbates variance amplification, while updates of the order-up-to levels are a necessary condition for BE. Evidence is also provided about the significance of information sharing and information quality on the amplitude of BE. Holland and Sodhi (2004) focused on the demand amplification generated by batching and order errors in a simple supply chain, composed of manufacturer, retailer and end customer. Based on observations from an appropriate simulation model, the authors statistically derived regression models of variance amplification for manufacturer's and retailer's orders. Our approach differs from Holland and Sodhi's one, since we analytically derive the mathematical expressions for the variance amplification due to batching, and use simulation to verify the correctness of the analytical formulae.

Scientific papers exploiting control system approaches to quantify the BE are less numerous; this is probably due to the complex mathematical formulation of control theory, which makes it a common tool mainly in the OR community. We briefly review control system models of BE, although, in our work, we will adopt a statistical inventory control model. Dejonckheere et al. (2003) have developed a control theory approach to quantify the variance amplification due to reorder policies. Results obtained demonstrate that order-up-to policies always cause BE, no matter the forecasting technique adopted; hence, they propose a new replenishment rule able to generate smooth ordering patterns. Recently, Kim et

al. (2006) have extended the works by Dejonckheere et al. (2003) and Chen et al. (2000) by investigating BE with gamma-distributed lead time. As a result, they derive expressions for BE, in terms of variance amplification, both with information sharing and absence of information sharing. In all these papers, the model adopted to quantify the BE is limited to one retailer; conversely, we investigate the BE generated in a supply chain by several retailers, as detailed in the next section.

## THE MODEL FOR BE QUANTIFICATION

### General overview

We refer to the two-echelon supply chain sketched in Figure 1. In such system, the distribution centre (DC) serves  $N$  retailers ( $R_1, \dots, R_N$ ); DC has access to an infinite amount of products, so that orders from retailers can always be satisfied without ordering at a manufacturer. For each retailer ( $j=1, \dots, N$ ), we assume a deterministic lead time  $L_j$  between the time an order is placed and received. Each retailer faces the final demand  $d_j$  of end customers. Demand data are assumed to have a uniform distribution, i.e. demand values ranging between two defined values are equally probable.

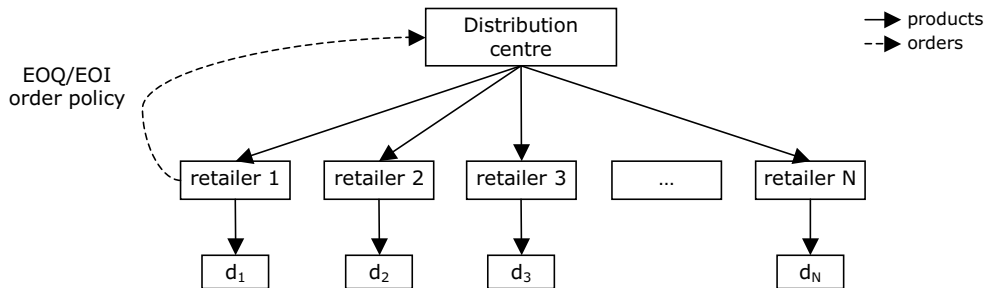


Figure 1: the supply chain analysed.

The minimum and maximum demand levels will be referred to as  $a_j$  and  $b_j$  ( $j=1, \dots, N$ ); both parameters refer to daily demand data. We suppose that retailers operate under EOQ reorder policy; accordingly, orders are placed when the inventory level is lower than the order point (OP). This latter is computed based on end customer demand; to this extent, we consider two separate scenarios, namely:

1. estimation of end customer demand by means of forecasting techniques;
2. computation of end customer demand based on statistical parameters of the related distribution.

The analytical formulae provided in both cases do not substantially differ, since scenario (2) can always be seen as a particular case of scenario (1), where demand statistical distribution is known to retailers. Hence, we will provide numerical validation only for formulae of scenario (2).

### Estimation of end customer demand by means of forecasting techniques

In line with similar studies on BE (Zhang 2004; Disney et al. 2006), we suppose that end customer demand is estimated by retailers based on a moving average forecasting with  $m$  observations. For each time period  $t$ , demand mean  $\mu_{j,t}$  and variance  $\sigma_{j,t}^2$  of the  $j$ -th retailer can be derived starting from the daily demand data  $d_{j,t}$  as:

$$\begin{aligned}\mu_{j,t} &= \frac{1}{m} \sum_{k=t-m}^t d_{j,k} \\ \sigma_{j,t}^2 &= \frac{1}{m-1} \sum_{k=t-m}^t (\mu_{j,t} - d_{j,k})^2\end{aligned}\quad (1)$$

Each retailer updates  $EOQ_{j,t}$  and order point  $OP_{j,t}$  levels according to the following set of formulae:

$$\begin{aligned}OP_{j,t} &= L_j \mu_{j,t} + k_j \sqrt{\sigma_{j,t}^2 L_j} \\ EOQ_{j,t} &= \sqrt{\frac{2\mu_{j,t} O_j}{h_j}} = \alpha_j \sqrt{\mu_{j,t}}\end{aligned}\quad (2)$$

being  $k_j$  the service level required,  $O_j$  the cost for orders placing [€/order] and  $h_j$  the daily cost of holding stocks [€/day] of the  $j$ -th retailer. To simplify the notation, we have defined  $\alpha_j = (2O_j/h_j)$ .

The  $j$ -th retailer places an order at time  $t$  if the current inventory level is lower than  $OP_{j,t}$ . We call  $T_{i,j}$  the stochastic time interval between subsequent orders  $i$  and  $i+1$ , and define  $p_{i,j}$  as the probability that retailer  $j$  places an order during period  $i$ : since  $T_{i,j}$  days pass between two subsequent orders, we have  $p_{i,j} = 1/T_{i,j}$ . It can be demonstrated<sup>1</sup> that, when considering a large number of days, the probability  $p_j$  that retailer  $j$  places an order can be expressed as:

$$p_j = \frac{\mu_j}{M_{EOQ,j}}\quad (3)$$

being  $\mu_j$  the demand mean. To obtain an analytical expression of the variance ratio, we investigate the distribution of orders and compare them with the demand data. Let  $A_j$  be the stochastic variable describing the orders placed by the  $j$ -th retailer. We demonstrate that the mean  $M_{A,j}$  and standard deviation  $\sigma_{A,j}$  of  $A_j$  can be computed according to the formulae below:

$$M_{A,j}(x) \equiv \mu_j\quad (4)$$

$$\sigma_{A,j}^2(x) \equiv \mu_j \left( M_{EOQ,j} - \mu_j + \frac{\sigma_{EOQ,j}^2}{M_{EOQ,j}} \right)\quad (5)$$

being  $\sigma_j$  the demand variance. Based on the above equations,  $BE_j$  of the  $j$ -th retailer and  $BE_{TOT}$  of the supply chain can be expressed as follows:

$$\begin{aligned}BE_j &= \frac{\sigma_{A,j}^2}{\sigma_{d,j}^2} \equiv \frac{\mu_j}{\sigma_j} \left( M_{EOQ,j} - \mu_j + \frac{\sigma_{EOQ,j}^2}{M_{EOQ,j}} \right) \\ BE_{TOT} &= \frac{\sum_{j=1}^N \sigma_{A,j}^2}{\sum_{j=1}^N \sigma_{d,j}^2} = \frac{\sum_{j=1}^N \mu_j \left( M_{EOQ,j} - \mu_j + \frac{\sigma_{EOQ,j}^2}{M_{EOQ,j}} \right)}{\sum_{j=1}^N \sigma_j^2}\end{aligned}\quad (6)$$

Eq.6 expresses the variance ratio as a function of  $M_{EOQ,j}$  and  $\sigma_{EOQ,j}^2$ . To derive them, we investigate the probability density function of EOQ, which, based on the assumptions made, can be considered as a stochastic variable depending on the mobile mean parameters (see eqs.1-2). Specifically, for the  $j$ -th retailer,  $f_{EOQ,j}$  can be approximated to a Normal distribution, expressed as:

<sup>1</sup> Due to the limited number of pages, the derivation of this and other formulae has been omitted. Interested readers are welcomed to contact the authors for additional details about the analytical procedure.

$$f_{EOQ,j}(x) = \frac{2x}{\alpha_j^2} \cdot \frac{1}{\sqrt{2\pi}\sigma_j} e^{-\frac{1}{2}\left(\frac{x/\alpha_j - \mu_j}{\sigma_j}\right)^2} \tag{7}$$

Hence,  $M_{EOQ,j}$  and  $\sigma^2_{EOQ,j}$  can be derived as:

$$M_{EOQ,j} = \int_0^{\infty} x \cdot f_{EOQ,j}(x) dx = \alpha_j \sqrt{\sigma_j} M(\rho_j)$$

$$\sigma_{EOQ,j}(x) = \int_0^{\infty} (x - M_{EOQ,j})^2 f_{EOQ,j}(x) dx = \alpha_j^2 \sigma_j \sigma^2(\rho_j) \tag{8}$$

being  $M(\rho_j) = \int_0^{\infty} 2z^2 \cdot \frac{1}{\sqrt{2\pi}} \cdot e^{-\frac{1}{2}(\rho - z^2)^2} dz$      $\sigma^2(\rho_j) = \int_0^{\infty} 2z(z - M(\rho_j))^2 \frac{1}{\sqrt{2\pi}} \cdot e^{-\frac{1}{2}(\rho - z^2)^2} dz$

and  $\rho_j = \mu_j/\sigma_j$ .  $M(\rho_j)$  and  $\sigma^2(\rho_j)$  can not be mathematically solved, and should be numerically derived as a function of  $\rho_j$ . The following table provides, as an example, the numerical values of  $M(\rho_j)$  with  $0 \leq \rho_j \leq 9.9$ .

	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0	0.4110	0.4550	0.5008	0.5482	0.5969	0.6466	0.6970	0.7479	0.7990	0.8499
1	0.9006	0.9507	1.0000	1.0485	1.0960	1.1425	1.1877	1.2318	1.2746	1.3162
2	1.3566	1.3958	1.4339	1.4709	1.5069	1.5418	1.5759	1.6091	1.6415	1.6731
3	1.7041	1.7344	1.7640	1.7931	1.8216	1.8497	1.8772	1.9043	1.9310	1.9573
4	1.9832	2.0087	2.0339	2.0587	2.0832	2.1075	2.1314	2.1550	2.1784	2.2015
5	2.2244	2.2470	2.2694	2.2915	2.3134	2.3351	2.3566	2.3779	2.3990	2.4200
6	2.4407	2.4612	2.4816	2.5018	2.5219	2.5417	2.5615	2.5810	2.6004	2.6197
7	2.6388	2.6578	2.6766	2.6953	2.7139	2.7324	2.7507	2.7689	2.7870	2.8049
8	2.8228	2.8405	2.8581	2.8756	2.8930	2.9103	2.9275	2.9446	2.9616	2.9785
9	2.9953	3.0120	3.0286	3.0451	3.0615	3.0778	3.0941	3.1103	3.1263	3.1423

**Table 1: numerical values of  $M(\rho_j)$  with  $0 \leq \rho_j \leq 9.9$ .**

**Computation of end customer demand based on parameters of the statistical distribution**

Under this scenario,  $\mu_{j,t}$  and  $\sigma^2_{j,t}$  of each time period  $t$  can be derived starting from the parameters of the demand distribution, that is:

$$\mu_{j,t} = \frac{b_j - a_j}{2} = \mu_j \quad \forall t$$

$$\sigma^2_{j,t} = \frac{(b_j - a_j)^2}{12} = \sigma_j^2 \quad \forall t \tag{9}$$

Accordingly,  $EOQ_{j,t}$  and  $OP_{j,t}$  reduce to:

$$OP_{j,t} = L_j \mu_{j,t} + k_j \sqrt{\sigma^2_{j,t} L_j} = OP_j \quad \forall t$$

$$EOQ_{j,t} = \sqrt{\frac{2\mu_{j,t} O_j}{h_j}} = \alpha_j \sqrt{\mu_{j,t}} = EOQ_j \quad \forall t \tag{10}$$

where we have used the same symbols of previous eq.2. As can be seen from eq.10, under this scenario both EOQ and OP only depend upon  $a_j$  and  $b_j$ . Based on eqs.10 and 3, the probability  $p_{i,j}$  that retailer  $j$  places an order during period  $i$  can be rewritten as:

$$p_j = \frac{\mu_j}{EOQ_j} \tag{11}$$

being  $\mu_j$  the demand mean for the  $j$ -th retailer. Thus,  $M_{A,j}$  and  $\sigma_{A,j}$  reduce to:



$$M_{A,j}(x) \equiv \mu_j \quad (12)$$

$$\sigma_{A,j}^2(x) \equiv \mu_j(EOQ_j - \mu_j) \quad (13)$$

The bullwhip effect  $BE_j$  for the  $j$ -th retailer and the total bullwhip effect  $BE_{TOT}$  in the supply chain examined can be finally expressed as follows:

$$BE_j = \frac{\sigma_{A,j}^2}{\sigma_{d,j}^2} \equiv \frac{\mu_j}{\sigma_j} (EOQ_j - \mu_j)$$

$$BE_{TOT} = \frac{\sum_{j=1}^N \sigma_{A,j}^2}{\sum_{j=1}^N \sigma_{d,j}^2} = \frac{\sum_{j=1}^N \mu_j (EOQ_j - \mu_j)}{\sum_{j=1}^N \sigma_j^2} \quad (14)$$

### MODEL VALIDATION

We now test the analytical formulae derived for BE quantification under scenario (2) through a simulation model, properly set up to this purpose. To validate our formulae, analytical results are compared with the variance ratio  $\sigma_{orders}^2/\sigma_{demand}^2$  computed starting from simulated data.

We consider  $N=246$  retailers ( $j=1, \dots, 246$ ), facing a uniformly distributed demand with  $a_j=10$  [unit/day] and  $b_j=55$  [unit/day]. For all retailers ( $j=1, \dots, 246$ ), we suppose  $L_j=4$  days, 95% service level required ( $k_j=1.64$ ), and  $EOQ_j=600$  units. The simulation starts with an initial stock level of 500 units and generates random demand values  $d_{t,j}$  between the above defined limits  $a_j$  and  $b_j$ . We consider 1100 days of simulation ( $t=1, \dots, 1100$ ). At every day  $t$ , the inventory level of the  $j$ -th retailer is updated according to  $inventory_{t,j} = inventory_{t-1,j} - d_{t,j}$ . When the stock level falls to the OP, an order is placed.

Comparison between BE resulting from analytical assessment and simulated data is proposed in Table 2. Results are shown for the  $j$ -th retailer, except where they have been referred to as "total".

	Analytical values	Simulated values	Comparison
Demand mean $\mu_j$	32.5	32.25	0.769%
Demand variance $\sigma_j^2$	168.75	172.39	2.111%
Orders mean $M_{A,j}$	32.5	32.21	0.892%
Orders variance $\sigma_{A,j}^2$	18443.75	18305.76	0.748%
Total orders variance	4537162.5	4528537.94	0.190%
Bullwhip effect $j$ -th retailer	110.47	109.30	1.059%
Total bullwhip effect	108.98	109.30	0.293%

Table 2: analytical and simulated results and comparison.

### FUTURE RESEARCH DIRECTIONS AND CONCLUSIONS

We have proposed an analytical assessment of the bullwhip effect as a function of order batching under EOQ inventory management policy. Our works contributes to the literature in that it provides exact formulae to quantify the BE in the case of both demand forecasting and computation of demand based on the parameters of the related statistical distribution. The model developed has been tested through an appropriate simulation tool; comparison between analytical results and simulated ones has shown that the proposed formulae allows accurately predicting the BE as a function of the EOQ.

Future research can be directed to extend the proposed tool to the EOI policy, being known in literature that order-up-to policies always generate BE (Chatfield

et al. 2004). Moreover, examining different demand statistical distributions is required, in order to test the correctness of the formulae proposed in this paper.

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## **WORKFLOW MANAGEMENT IN PLM SYSTEMS**

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### **ABSTRACT**

A product being the backbone of any manufacturing industry, their management is the top priority for any company. Managing the products from cradle to grave encompasses various functions of an organization and often multiple organizations. In a concurrent enterprising architecture, integration of various business processes, tools and stakeholders across the product life cycle from the ideation to phase-out of the product provides greatest competitive advantage.

In the past PDM (Product Data Management) as a technology was partly contributing in all this. Over a period of time Product Data Management (PDM) has gone through several changes such as scope increase, concept re-definitions and new technology underpinnings to finally evolve into what is today commonly known as Product Life Cycle Management (PLM).

PLM provides the Information Technology backbone that supports the management of product life cycles from cradle to grave and broadly focuses on providing a cross functional and cross enterprise level integration throughout the product life cycle. "Workflow Management" enables the part of this overall integration by managing the collaboration (sequence, connectivity, access controls) across Extended Enterprise.

Existences of various concepts and methodologies, which are proprietary to the organizations, have proved to be obstacles in the proper evolution, understanding and importance of the workflow management in the product data and information flow. In order to understand the significance and contribution of workflow within and across extended enterprise we need unambiguous answers to the following:

- ◆ Who defines the workflow in PLM?
- ◆ What information is needed in the workflow?
- ◆ What is an effective approach to define the workflow in PLM?

This paper explores solutions to the present challenges in workflow management and provides a treatment on the transformation of the workflows from legacy systems and PDM concepts to the present and evolving PLM concepts and their application to provide organizational benefits.

### **INTRODUCTION**

The evolution from PDM (Product Data Management) to PLM (Product Lifecycle Management) was a migration from "paper-oriented workflows for managing drawings, BOM (Bill Of Material), ECN (Engineering Change Note) and design release, limited to a single department and "one enterprise" to a more "global, automated and better managed" paradigm. Gone are the days when designers had a choice to create their vision of new product and go for multiple iterations to assess them. Release would take days and production would wait for the right

versions to come in. Today's enterprises have become smart by involving more knowledge pool across diverse locations, collaborating across boundaries, to integrate information and optimize processes across designers, manufacturers, suppliers and even customers for the present more complex & faster product proliferations. This has been achieved through a clear and systematic definition of the term "Workflow".

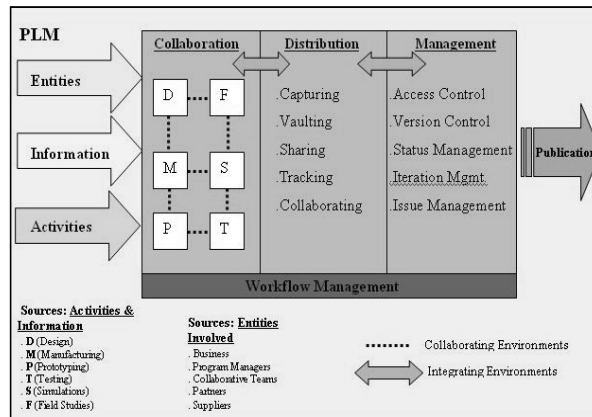


Figure 1: Components of workflow management

Workflow is "Management of the various activities, related information and entities that perform these activities through process automation". A well defined workflow can speed the flow of innovative products in the markets, reduce the overheads and most importantly can prevent delays in supply chain by providing right information at right time. Figure 1 illustrates the discrete breakdown of the workflow management at enterprise level in a PLM solution.

### **WORKFLOW MANAGEMENT: A FEW CHALLENGES**

**Managing huge amount of data:** The most vital element today is aligning of the abundance of data & information flow occurring in the development of the product. Design & Manufacturing are well known for churning huge amounts of product data and information in short span of time. How do we capture, share, collate & track this information is the call of the hour today? Mismanagement of data impacts the overall efficiency of operation like resulting in duplication of work:

**Managing workflow definition, "Who defines it and how":** Most of the workflow capabilities are defined based on current needs without considering the scalability. This approach results in huge gap in expectations versus actual achievements. Further trying to automate all the capabilities can be a myopic view and may not offer the scalability required and the required ROI. A clear focus on defining and understanding the impact of workflow can reduce lots of revenue leaks and return significant overall benefits.

**Managing information needs "What is needed and when":** Consider some of the situations:

- Do the designers have all the relevant & updated information of changes happening to the product? Designer says, “We had almost released the design to production and then the change note came in. We had to rework with extra people put in.”
- Does manufacturing have relevant information on the latest versions of the part? Manufacturing says “We manufactured the part with revision A as part with revision B was not uploaded / updated in the system.”
- Is the process simple enough to understand? Business architect says “Process being iterative (especially NPD), includes a mesh of cross functional interactions. We lose traceability.”
- Does present workflow cover all the departments or only specific departments and areas? Marketing feels “Present workflow does not cover my department needs.”
- Is the information and data exchanged in collaborative tools captured and maintained? IT Manager says: Though we collaborated the design, tracking the same and maintaining it in the systems have resulted in cost overheads.

Unless a holistic view is taken to determine the information needs at each step in workflow contextualized to functions/organizations involved, the situations as above will remain.

### **WORKFLOW MANAGEMENT – A DEEP DIVE**

Consider the illustrative flow (figure 2). For Design office (refer to design box) the Information (viz. from sales on design changes, modifications, customer requirements etc.) is carrier and the Activity (incorporating design changes, verification, release to manufacturing etc) is the building block, i.e., information resulting in activity. The Production office starts with the Activity (e.g. developing a prototype) while the Information (e.g. learnings about the manufacturing process while building the prototype) that can be used to optimize the design and cost becomes a building block; i.e., activity resulting in information. The collaboration may be within the boundaries of an enterprise or even across boundaries, for example the fabless semiconductor players only design while the actual manufacturing is done by a fabricator. The Workflow Management approach extends such collaboration throughout the supply chains across enterprises, and also across complex network of processes and functions, to build a comprehensive product management system leading ultimately to an “Extended Enterprise”.

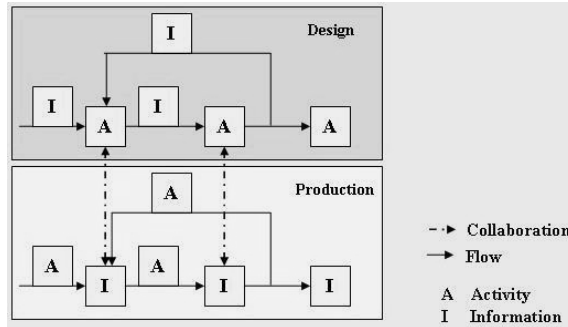


Figure 2: Collaborative workflow illustration

**WORKFLOW MANAGEMENT – AN EFFECTIVE APPROACH**

PLM believes in the common processes, common methods and common tools across the industry. In discrete terms, first comes a harmonized way of working, next synchronized methods and finally common tools for better product proliferations. There are multiple dimensions that need to be considered while defining a workflow solution for an enterprise. The approach to these dimensions needs to be contextualized to the environment (organization, function etc) its being deployed into.

**Data Synchronisation: Traceability, Updates & Information exchange in collaborative environment**

In large supply chains while collaborating for particular design change, exchange of engineering information and knowledge is phenomenal and various parties contributing in the change can have a serious effect on overall flow. In such a volatile and high risk-sharing environment it is imperative to provide right information to right people in a short span ensuring traceability and access control. Segregation of the data by allotting specific workspaces for functions could prove beneficial in data recovery in later stages.

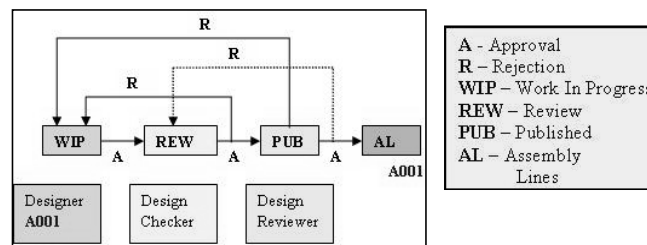


Figure 3: Illustrative Design Release Process

Figure 3 illustrates a Design Release Process (DRP). The DRP of the product involves multiple steps before the design is officially released for assembling. This process can be managed leveraging policies and rules established for various components like:

- “State management” – where the state change of the design from WIP (Work In Progress) to Published can be captured
- “Version management” – where the version like A001, B001 can be taken care of so as to have better visibility & traceability
- “Revision management” – where all the revision history of the product’s design can be maintained
- “Document management” – could provide an insight into all the technical documents used and referred for the design of the product and many more can be customized as per the industry needs.

The breakup of the product life cycle into small process cycles supports the better workflow and traceability of the product. As is illustrated in figure 3, the design is released in the PLM system. All the state changes and criteria for the workflows (i.e. if approved go the next stage and if rejected come back to the defined stage) can well be automated and controlled in the PLM systems. The respective actors can be identified at respective states. This helps in reducing the time to release the design for final assembly and in turn drastically reduces the time to bring product into the market. Such synchronized data flow can prevent revenue leaks. Thus by definition “*Workflow manages the activities (design release), related information (approval/rejection) and entities (designer, design checker, program approver and design approver) that perform these activities through process automation*”.

The best way to manage engineering information is to keep analyzing “As-Is” process maps and keep optimizing them.

### Operationalizing Access controls

Typically in any product design initiative there is a whole project team (can be cross enterprise) is divided into subgroups with access rights defined to each group. Consider three teams working on three different parts of a design figure 4.

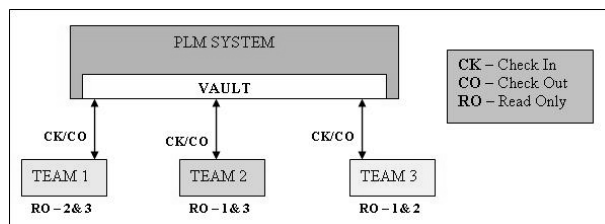


Figure 4: Multiple teams accessing design

They access the same vault but every team has been defined the check in and check out rights in the vault. The team working on the design would only have the write permissions and other teams would have the read permissions and can use the design for reference. Also, once the design is checked out, the lock can be created over the part, which means other team would have this part for reference only. Similarly, the import and export of the data from various locations can be maintained.

### CONCLUSION

For having an effective workflow definition and management, the main focus in the industry should be on the harmonization and alignment of the common

processes and tools to adapt to new technological changes. One of the important aspects to consider while any such initiative is launched is the change management. The collaborative environment and extended enterprise approaches have shown the encouraging results to increase the productivity, reduce time to market and increase in quality. The workflow management if mapped to the defined processes not only automates certain tasks but also brings in new teams and people to work more effectively and efficiently.

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## **LEAN MANUFACTURING: A NEW CONCEPT OR A RE-PACKAGED JUST-IN-TIME MODEL?**

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### **ABSTRACT**

The objective of this research was to have a current understanding on the fundamentals of lean manufacturing (LM). The paper discusses the commonality of concepts and tools between Just-in-Time (JIT) and LM approaches to business. An industrial survey taken from eight U.S. companies all involved in LM revealed that the philosophy of lean thinking must be transformed into the entire organization both vertically and horizontally. A lean manufacturing floor is only a subset of a lean enterprise and may not by itself provide a maximum desirable productivity. Instead, a culture of lean thinking within the framework of continuous improvement is the central requirement for global business competitiveness. The survey also indicated that Manufacturing Resource Planning (MRPII) and LM may coexist but that MRPII usage must be limited to the planning function whereas manufacturing and material order launching must be executed through JIT/ LM methods. Additional survey comments are provided in regards to LM benefits, critical success factors and tool usage.

### **INTRODUCTION**

More than 40 years ago, the new manufacturing concept of Material Requirements Planning (MRP) created a significant change in the planning and scheduling of manufacturing operations and purchasing activities across a large spectrum of industries. This revolutionary approach had two fundamental differences from the old reorder point policies of inventory replenishment and scheduling of shop floor activities. It first required forecasting only for independent items, such as the end items, service parts and common sub-assemblies/components (in build-to-order and assemble-to-order environment). All the other requirements for manufacturing and purchasing needed to be computed through an MRP's gross-to-net algorithm. The second requirement was to have a backward schedule assigned to all shop floor and material purchase activities. In the 1970's, a closed-loop model of MRP was introduced under the banner of Manufacturing Resource Planning (MRPII). This model stressed the importance of including the business plan, sales and operations plan, and production plan (aggregate plan) as various checks and balances at top planning levels before the master schedule could trigger the MRP engine to generate manufacturing and purchase orders. Although MRPII implementation has increased the business productivity of many manufacturing operations, it has some fundamental and undeniable problems associated with it. Four critical problems associated with MRP II applications are: 1) the assumption of constant/fixed lead times; 2) the assumption of infinite manufacturing capacity; 3) inadequate or inflated Master Production Schedule (MPS); and 4) data inaccuracy as related to bills of material, inventory records and routing information. These problems often have resulted in work-in-process (WIP) accumulation, missing customer due dates, work center inefficiencies, hidden

quality/defect problems, and employee frustration. The “schedule-push” approach of MRPII on the shop floor needed a new challenger.

### **JUST-IN-TIME MANUFACTURING**

In the 1980's many companies, disappointed by the inherent problems associated with MRP II, began exploring a dramatically different approach to manufacturing within the framework of Just-in-Time (JIT) philosophy. This approach, as originally developed by the Toyota Production System (TPS), is based on a demand-pull system of production as opposed to a schedule-push method of MRP II. However, the fundamental core of JIT philosophy is the elimination of waste (muda) through relentless continuous improvement (Kaizen) activities. There are, specifically, seven types of manufacturing wastes as defined by TPS:

- Waste of process
- Waste of overproduction
- Waste of motion
- Waste of delay
- Waste of transportation
- Waste of inventory
- Waste of defects

The above wasteful elements of production are continuously reduced with the objective of a final elimination. The remaining of this section lists and briefly explains some of the established TPS methods to combat these wastes. Needless to say, these are only a few proven techniques and by no means they cover the entire spectrum of all kaizen methods.

- **Pull production system with Kanban mechanism**  
To have a maximum control of material flow with production authorization coming from downstream work centers, hence resulting in a minimum level of inventory at each work center.
- **Production synchronization**  
To apply takt time (precise time for products to move through each work center) along with a line balance and Kanban pull to achieve a smooth and predictable flow of material.
- **Heijunka (level-loaded production)**  
To avoid the peaks and valleys of capacity load requirements and related production activities. The philosophy of TPS is to have a monthly frozen production plan with  $\pm 5\%$  tolerance limits.
- **Nagara (multi-tasking)**  
To train operators on several machine tools so that they may be involved in the set-up and operations of other machines while their own machines are running. Some companies apply a “one-up, one-down” method of training so that each operator is fully trained on at least the operations of the immediate work centers before and after.
- **Jidoka (automatic line stoppage)**  
To provide an autonomous system where either the machine or operator can halt the production if a quality or defect problem is sensed or detected. The JIT/TPS rule is to never pass a defective part to the next work center.
- **Set-up reduction**  
To reduce the machine set-up times ideally to less than 10 minutes and hence a single-minute-exchange of-die (SMED). The purpose of SMED is to provide flexibility to run small lot sizes of high product mix.
- **TPM (Total Productive Maintenance)**

To increase the machine uptime by involving autonomous teams of operators in the basic elements of machine maintenance on a routine basis. The goal of TPM is to achieve higher production capacity by increasing machine uptime. The performance measure for TPM should be machine effectiveness as opposed to machine efficiency where “effectiveness” refers to the availability (= uptime) of the machine, if and when it is needed.

- **Poka-Yoke (Fail-Safe)**

To design work centers and support system so that the operators do not have to be concerned about making production errors. Principles of proper layout and ergonomics can help achieve this goal.

- **Five S's (Seiri, Seiton, Seiso, Seiketsu, Shitsuke)**

To promote work center/machine standardized cleanup procedures through tidiness, orderliness, cleanliness, standards, and sustaining discipline.

- **Five Why's**

To ask multiple sequential questions to seek the root cause of the problems.

In the experience of the author, the above tools by themselves and without a well defined framework would create nothing but confusion and misunderstanding at various levels of the production planning and control. One must understand that JIT is a philosophy of manufacturing floor execution and control with a relentless goal of waste elimination. Without an extensive education and total management commitment the benefits from these methods, as adopted from TPS, would only be marginal. Only a systematic and patient preparation and implementation would yield a positive and high velocity impact on productivity (Pouraghabagher, 1993).

## LEAN MANUFACTURING

The concept of lean manufacturing (LM) has recently become a visible signal within the competitive circle of the U.S. manufacturing companies. Although the heart of the matter in LM is the same as that of JIT/TPS, waste elimination through Kaizen, it seemingly has not been limited only to manufacturing operations. These days the concept of “lean” is being used in lean supply chain, lean accounting, lean information technology, lean customer relations, lean product development, to name a few. The true believers and practitioners of LM have elevated it to a lean enterprise status. In the past 10 years, a number of articles and books have discussed various attributes of lean approach to business. Examples include, the history of lean management in America (Emiliani, 2006), lean thinking (Womack and Jones, 1996), the integration of lean management and six sigma (Arnheiter and Maleyeff, 2005), and lean R&D (Arnheiter, 2005). In addition, a multi-year research program at MIT focusing mainly on the international automobile industry introduced the term “lean manufacturing” and emphasized on the expansion of lean concepts across the total enterprise. This work by MIT was a direct reason for the formation of Lean Aerospace Initiative (LAI) in the U.S. to promote lean thinking, not only in manufacturing but in all aspects of business (<http://web.mit.edu/lean/index/html>).

The principles of LM can be summarized by the following elements:

1. **Value:** Is solely defined by customer(s) in terms of time, cost, quality, flexibility and product support/services. Everything else is non-value added.
2. **Value Stream-Mapping (VSM):** Is an end-to-end mapping and linking all the processes. In doing so, all non-value-added (wasteful) elements are eliminated. The current and future status of all processes are mapped out using classical

symbols of process, motion, storage, and other activities. (There are currently a number of reasonably priced software programs available to facilitate VSM.)

- 3. Flow:** Is established with the concept of value in mind. In manufacturing, the flow of material and supportive information for each work center and/or department is linked to the next to maximize the value defined by the customer(s).
- 4. Pull:** Is promoted through a demand-pull system using production authorization and material withdrawal by various signs and signals (Kanban). The purpose is to have a precise predictability and control for inventory build-up at each work center and throughout the plant. With a controlled and regulated material flow, high quality products and short customer delivery promises are achievable.
- 5. Kaizen:** Is the core of LM to ensure that every aspect of manufacturing is placed under microscope with the objective of further waste reduction and elimination on a never-ending journey.

The above elements of LM seem to be straight-forward. However, in practice LM may not show measurable productivity increases due to several misunderstandings by the management. First, the executives and managers at all levels of the organization must necessarily be the true advocates of lean thinking. They must understand that the central theme in a lean enterprise is continuous improvement to eliminate waste. As such, an organic involvement of all employees, especially operators, manufacturing planners/production control staff and buyers must be encouraged and rewarded. Similar to a JIT manufacturing system, a LM philosophy must promote a "humanized" production system (Pouraghabagher, 1991). The employee involvement is one of the top business objectives within TPS especially at operational level where a constant generation of continuous improvement suggestions is encouraged, expected and formally acknowledged. The lean concept explores its highest potentials if the emphasis is placed on people rather than technology. Another likely management shortcoming is the possibility of falling into a trap of using a tool menu full of buzz words. The techniques of Kaizen and some of the specific tools used in TPS, as listed previously in this paper, must be studied and selectively applied to one's environment. Without adequate education and training on the philosophy of lean thinking, neither the management nor the operators may be ready for implementation of LM principles. Two examples, as experienced by the author, may include Jidoka (line stoppage by operators) and "no-kanban, no-production" approach on the shop floor. Both of these two methods are radically different than the typical operations within an MRPII system. Jidoka promotes an elimination of defective parts before moving to the next work center, while "no-kanban, no-production" results in the highest level of WIP control. Finally, and most importantly, an overall assessment of LM implementation must yield a significant cost reduction to achieve profit maximization, as is the case in TPS (Smalley, 2006). A kaizen program without a correlation with profitability is merely a romantic notion.

## LM SURVEY

In order to have a more current understanding of LM practices, a 20-question survey was sent to 10 companies that were identified to have been involved in various stages of lean concepts implementation. Eight companies responded to the survey. Their profile consisted of two consumer products manufacturers, one producer of industrial goods, three aerospace firms, one company in supply tracking business, and one producer of components for medical devices. Except for one company that was small size in terms of revenue, the remaining seven companies were medium and large by revenue, including two multinationals.

Half of these companies had been exposed to JIT and “pseudo-JIT” manufacturing approaches as long back as 20 years ago. The other half reported to have been indoctrinated to the LM philosophy during the past two years. The operational and manufacturing models of these companies are summarized below. The numbers in parentheses indicate the observed frequencies of the responses (For some questions multiple answers were possible).

#### **Manufacturing Environment**

- Build-to-Stock (1/8)
- Build-to-Order (4/8)
- Assemble-to-Order (2/8)
- Engineering-to-Order (2/8)
- Combination: BTO + ETO (1/8); BTS + ATO (1/8)

#### **Production Volume, Product Mix**

- Low volume, high product mix (5/8)
- High volume, low product mix (2/8)
- Combination: high, high (1/8); medium, high (1/8)

#### **Major Manufacturing Planning and Control System**

- MRP + Program Management (1/8)
- Modified MRP (1/8)
- JIT (2/8)
- LM (1/8)
- MRP + LM Execution (1/8)
- MRP Planning; JIT Execution (2/8)

An important question in the survey asked the companies to report the LM tools that they are currently using. Table 1 has a summary of results.

<b>LM Tool</b>	<b>Frequency</b>
VSM	7/8
Flow analysis	8/8
Pull production system	6/8
Kanban for production	6/8
Kanban for material movement	4/8
Kanban for supply chain	4/8
Andon (Light signals for visual factory)	5/8
Nagara (Multi-tasked operators)	4/8
Jidoka (Automatic line stoppage due to quality problems)	3/8
Poka-yoke (foolproof production mechanisms)	5/8
Heijunka (production level loading)	5/8
Takt time	5/8
SMED	2/8
TPM	3/8
Five S's	7/8
Five Why's	6/8
Kaizen	5/8

Table 1: Frequency of LM tools usage

The survey had three questions dealing with the role of operators in LM. The feedback for these questions are provided below.

#### **Activities by Operators in Addition to Actual Production**

- Production data gathering (8/8)
- Related data analysis (4/8)
- Kaizen board activities (4/8)
- Sharing information across shifts (6/8)
- Sharing information across work centers (7/8)

**Employees Suggestion Program**

- Existing suggestion program (7/8)
- Existing formal procedure to review suggestion (7/8)
- Typical time period to respond to suggestions (2 days – 3 month)
- Actual utilization/implementation of suggestions (15%-75%; Median = 40%)

**Recognition and Reward Program**

- Direct monetary rewards (6/8)
- Non-monetary rewards (7/8)
- Profit sharing (1/8)

The next question was related to the major competitive advantages of LM. Responses are summarized below.

**Advantage of LM**

- Lead time reduction (7/8)
- Cost reduction (8/8)
- Quality enhancement (8/8)
- Flexibility/agility increase (8/8)
- ROI (4/8)
- Other: Overall waste reduction; increase in employee moral; customer satisfaction; transformation of entire business into lean thinking

Finally, there were three open-ended questions. The first one asked for a listing of the top critical success factors to in order to become a world-class LM company. The following summary shows commonly stated critical success factors compiled together.

**Survey Reported Critical Success Factors for LM**

- Educated, committed and supportive top management
- Education and training of LM philosophy and tools vertically and horizontally within the organization
- Knowledgeable and empowered employees, suggestions driven and decision-making involvement
- Promotion of a culture of continuous improvement mindset
- Lean thinking should not be limited to manufacturing operations
- Develop a lean vendor and customer partnership and knowledge base
- Create metrics and business performance measures compatible to a lean enterprise
- Other: Lean is for everyone, managers down to operators; develop subject matter experts in LM; have a sense of urgency; strategic/tactical goal alignment; include LM in company's "50 year plan"

The second open-ended question asked the companies whether it is possible to have an MRPII system while being committed to the LM philosophy. There was only one "No" answer while the remaining seven companies responded that MRPII is suitable for planning but the execution must take place within the JIT/LM framework and hence implying that MRPII can coexist with LM.

The final question was whether the implementation of LM would help the productivity of manufacturing companies and therefore would have a positive impact on the U.S. economy. All eight companies gave a strong "Yes" for the answer. Furthermore, they provided strong supportive statements that LM is beyond buzz words and it must become a mindset within every process and echelon of their organizations. Some even responded that a lean enterprise is the only way one can face the issues of labor economics, energy cost, logistics cost, environmental, and global business competitiveness.

## COMMENTS ON SURVEY RESULTS

The results of this survey are important due to the background of the companies surveyed. Seven of them were medium and large manufacturing firms with extensive experience in transformation from MRPII to JIT to LM while the remaining small company was a true believer in LM philosophy. Hence, their feedback may be taken as reliable and useful information. Since LM is much overlapped with TPS, if not adopted from it, a few comments on some of the above findings are needed.

**1.** No matter whether the companies reported using MRP, JIT, or hybrid MRP systems, they all confirmed that LM approach is the gate to their future productivity and competitiveness.

**2.** Although the results show that these companies are using many of the LM tools, they are relatively low in activities of Jidoka, SMED and TPM. In TPS these are critical tools as Jidoka promotes a zero-defect manufacturing goal while SMED and TPM promote fast set-up time and machine uptime, respectively; both are critical in manufacturing responsiveness.

**3.** In terms of non-production related activities by operators, although the survey showed a high level of involvement in the areas of production data gathering (8/8), sharing information across shifts (6/8), and across work centers (7/8), there seem to be an opportunity for these companies to encourage their operators to perform simple work center data analysis and kaizen board activities. These tools are commonly used in TPS and they seem to empower the operators.

**4.** Referring to the survey results for the suggestion programs, the respondents seem to be fairly active in that area. However, 40% as the median rate of implementation for the received suggestions is significantly lower than that of TPS. In the past, TPS has reported receiving more than one million suggestions per year with an amazing implementation rate of 95%.

**5.** Question related to "advantages of LM" yielded very positive results in terms of lead time, cost, quality and flexibility improvements. However, only 50% of the respondents (4/8) reported ROI to be one of the main advantages of LM. The word of caution here is that in TPS waste elimination must have a linkage to profit maximization. Perhaps such a linkage may not be observable at microscopic levels of kaizen activities but in a long run it must show measurable results.

**6.** The question related to the suitability of MRPII use while being simultaneously committed to the philosophy of LM produced surprising results as 7/8 reported MRPII may be used in some form of planning while LM should take over the execution of manufacturing and purchasing plans. Indeed there is a lot of debate in the U.S. about this very question. Such debates have taken fairly serious, and at times unfriendly, forms on the internet by several pro and con LM website alliances. However, it seems that unless LM goes through a cycle of maturity, MRPII model may still be useful at least for the planning of the end-items and long lead time material as well as techniques of pick-list simulation and plant's capacity what-if-analysis.

## CONCLUSION

The purpose of this paper was to do a comparative analysis between JIT and LM systems. The philosophy of JIT is based on TPS which focuses on the waste elimination of manufacturing execution activities. This system has been practiced by a number of U.S. companies in the past 25 years. Although LM

seems to be a fairly recent manufacturing model, at its core it shares the same philosophy of JIT; waste elimination.

An industrial survey revealed that although LM utilizes many of JIT techniques perhaps the major difference between the two concepts is that LM, as opposed to JIT, should not be limited to the manufacturing operations. Rather, it must promote a transformation into an entire lean enterprise. On the application of LM tools, the survey indicated that in comparison to TPS the respondents are not strongly involved in Jidoka, SMED and TPM activities. On the question of utilization of employees' suggestions, the reported overall 40% rate seems to be significantly lower than that of TPS reported to be above 90%. Finally, the survey revealed that LM practitioners are not totaling discarding the usage of MRPII system. However, its usage is limited to the planning phase of manufacturing.

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# **TRANSPORT AND DISTRIBUTION**



## **THE DEVELOPMENT OF TRANSPORT COMPANIES IN TRANSITION ECONOMIES: A RESOURCE-BASED THEORY PERSPECTIVE**

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### **ABSTRACT**

Drawing on the resource-based view of the firm and on the Western third-party logistics' experience, this study describes the context of the local transport companies functioning within the framework of two transition economies. Current resources and competences of these companies are discussed and a development framework is suggested.

### **INTRODUCTION**

During the last quarter of the 20<sup>th</sup> century, dramatic changes have occurred in the transportation fields of many countries. At a global scale, there have been three underlying trends – globalization, deregulation and privatisation along with the media revolution. Each trend has had a great influence on the traffic, particularly in developing countries in transition. At a sector-based level, operators' internationalisation has progressively increased.

In planned economies, transport firms were state-owned and their activity was reckoned not on the quality of services but on the use of resources. State control protected enterprises against competition, which did not encourage the reduction of costs and the improvement of services. The fall of the Soviet Union had deeply shattered those conditions.

### **LITERATURE REVIEW**

The apparition of logistics service providers in developed countries started in the 1970s and the 1980s and was characterized by the externalisation of peripheral activities, international competition, customers requirements etc. TPLs have progressively turned to a policy of global logistics offer able to take charge of the organisation of the whole logistics chain, becoming thus an essential partner for industrial and commercial enterprises. Meanwhile, in order to face stronger competition, TPLs had to group together or to enlarge the range of logistics services more lucrative than basic activities such as haulage. A third party logistics provider is defined as an "external provider who manages, controls and delivers logistics activity on behalf of a shipper" (Hertz & Alfredson, 2003). Activities carried out by a TPL consist of at least management and execution of transportation and warehousing (Laarhoven et al., 2000).

In the early 1990s, the RBV was presented as a new paradigm in Strategic Management, putting the optimal mobilization and combination of the firm resources and competences at the basis of competitiveness. Even if resources represent a basic entity that can be used by a firm to organize the best possible the production process, it is yet on central skills that competitiveness can be measured: "Core competences are the collective learning in the organization, especially how to coordinate diverse production skills and integrate multiple streams of technologies" (Prahalad & Hamel, 1990).

Logistics competences as core competences have proved their effect on the developed countries' TPL performance during the last years. They can support different value disciplines and are characterized by two major dimensions: 1) demand-oriented competences, related to customer service, time-advantages and responsiveness to target markets; and 2) supply-oriented (or operations-oriented) competences, stressing the internal customers of the company (Morash *et al.*, 1996). The TPL achieve different service performance, according to logistics competences they hold (Lai, 2004). According to the literature, companies detaining only standard skills are more vulnerable to competition. In contrast, developing logistics competences and getting specific assets can be a source of competitive advantages. In this context, logistics competences and especially their first dimension appear as a source of competitive advantages for transport and logistics companies.

## **METHODOLOGY**

The methodology consists of two parts. First, we made a review of literature dealing with the development of TPL in Western Europe and other developed countries. The literature on the RBV is also analyzed, paying particular attention to logistics resources and competences. As such, logistics competences have a positive influence on TPL performances in developed countries and can be considered a source of competitive advantages in the field. The question is: is this affirmation valid in transition economies, due to their specificities of activity, and which resources and competences could be useful for transport operators to obtain competitive advantages? The second part consisted of collecting primary data on transport and logistics companies of two former planned economies - Moldova and Romania, and carrying out exploratory interviews with head managers of some representative transport and client companies. The objective of these interviews was to find out which resources and competences of transport companies in former planned economies can provide them with a sustainable competitive position and to draw a development framework to these companies.

## **THE CONTEXT OF ACTIVITY OF LOCAL TRANSPORT COMPANIES**

The main changes which followed the fall of the Soviet Union and affected the activity of transport companies in the transition countries are: An economic recession, the decrease of the budgetary financing and the need to reduce the activity costs ; The downsizing of public companies and the privatizations ; The progressive orientation of the transport flows to the West, while the road network had been conceived to link eastern markets ; Poor logistics facilities, unable to meet the clients' requirements in a market economy; The increase in the clients' expectations about the quality, the availability, the reliability and the prices proposed by the transport companies ; The increase in the competition at the national and international level, due to the deregulations in the transport sector, to the privatizations, to the creation of new transport companies and to the arrival of international transport companies.

The transport companies of most of the eastern European transition economies still encounter numerous barriers to a smooth activity and to their integration in regional and European transport networks, from which the main are: extortion of money by the control services of the neighbouring states, long periods of documents elaboration at the border-crossings, difficulties in obtaining visas and transport authorizations etc.

## **THE CURRENT RESOURCES AND COMPETENCES OF LOCAL TRANSPORT COMPANIES**

In this paper attention will be concentrated on Republic of Moldova and Romania, as two neighbouring countries, former planned economies, where the same language is spoken and which share important historical, cultural and economic features. The total area of the two countries is of more than 272.200 sq km (238391 – Romania, 33843-Moldova), with a total population of 26,6 mln people (Romania – 22,272 mln, Moldova – 4,33 mln). The transport and logistics market in Romania is estimated to 4,2 billion euro/year (250 billion Euro in the EU) oriented mainly to exchanges with the EU countries (67,7% of Romania's exportations in 2006 and 62,6% of its importations). Romania's road transport market grew with 38,4% in 2005 compared to 2004 and the engine of this growth was international transport, with 42,3% of growth. 38-40% of the local transports and 84-85% of the international transports were carried for "hire or reward". The same dynamics are observed in Moldova: the amount of sold TIR cards has been constantly growing, from 47600 in 2004 to about 61000 in 2006. The volumes of goods carried by road transport grew from 19,5 million tonnes in 2003 to 24,6 in 2005, the modal part of road transport in Moldova being of nearly 62%.

According to the exploratory data (interviews and studies), the Moldovan and Romanian road transport companies, despite some differences, hold a range of common specific resources and competences, such as: knowledge of local conditions; low wages and skilled personnel; language skills and drivers' willingness to travel; relationship management and competences to overcome barriers to activity specific to these countries (mentioned previously). Although the transport market has been growing during the past years, the turnover of many Moldovan and particularly Romanian transport companies decreased (1,8% decrease in Romania, compared to the 2005th year) and the profitability is also decreasing even until 1%/year for firms with less than 75 people. Some big Romanian transport companies (>200 people) have also had a decrease in their profitability, but it is due to the investments in IT, GPS systems, truck fleet etc during the last years. Nevertheless, the competitive advantages of local transport operators provided by resources and competences mentioned earlier are gradually eroding with the increase of some types of costs (workforce, insurances, maintenance etc) and the decrease of the tariffs for haulage, which are generally not negotiable (small companies must accept the market price and big local companies hold contracts with local/regional clients with a strong bargaining power. All interviewed transport managers consider that local companies are threatened by foreign competitors, which are better managed, hold a strong know-how, human resources familiar with the modern logistics' principles, financial capital and modern technologies.

## **A DEVELOPMENT FRAMEWORK**

Western TPL experience shows that profitability in haulage services is usually low and small companies have low chances to survive on this competitive market. At the same time innovations in road freight services provide business users with substantial downstream benefits, both dampening cost increases and raising sales revenues. Service performance in this area depends on the capability of TPLs as the deployment of a collection of resources that enables them to successfully compete against other rivals. Consequently, competitive advantages may be enhanced by a higher capability to perform different logistics services.

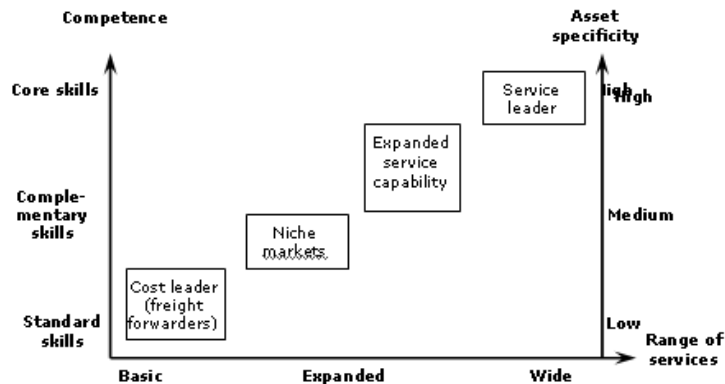


Figure 1: TPL in a competence perspective: Source: Personal elaboration, inspired by Haldorsson & Skjøtt-Larsen (2004), Lai *et al.* (2004).

Despite some specific resources and competences that they hold and their cost advantages, Moldovan and Romanian transport companies face actually obvious problems of competitiveness. Our study revealed that they lack a clear strategic orientation and a monitoring of the costs. The percentage of small companies (owner/driver) is very high – about 80% and it will be very difficult for these companies to face the foreign competitors. First of all, local transport companies should identify the resources and competences they hold which could provide them with competitive advantages and the ways to consolidate and improve these resources and competences in the future. Then, it is important to clearly set the strategies of development and positioning (according to Fig. 1.) and to ask themselves about the geographic area to serve (national, regional, international...), the types of clients to target, the range of services to offer etc. Economies of scale and scope will set the conditions for road haulage and logistics market developments in the next years and concentration is strongly advised to transport operators both in Moldova and Romania. Also, more attention should be paid to the professionalization and to payment of human resources, in order to improve the quality of the services provided and to avoid the leaving of the personnel to more attractive fields of activity.

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## **A TRANSPORT PROVIDER'S CAPABILITY FOR MASS CUSTOMISATION**

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### **ABSTRACT**

This paper aims to assess the role of flexibility in satisfying competitive opportunities while accommodating supply chain uncertainties. In this way we may then determine the role of different transport flexibility types in delivering strategic mass customisation outcomes. A transport flexibility construct is explored via action-based research in a steel industry logistics triad. The findings highlight efficiencies in the logistics operations and are used as a catalyst to instigate supply chain re-engineering. The changes implemented lead to substantive improvements in supply chain performance.

**Key words:** transport, value chain, flexibility

### **INTRODUCTION**

Mass customisation is a strategy aimed at satisfying the demand for a variety of products and services while keeping costs competitive to mass production. Davis (1987) is one of the first proponents of the term mass customisation which he defines as "*The ability to provide individually designed products and services to every customer through high process agility, flexibility and integration*". Mass customisation is characterised by stable process change but dynamic product change. This is termed "dynamic stability" by Boynton et al. (1993) and involves "stable but flexible platforms of process capabilities or know-how". Hence a mass customised organisation may satisfy changing customer needs but retains a high degree of efficiency.

A similar comparison of mass customisation with other manufacturing strategies is undertaken by Sahin (2000), who compared and contrasted mass customisation to the concepts of focused factories, lean manufacturing and agile manufacturing. We focus here on developing some of the arguments espoused by Boynton et al (1993) and hence highlight the differentiating features relating to flexibility. We may also deduce from Boynton et al. (1993) and Sahin (2000) that there are two types of flexibility – one is reactive and aims to accommodate uncertainties while the other is proactive and planned, and may be seen as a competitive offering. We build on these notions further in the next section.

While much of the research on mass customisation has focussed on the product delivery process little attention has been paid to the role of transport, a key operational function enabling the flow of materials and resource between suppliers and customers. Also, there is limited research on transport flexibility as an enabler for mass customisation. And yet there is an underlying premise in the supply chain that logistics providers will respond to changes in demand and be willing to accommodate uncertainties (Boughton, 2003).

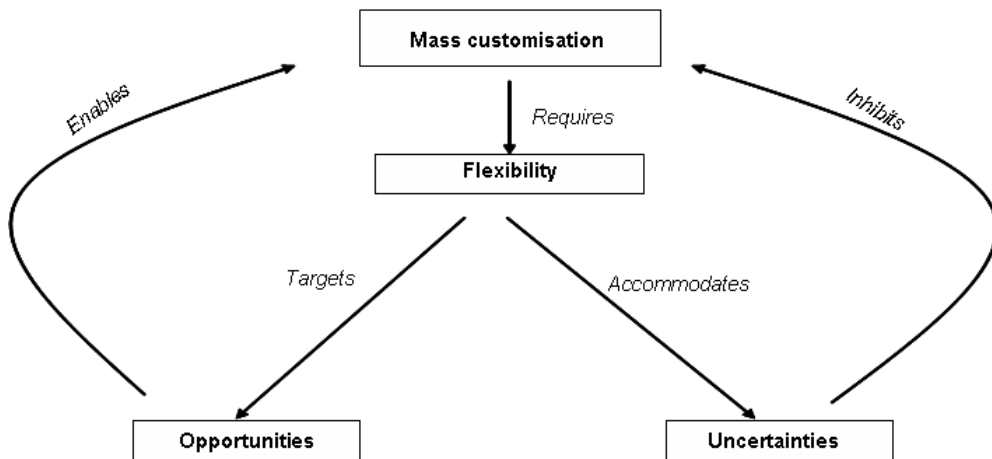


In this paper we aim to develop a framework, utilising recent definitions of transport flexibility (Naim et al, 2006), by which to judge a third party logistics provider's capability to offer degrees of different flexibility types in order to satisfy a mass customised supply chain strategy.

### **FLEXIBILITY, OPPORTUNITY AND UNCERTAINTY**

A wide range of the research on mass customisation indicates that a key requirement is process flexibility (for example, see Boynton et al., 1993, and Sahin, 2000). Flexibility is defined along many dimensions within the literature. For our purposes we build on an observation made by De Toni and Tonchia (1998). They describe flexibility as either internal to an organisation or external and perceived by customers as a competitive offering. Further, De Toni and Tonchia (1998) distinguish between flexibility enabling a business to change (proactive flexibility) or adapt (reactive flexibility). This is reinforced by Sawhney (2006), who considers that proactive flexibility can be used to target new opportunities (such as offering product variety). Conversely, reactive flexibility represents a response to uncertainty generated by the supply chain.

An examination of these factors reveals a closeness to the characterisation of mass customisation. Exploiting opportunities justifies the adoption of mass customisation. Therefore, opportunities can be considered to have a positive impact and enables mass customisation. Contrary to this, uncertainty inhibits mass customisation and thus has a negative effect upon it.



**Figure 1: A model for Determining Organisational Readiness for Mass Customisation**

Having established the need of mass customisation for flexibility we now propose a model for determining an organisation's readiness for mass customisation in Figure 1. Flexibility, according to the model has two main purposes: targeting opportunities and accommodating uncertainty. Opportunities enable mass customisation and therefore have a positive influence on it. Contrary to this, uncertainty inhibits mass customisation and thus has a negative effect upon it.

**LOGISTICS AND TRANSPORT FLEXIBILITY**

For the purposes of this paper we utilise the transport flexibility definitions as given by Naim et al. (2006). Synthesising the literature they were able to identify key components of transport flexibility as detailed in Table 1. In terms of the external (capability) flexibility types, these are largely unchanged from those suggested in the manufacturing literature, although they have been adjusted to reflect the provision of a transport service rather than the manufacture of a product. An additional capability of access flexibility has been added to reflect the geographical nature of transport services.

<b>External flexibility types</b>	<b>Definition</b>	<b>Internal flexibility types</b>	<b>Definition</b>
Product	The range and ability to accommodate the provision of new transport services	Mode	Ability to provide different modes of transport
Mix		Fleet	Ability to provide different vehicle types to carry different goods
Volume		Vehicle	Ability to configure vehicles to carry products of different types or to cater for different loading facilities
Delivery		Node	Ability to plan, approve and implement new nodes in the network
Access		Link	Ability to establish new links between nodes
		Temporal	Ability to sequence infrastructure investment and the degree to which the use of such infrastructure requires coordination between users
		Capacity	Ability of a transport system to accommodate variations or changes in traffic demand
		Routing	Ability to accommodate different routes
		Communication	Ability to manage a range of different information types

**Table 1: Types and definitions of transport flexibility (Naim et al., 2006)**

Turning to internal flexibility types, Naim et al (2006) give nine definitions. The first three relate to the physical movement of the goods and consider both the choice of transport mode and the capabilities of the vehicle fleet. Node, link and temporal flexibility are more closely aligned with the infrastructure provision that supports the physical movement. Assets that affect these elements of transport flexibility include warehouses and transport infrastructure. The final three internal flexibility types are directly translated from existing flexibility literature. These definitions of flexibility form the basis for our analysis of the readiness for mass customisation.

## **METHOD**

We utilise here an action research based approach exploring the issues of uncertainty and opportunity with regards to transport flexibility. The action research methodology chosen is exploratory in nature and therefore has inductive-empirical dimensions. Our unit of analysis is a logistics triad (Beier, 1989), involving consigner, consignee and logistics provider. Beier (1989), Bask (2001) and Larson and Gammelgaard (2001) argue that the triad is the minimum unit of analysis required in researching, analysing, designing and re-engineering supply chains.

A team of researchers, including the authors, carried out a study on a triad within the steel supply chain using a methodology called the Quick Scan (Naim et al., 2002). The supply chain consisted of a primary steel producer (consignor), steel tube manufacturer (consignee) and a logistics provider. The focus was on both the physical and information flows between the three companies. The three-case company research was chosen because of the opportunity it offered for a study beyond dyadic relations which is amply evident in recent literature. In addition, there is no explicit triadic research undertaken in the steel sector.

One output of the original Quick Scan was to triangulate the main data sources (process mapping, archival data analysis, interviews and a simple questionnaire) to ascertain and document the sources of uncertainty in a supply chain. Triangulation of the different data sources results in the production of a balanced perspective, where no one Quick Scan team member's influence is greater than another's. In this research the major output was to determine the internal transport flexibility types of the logistics provider and consider whether those flexibility types are in response to uncertainties or have been developed as a competitive opportunity or both. A brainstorming session involving just the research team was conducted to identify and document as many different impressions as possible. The next step was to quantify and justify these first impressions.

After the Quick Scan was completed the three companies in the triad implemented a number of the operational findings. A follow up visit by the researchers was made 6 months into the implementation. This involved a joint meeting with the business champions and the interrogation of archived performance data.

## **RESULTS**

The Quick Scan substantiated the concerns of the business champions' perceptions that due date conformance was poor. Based on historical archived

data, and confirmed via observations and interviews, 37% of tonnes are manufactured by the steel producer ahead of schedule, 24% on time and 39% late. Therefore, the logistics provider has to respond at short notice to changes in delivery requirements in terms of volume changes and due date requirements. This caused tension within the supply chain. Cause and Effect analysis indicated that the primary reason was poor communication between all three stakeholders in the triad.

The supply chain diagnostic recommended better communication between the three stakeholders in terms of the consignee communicating directly with the logistics provider as well as the consigner. There was also a need for relevant, agreed and transparent measures of performance.

Figure 2 presents the assessment as to the degree of transport flexibility within the steel supply chain at the time of the initial Quick Scan. The majority of the flexibility types are ranked as low. The logistics provider only uses road transport with a standard fleet of vehicles. This is because the unit load for each shipment, a steel coil, is identical. Equally, there is no need for flexibility in the

		Degree of Flexibility		
		Low	Medium	High
<b>Internal Transport Flexibility Types</b>	<b>Mode</b>	<input type="checkbox"/>		
	<b>Fleet</b>	<input type="checkbox"/>		
	<b>Vehicle</b>	<input type="checkbox"/>		
	<b>Node</b>	<input type="checkbox"/>		
	<b>Link</b>	<input type="checkbox"/>		
	<b>Temporal</b>	<input type="checkbox"/>		
	<b>Capacity</b>			<input checked="" type="checkbox"/>
	<b>Routing</b>	<input type="checkbox"/>		
	<b>Communication</b>	<input type="checkbox"/>		
<b>External Transport Flexibility Types</b>	<b>Product</b>	<input type="checkbox"/>		
	<b>Mix</b>	<input type="checkbox"/>		
	<b>Volume</b>			<input type="checkbox"/>
	<b>Delivery</b>		<input type="checkbox"/>	
	<b>Access</b>	<input type="checkbox"/>		
<b>Collaboration</b>		<input type="checkbox"/>		
<b>Information Transparency</b>		<input type="checkbox"/>		

Identified     
  Opportunity     
  Uncertainty

**Figure 2. Original transport flexibility types for the steel logistics triad**

distribution network as the consignee is 60 km from the consignor, a distance that can be completed in 1.5 hours. The choice of route is also constrained due to weight restrictions affecting which roads the vehicles can use. Communication flexibility is also low. The processing time from when the consignee requests a delivery through to the logistics provider being informed takes 48 hours. During this time, the information is transmitted through five different people or systems. This also impacts on information transparency. There is also a low level of collaboration in the triad, especially between logistics provider and consignee, which further inhibits communication flexibility. The only internal flexibility ranked as high is capacity. The logistics provider can call on a large fleet of vehicles, or can subcontract extra capacity, to respond to demand variability. This is primarily as a response to uncertainty but has been exploited by the logistics provider as an opportunity and to differentiate itself from potential competitors.

The lack of flexibility offered by the logistics provider reflects the demands of the triad as given by the external flexibility types. Only volume and delivery flexibility are actually needed, enabled by the high capacity flexibility identified. There can be a high degree of change in the number of loads delivered each day within the triad. Further, requests are made to change delivery dates, reflecting variations in raw material requirements for the tube manufacturer and availability of coils at the steel producer. Otherwise, little flexibility is required.

Next, we discuss how the recommendations described earlier and subsequently implemented have impacted upon transport flexibility within the case triad. The revised positioning of the triad within the framework can be found in Figure 3, the changes that have occurred being indicated. The main changes were direct communication between the tube manufacturer and the logistics provider, cutting processing lead-times from 48 hours down to under 6 hours, and the introduction of a new performance measurement system involving all parties. Consequently, there is now greater collaboration and information transparency within the triad, leading to improved communication flexibility. This increased communication flexibility has two drivers. The first is the uncertainty still associated with variations in demand. The second driver is the opportunity for the logistics provider to be more proactive in managing its own fleet and in offering better transparency of its capacity and assets to the other members of the triad. These changes have strengthened relationships within the triad.

The other change has been a reduction in the volume flexibility demands on the logistics provider. The Quick Scan highlighted the variability in demand and steps have been taken, particularly by the tube manufacturer, to stabilise their delivery requirements through better production planning and scheduling. Coupled with the improved information transparency and hence communication flexibility, the tube manufacturer has better visibility of the logistics providers assets and vehicle/fleet availability. Consequently, there is less of a need for volume flexibility. The impact of the above changes has been an improvement in delivery performance with 96% of weekly planned deliveries now being made on time and in full.

		Degree of Flexibility		
		Low	Medium	High
<b>Internal Transport Flexibility Types</b>	<b>Mode</b>	<input type="checkbox"/>		
	<b>Fleet</b>	<input type="checkbox"/>		
	<b>Vehicle</b>	<input type="checkbox"/>		
	<b>Node</b>	<input type="checkbox"/>		
	<b>Link</b>	<input type="checkbox"/>		
	<b>Temporal</b>	<input type="checkbox"/>		
	<b>Capacity</b>			<input checked="" type="checkbox"/>
	<b>Routing</b>	<input type="checkbox"/>		
	<b>Communication</b>	.....>	<input checked="" type="checkbox"/>	
<b>External Transport Flexibility Types</b>	<b>Product</b>	<input type="checkbox"/>		
	<b>Mix</b>	<input type="checkbox"/>		
	<b>Volume</b>		<input type="checkbox"/>	.....<
	<b>Delivery</b>	.....>	<input type="checkbox"/>	
	<b>Access</b>	<input type="checkbox"/>		
<b>Collaboration</b>		.....>	<input type="checkbox"/>	
<b>Information Transparency</b>		.....>	<input type="checkbox"/>	

Identified   
  Opportunity   
  Uncertainty   
 .....> Direction of

**Figure 3. Transport flexibility types for the steel logistics triad after implementing the Quick Scan findings**

**DISCUSSION AND CONCLUSION**

This paper has drawn from the generic and manufacturing orientated literature on mass customisation in order to generate a possible model for applying mass customisation in a logistics triad. We have focussed on the role of flexibility in mass customisation and specifically addressed the issue of transport flexibility. We are interested in the use of flexibility in exploiting opportunities while also coping with uncertainties.

Utilising the Quick Scan supply chain diagnostic, the degree of each flexibility type offered by the logistics provider in a logistics triad is assessed. It is determined that capacity flexibility is the substantive type offered, both as an opportunity offering and to accommodate uncertainties. The latter is primarily due to poor communication between all three stakeholders in the triad, but particularly that between the logistics provider and the consignee. Therefore, the logistics provider responds at short notice to changes in delivery requirements in terms of volume changes and due date requirements.

The Quick Scan diagnostic recommended better communication between the three stakeholders in terms of the tube manufacturer communicating directly with the logistics provider rather than via the steel producer. Hence, the triad increased its communication flexibility with an associated increase in information transparency.

The results of this paper inform further empirical research into the area of transport and logistics flexibility and mass customisation. While only a single triad has been researched, this has been in depth which further research can validate and enhance. From a managerial perspective, the model we develop may act as a template by which a logistics provider may exploit a mass customised logistics strategy vis-à-vis their transport flexibility capabilities. They may then determine the degree of collaboration and information transparency necessary in order to support either a specific triad or more widely among a number of triads in a distribution network.

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## **STUDY OF THE INFLUENCE OF CHINA FREE TRADE ZONE CONSTRUCTION ON THE EAST ASIAN SHIPPING LOGISTICS NETWORK**

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### **ABSTRACT**

There have been a few studies highlight the East Asian Shipping Logistics Network, while the influences on them by the construction of Chinese free trade zone have been completely ignored. The object of this paper is to analyze the Influence of China Free Trade Zone Construction on the East Asian shipping logistics network. To achieve this object, the paper will be structured in the following ways: Section 1 presents the situation of the East Asian shipping logistics network, mainly sea routes of through transportation and transfer transportation. Section 2 introduces the developmental process of Chinese free trade zone. Section 3 take the example of the construction of the free trade zone of Shanghai and zone, analyses the Influence of them on the East Asian shipping logistics network. Section 4 presents conclusions and further comments.

**Key word:** free trade zone, shipping logistics network, East Asia, china

### **INTRODUCTION**

In the last years, the Chinese government attaches great importance to the construction of the free trade area of the port city increasingly. Considering bonded zone bonded logistics zones and bonded seaport district, gradual pushing situation is very obvious. The increase of freedom and open degree of Chinese port city trade zone continuously certainly will infect the shipping logistics network in East Asia. Through the analysis of the process of development of Chinese free trade area, we carry the research on the influence of the shipping logistics network of the region in East Asia.

### **CURRENT NETWORK SITUATION OF EAST ASIA SHIPPING LOGISTICS**

The shipping logistics network of East Asia is the second largest line of the world on the transportation volume, which follows the Pacific Ocean. With the process of the manufacturing industry to transfer East Asia increasingly, the import and export of containers have discharged at rise continuously in East Asia. The shipping logistics network of East Asia has three categories: (1) some sail segment of the medium long range line. Because of its large number, this type of line occupies the higher comparison in the shipping logistics network of East Asia. (2) The specialized longer liner inside the district. The typical model line takes the port of Korea or Japan as the start harbor, through the ports of Taiwan, Hong Kong and mainland China, then drive onto the port of Southeast Asia. (3) The short distance shuttle service includes China-Japan line, China-Korea line, Japan-Korea line and soon. The ships of these lines are usually smaller, but the volume handled in this kind of line has the overwhelming majority of the goods inside the district in East Asia.

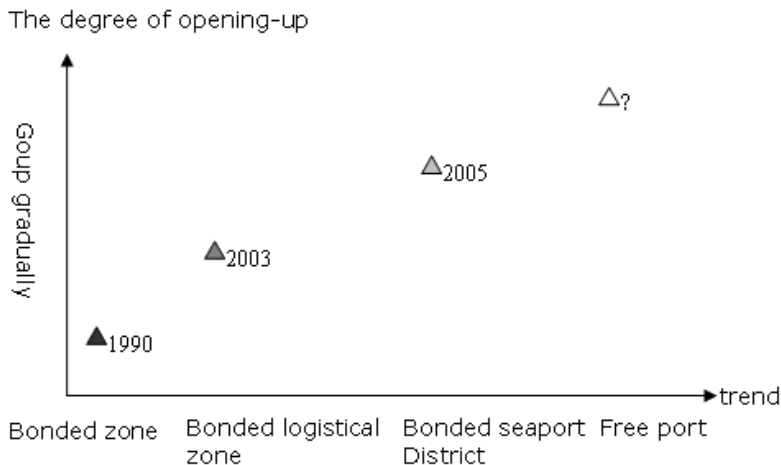
In recent years, with the raise of freedom and open degree of Chinese free trade zone



continuously, making policy advantage of the offshore transfer center is no longer very obvious. The structure of transfer transportation has been changed and shipping logistics network of East Asia has taken place the bigger variety.

### THE PRESENT CONDITION OF CHINESE FREE TRADE AREA

Take a wide view of the development of the Chinese free trade area, mainly from bonded zone to Bonded Logistics Zones, again from Bonded Logistics Zones to Bonded Seaport District.



**Picture 1 The trend of Chinese free trade zone**

- **The rise of the bonded zone**

The so-called bonded zone refers to china special economic zone in the foreign harbor city, which is based on China establishing the economic special area successfully in 80's in last century, drawing on the successful experience of international free trade zone. Since the approval of shanghai waigaoqiao bond zone in 1990, China has already set up Tianjin, Dalian, Shenzhen, Xiamen etc. 15 bonded zones. As the most degree of opening district at that time, protecting the bonded zone has ever become domestic and international capital's favor.

- **From Bonded Zone to Bonded Logistics Zones (Integration)**

After China joined the WTO, with the implement of some measures, the original policy advantage of the bonded zone has weakened gradually. For strengthening the international competition ability, Chinese government decided to carry on new reform towards bonded zone. In February 2003, the customs decided to carry on "Integration" experiment. in Shanghai waigaoqiao bonded zone, in December in the same year, the shanghai waigaoqiao bonded logistics zone has been established formally. On August 16 in 2004, the government extended the scope further of bonded logistics zone, and confirmed the bonded zone of Qingdao, Ningbo, Dalian, Zhangjiagang, Xiamen, Shenzhen and Tianjin carried on the experiment of Integration with the near harbor.

"Integration" is the traditional development model of the free trade zone in the world. This first advantage of the bonded zone and the harbor area to concentrate together and the direct advantage are that as soon as the goods enter the zone, the drawback of duties will be paid, which will be enjoyed after the goods leave the bonded zone. It makes the business enterprise to leave the career of "A day trip aboard". Another is that two or more containers sent to the same destination without laden may be put together as a whole case, which breaks the rule that the container of delivering must be similar to originally.

- **From Bonded Logistics Zones to Bonded Seaport District**

To make the development of the port adapted the demand of the trade of world more, in June, 2005, Chinese government has set the bonded seaport future policy, this new policy which is the highest level and most breadth now. Its formality basically is in line with the free trade area, but only the sea city is affirmed international shipping center natural by movement. Then it can apply for the establishment of it.

Bonded seaport District and export to process the area and protect the tax logistics area three and port of function are to gather the functions of bonded zone, export processing zone, bonded logistics zone and port in a whole, is the implementation and wide development of "Integration". Bonded seaport District is different from "port" and "zone", which have the dual characteristic. In addition to the port function, the Bonded Seaport District main embody the following five functions: international transfer transportation, international distribution, international purchase, international re-exports trade, export processing zone etc.

**Table 1 Current Situation of free trade zone in china**

Port	Bonded Zone	Bonded Logistics Zone	Bonded Seaport District
Shanghai	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tianjin	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Dalian	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Shenzhen *	<input type="checkbox"/>	<input type="checkbox"/>	
Guangzhou	<input type="checkbox"/>		
Zhangjiagang	<input type="checkbox"/>	<input type="checkbox"/>	
Haikou	<input type="checkbox"/>		
Xiamen	<input type="checkbox"/>	<input type="checkbox"/>	
Fuzhou	<input type="checkbox"/>		
Ningbo	<input type="checkbox"/>	<input type="checkbox"/>	
Qingdao	<input type="checkbox"/>	<input type="checkbox"/>	
Shantou	<input type="checkbox"/>		
Zhuhai	<input type="checkbox"/>		

**\*There are two bonded zones in Shenzhen.**

## **THE INFLUENCE OF CHINA FREE TRADE ZONE CONSTRUCTION ON THE EAST ASIA SHIPPING LOGISTICS NETWORK**

In the shipping logistics network of East Asia, the transfer transportation of containers from mainland China occupies a large proportion. The business of container for transshipment from mainland China carries on in Hong Kong, the northern ports then turning to Japanese port in turn. In recent years the Busan port has already become the main transfer port of Chinese northern ports, the ports of Japan have already been insignificant. While with the construction of Chinese free trade zone continuously, especially the great improvement of some port's soft environment in mainland China, it has large influence on the original structure of transfer transportation, which makes the network of transfer transportation in East Asia.

This paper selects Shanghai port and Shenzhen port two mainland Chinese ports which are one of the world's ten biggest ports and analyzes the variety of the volume (comparison) of container for transshipment and the influence on the East Asia' important transfer center in the construction process of their free trade zone. For Bonded zone not contacting with the ports directly, it can't make the port develop various policy advantages of Bonded zone, and have less affect on the port's turnover of container transshipment. Therefore it studies the influence of the shipping logistics network of East Asia after the foundation of Bonded logistics zone in mainland China.

● **The influence of the foundation of Shenzhen bonded logistics upon the transfer center of Hong Kong**

Rely on the superior geography position and free port policy, Hong Kong has become important transfer center in the world since 1970's the total turnover of the port is 238,000,000 tons in 2006. The goods of only mainland China are close to 100 million tons.

Country (area) of loading goods	volume thou.ton	Proportion	country (area) of unloading goods	volume thou.ton	Proportion
Mainland china	51031	36.1%	Mainland china	43198	44.7%
Total	141500		Total	96700	

**Table 2 The volume of mainland china's goods of Hong Kong port load and unload**

**Source Census and Statistics Department of Hong Kong**

Year	Container transshipment volume (thou. TEU)	rate of increment
2003	8001	8.1%
2004	9487	18.6%

2005	10151	7.0%
2006	10965	8.0%

**Table 3 The container transshipment volume of Hong Kong port**

**Source Census and Statistics Department of Hong Kong**

But in recent years, with the continuously increase of the mainland Chinese port facilities and soft environment, especially the rapid development of Shenzhen where there is only one river separate from Hong Kong, Hong Kong is not only choice that the containers transshipment Pearl River Delta Area of china has any more. Especially since the foundation of Shenzhen Bonded logistics zone, the port of Shenzhen has made use of the policy of "Integration" to develop the business of container for transshipment vigorously, the amount and comparisons increase year by year (See table 5). At the same time, the container for transshipment volume of Hong Kong increases greatly, and the speed of growth in 2005 descends 12 percentage points compared to in 2004.

Year	2002	2003	2004	2005	2006
Container transship volume	53.0	106.42	154.85	202.36	251.8
Rate of increment (%)			45.51	30.68	24.43
The proportion of Container transship volume in the container throughout (%)		9.99	11.34	12.49	13.6

**Table 4 :The schedule of Shenzhen port's container transshipment volume in recent years Thou. TEU**

**Source the government of Shenzhen port**

- **The influence of the foundation of shanghai bonded logistics upon the transfer center of Busan**

After the Kobe heavy earthquake in 1995, the Busan port gradually replaced Kobe as the important transfer center in the northeast Asia. With right advantage of location and free port policy, the Busan port attracts a great deal of containers transshipment of mainland China. In 2004, more than 300 thousand TEU in all total containers transshipment came from mainland China. Facing the strong Chinese market, the Busan port aims to the construction of hinge harbor in the northeast of Asia. But in recent years, the development of the Busan port is not very ideal under the influence of the strong impact of the Chinese port especially shanghai port's rapid development where there is apart from 482 sea miles with an huge effect on the Busan port.

Year	Turnover volume	Container transshipment volume		
		Volume	Proportion	From China (%)
2003	10410	4250	40.8	26.85
2004	11440	4760	41.6	27.39

2005	11840	5180	43.8	
2006	12030	5220	43.4	

**Table 5 The container transshipment volume of Hong Kong port  
in recent years thou.TEU**

**Source: Korea Container Terminal Company**

For boosting total competition ability of the Shanghai port, the Chinese government considers much of the construction of its soft environment. Shanghai Waigaoqiao bonded logistics zone first established in the whole country in December 2003. With the development, its advantage of attraction of container for transshipment develops gradually. This changes the structure of transfer transportation in East Asia, particularly to the volume of container for transshipment of Busan port. Since 2005 the speed of increase has been slowly obviously, especially in the first eight months of 2006, the volume of container for transshipment is only 3,465,000 TEU, falling 7%. The main reason is the greatly increase of container transshipment volume of Shanghai port.

In recent years, the container transshipment volume of Shanghai port has an increasing trend as a whole. The volume is 403,000 TEU in 2005, which increases 42.9% in comparison to 2004. The proportion is also at a rise (1.94% in 2004, 2.23% in 2005, 2.77% in the first half of 2006). Because the main source of container for transshipment of Shanghai port is the western America and eastern America, the growth of the volume means that the volume of container for transshipment coming from America will reduce relatively. While the most of container transshipment volume of Busan port is the east line re-exports goods (see table 8), the important destination of the east line goods is America.

Line	containers transshipment volume	The proportion of Container transshipment volume %
America	13.1	32.50
Mediterranean sea	6.63	16.45
The northeast of Asia	4.67	11.58
Total	40.31	

**Table 6 The area that Shanghai port's containers transshipment  
volume come from (thou. TEU)**

**Source: Shanghai International Port (Group) Co., Ltd**

Line	Shanghai	Tianjin	Dalian	Qingdao	other	Total
East line	39997	129798	95694	101454	80658	447601

West line	19321	59184	29609	31985	64748	204847
Total	59318	188982	125303	133439	145406	652448

**Table 7 the container volume in China-Korea line in 2004**

The turnover in trunk line also increases very quickly, only shanghai Yanshan port's turnover increased 7% in the trunk line from December of 2005 to March of 2006. The turnover's increase in trunk line will urge the ship company carries on the adjustment to the line, such as the Shanghai-Auckland line managed by HYUNDAI has been changed to direct line, which won't arrive at Busan port. This means the decrease of container transshipment volume from shanghai port to Busan port.

Time segment	05.12	06.1	06.2	06.3	
container transshipment volume	31531	55499	46840	55691	189561
Turnover volume in trunk line	162068	181672	113121	174430	631291

**Table 8 the change of container transshipment volume of Shanghai Yanshan port (TEU)**

**Source: shanghai international port(group) co.,ltd**

	2004		2005		the first half-year of 2006	
	volume	Proportion	volume	Proportion	volume	Proportion
Total turnover	1455.4		1808.4		1008.2	
Container transshipment volume	28.2	1.94%	40.3	2.23%	27.9	2.77%

**Table 9 The container transshipment volume of Shanghai port (thou.TEU)**

**Source: shanghai international port(group) co.,ltd**

Through the above analysis, we can find that the construction of the country free trade area, especially since the foundation of bonded logistics zone, the mainland china's ports has had the preferable condition for the business of container transshipment, drawing on the shipping company to develop direct line, urging them to adjustment to the former line. Worthy of paying attention to, with the development of three bonded seaport districts continuously, those will attract more volume of container for transshipment, and the shipping logistics network of East Asia must takes place the larger variety.

#### **4. CONCLUSION**

Remarkable is, whether Bonded Zone, Bonded Logistical Zone or Bonded Seaport District, are all a kind of transition form that the Chinese Bonded Zone develop to free trade zone. With the freedom degree of the zone raise continuously, it must trend toward the structure of free port in the future, Then, the transfer center aboard won't have the obvious policy advantage and mainland china's will replace some of them to become the new transfer center, and the structure of transfer transportation and the whole network about form and the East Asia's network about shipping and logistics will take place the important variety.

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## **DIRECT TO CUSTOMER: VALUE ADDED SERVICES BY THIRD PARTY LOGISTICS SERVICE PROVIDERS IN PHARMACEUTICAL DISTRIBUTION**

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### **CONTEXT**

The pharmaceuticals industry, which includes the discovery, development, and distribution of drugs, is characterized by its large size, high growth, globalization, and high investment in Research and Development. Of late, the industry has been going through a challenging phase. Pharmaceutical companies are facing informed and active stakeholder pressure from government, media, NGOs and the public. They are under constant pressure to innovate, comply with a myriad of regulations, and meet the demands of quality standards. At the same time, they are facing the challenge of maintaining the double-digit growth rate, which is a goal they are hard-pressed to achieve as patents expire, blockbuster launches decline, and large customers, especially governments, step-up pricing pressures on the industry. Influx of counterfeit products into the supply chain and parallel trade are also impacting their top line. This, in addition to rising marketing, general and administrative costs, is forcing major drugs companies to adopt novel ways to contain cost and at the same time deliver results.

With a renewed focus on cost containment, the pharmaceutical industry is on an efficiency drive and the drug supply chain represents an area ripe for improvement. In many industries, innovative supply chains are used to differentiate in the marketplace and drive commercial upsides, such as increased revenue, improved profitability and greater customer insight. Now it's the turn of the pharmaceutical industry to embrace such opportunities.

Emergence of technology savvy Third Party Logistics Service Providers (3PLSP) has fuelled a revolution in the inbound, outbound and reverse logistics arena. They have already been taking wider roles in the supply chain such as sourcing logistics, warehousing, assembling & packaging, reverse logistics etc. They are in a position to reduce the end-to-end transportation and logistics cost, optimize inventory and lead time. 3PLSPs are now geared up to offer supply chain solutions specific to various industries.

3PLSPs can play a pivotal role in the journey embarked by pharmaceutical manufacturers towards transforming their distribution supply chains. Recognizing the challenges confronting the pharmaceutical industry, 3PLSPs are strategically



positioned to compliment the initiatives undertaken by pharmaceutical manufacturers in streamlining their distribution operations through a host of value added services including

- **“Direct to Customer”** service that would enable the manufacturers to deliver their products directly to the customers (retailers), thus avoiding the chain of wholesalers and resellers.
- **Cold storage** solutions for medicines and vaccines that are temperature sensitive, with precise storage requirements. Distribution of these products to all corners of the world requires packaging and storage solutions that can be effectively addressed by 3PLSPs.
- **Track and Trace** solution using radio frequency identification (RFID) technology to help pharmaceutical companies counter the threat from counterfeits and drug diversion.

The objective of this paper is to provide a detailed overview of 3PLSP’s ‘Direct to Customer’ distribution solution to the pharma industry.

#### **PHARMACEUTICAL SUPPLY CHAIN:**

Present-day pharmaceutical supply chain is global – with manufacturing of active ingredient in one country, dosing and blister packing in another, delivery to in-market warehouse and then to wholesalers / distributors and pharmacies or hospitals. The majority of pharmaceutical distribution is through wholesalers with hospitals, managed care organizations and retail pharmacies as the biggest customers. The typical pharmaceutical supply chain comprises a multilayer model that typically includes the manufacturing factory (where finished goods are often stored), a warehouse (where individual products may be repackaged and product information leaflets inserted), a couple of wholesaler and reseller layers (where pallets are broken down for fine distribution), and finally the pharmacist layer – either hospital-based or retail. These layers are rarely integrated, resulting in inefficiencies and increased total cost within the total supply chain. This is forcing manufacturers to re-assess their distribution strategies to react to the pressures they are facing. Some of the key drivers influencing this change include:

- the desire to gain increased controls over supply chain flows through the use of more direct channels to market
- a need to improve communication with pharmacies and gain the information necessary to improve sales activities
- Government legislation resulting in increased cost pressures and the need to optimize distribution cost-to-serve.

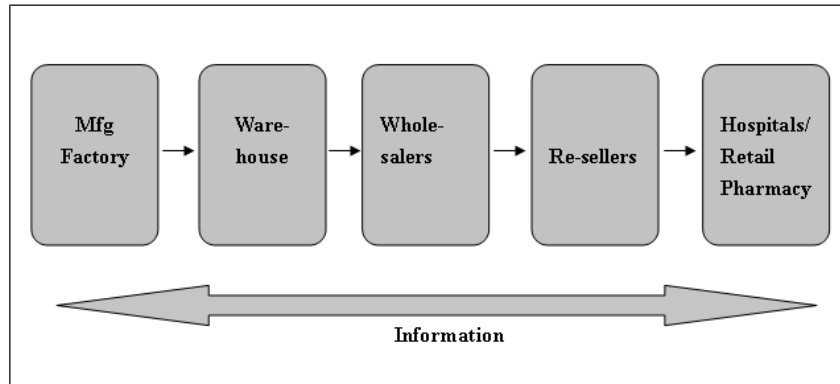


Figure: Typical Pharmaceutical Supply Chain

Some of the trends shaping the current pharmaceuticals distribution landscape include:

- Pharmacy deregulation, which is leading to the rise of the in-supermarket pharmacy. Big supermarkets are starting to enforce retail practices like factory-gate-pricing, RFID and increased data sharing onto the pharmaceutical industry.
- Wholesalers continue to vertically integrate through pharmacy acquisitions.
- Governments are increasing their focus on the introduction of price-saving strategies and policies. Such policies imply increased attention to in-country distribution costs and alternate channel designs on the part of the manufacturers.
- With the increase in drug counterfeiting, governments and regulatory authorities are demanding implementation of new practices by pharmaceutical manufacturers to curb the same.

The above trends are forcing the pharmaceuticals industry to rethink the supply chain model. The industry must undergo a radical transformation in order to address these new challenges. To start with, it should strategize and implement changes across three crucial dimensions:

**Supply Chain design.** This refers to the design of a company's supply chain into specific market sub-segments, for example, patients, retail, hospitals. As global healthcare expenditures spiral upwards, major hospital systems are looking to renew their procurement supply chains with a view to manage their procurement budgets. The opportunity for the pharmaceutical industry is to come to the table with solutions that deliver benefits to both parties, for example, tighter integration of hospital stock systems with pharmaceutical company replenishment systems.

Cool chain capabilities for the movement of temperature-controlled goods are becoming increasingly important for many companies as their portfolio develops, leading to specific channel and supply chain designs for this product segmentation.

**Network optimization.** Pharmaceutical companies need to examine their respective warehouse networks if they wish to deliver an integrated global network. Not only does this mean rationalizing their own warehouse network, but, more importantly, ensuring it integrates with and takes advantage of the capabilities of the channel partners, whether they are third party logistic providers or wholesaler chains.

**Capability alignment.** Capabilities across factories, warehouses and channel partners should be integrated and aligned. For example, in the area of packaging postponement, with leading third party logistics companies implementing clean room/compliant facilities to support packaging postponement, the capabilities need to be aligned not only within the walls of the pharmaceutical manufacturing company, but, more importantly, with its strategic partners.

Collaboration with 3PLSPs via the 'Direct to Customer' service model can address the transformation challenges across the above three dimensions.

#### **EMERGENCE OF 'DIRECT TO CUSTOMER' DISTRIBUTION MODEL:**

Pharmaceutical companies are using increasingly complex supply chain methodologies to manage production and distribution costs more effectively, focusing on the points in the process where they are most vulnerable. The problem tends to be one of direct control.

This has led to an elongated supply chain which ensures the continuity of supply and delivery to many individual outlets. However, as soon as the products leave the company's control, the potential is increased for uncontrolled products to slip into the system from other markets and find their way onto pharmacists' shelves - for example, products meant for South America which then subsequently appear in the UK.

Diversion tends to affect mature products, where the price difference can be highlighted. While diverted products may not carry the same fear factor as counterfeit goods, the link between the two is strong, as diversion leads to supply shortfall in legitimate markets, a gap easily filled by counterfeiters.

In addition to this, as globalization of the network becomes more demanding, the shipment of goods and services becomes more critical in the effort to stay ahead of the competition. The growth of new global markets and the demands of providing products to those markets in accordance with regulatory restrictions have placed increased pressure on the industry. Pharmaceutical products and services that are provided to the health care market must move efficiently through the supply chain so that the right therapeutics is at the correct location and delivered when needed. The pharmaceutical companies must have a seamless, cost-efficient, rapid and reliable distribution system to assure compliance and to expand their market share.

Major 3PLSPs like Fedex and DHL, keen on leveraging their worldwide operations, have been proactive in creating frameworks and developing solutions customized to pharmaceutical industry's requirements, that would aid in continuously enhancing and strengthening supply chain logistics, strategies and opportunities for new business. One such framework is the Direct to Customer service, where these 3PLSPs act as a single layer of distribution between the pharmaceutical manufacturer and the pharmacies.

There are different drivers for the Direct to Customer distribution model:

- Pharma companies seeking to change their relationship with wholesalers, countering parallel trade and counterfeit products entering the supply chain.
- This shared-user distribution model offers cost effective web-enabled order to cash capability to medical product companies and small to medium sized pharma, who do not wish to create the infrastructure themselves.
- Pharma companies seeking to by-pass wholesalers and exercise greater security in the whole supply chain.
- Pharma companies seeking to enhance their servicing (delivering) capability to pharmacies through a web-enabled front end.
- 3PLSPs seeking an opportunity to leverage their global presence and well-entrenched networks.

### HOW DOES IT WORK?

A typical 3PLSP currently works in the pre-wholesaler arena. But, with the 'Direct to Customer' service it would challenge the wholesalers by offering its clients (manufacturers) an opportunity to deliver their products direct to the customer (hospitals or retail pharmacies). Due to its global presence, it would be in a position to offer a lot of benefits to the client manufacturers and customers.

The 3PLSP offers a web ordering facility to the customers where they can log in and place the required orders. The portal then transmits the orders to the Order Management module of the ERP transaction system, which processes the orders (shipping, invoicing and receivables management). The ERP system also keeps a track of the on-hand balance and triggers a replenishment order, when required, to be sourced from the manufacturer's plant.

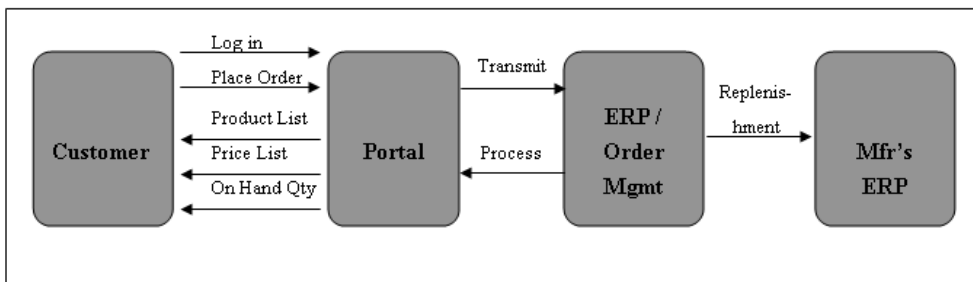


Figure: Information Flow in 'Direct to Customer' distribution model

**BENEFITS:**

Pharma companies stand to benefit from the Direct to Customer distribution model in the following ways:

- Increased revenue from improved distribution margins.
- Better control over inventory, offering control over parallel trading
- Increased visibility of product flow
- Reduction in supply chain costs through consolidation
- Improved demand management
- Real time shipment tracking and tracing
- Greater customer insight and targeting
- Hassle-free and more effective channel relationships

Warehouse network rationalization savings can be realized through a reduced network of distribution centres, higher levels of vehicle utilization, and reduced stock holdings. In addition, these savings can be accompanied by an improvement in service levels.

**CONCLUSION:**

In the long run, 'Direct to Customer' distribution model does hold promise for the pharmaceutical industry. In the ever-flattening world, it offers a vehicle for strategic collaboration between the manufacturer, channel partners and the customers. Leading pharmaceutical companies like Novartis have recently expressed their willingness to experiment with this emerging format of distribution. While some of the other leading companies have eschewed from this model for now and, rather, decided to go the extra mile on their own i.e. have a direct channel between the company and the pharmacies, its not too far when the industry, as a whole, would embrace the 'Direct to Customer' model, no sooner its benefits become more evident.

However, the biggest hurdle to its wide-spread adoption is the internal resistance to change within the industry. On their part, pharmaceutical companies need to exhibit the organizational and cultural traits that facilitate the removal of internal barriers. Equally important, pharmaceutical companies need to view the supply chain philosophically, to view it as a route to delivering and developing new commercial propositions, rather than just a cost base to be squeezed. Lastly, recent innovators have particularly been characterized by their boldness to move. It is only companies that take on, or work with the channel partners to realize the vision that can ultimately reap the benefits.

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## **HIGH TECHNOLOGY DISTRIBUTION INDUSTRY – AN EVOLUTION**

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### **ABSTRACT**

Distributors have been playing a key role in high-tech industry moving beyond their traditional roles to provide value added services to their partners and also driving the supply chain efficiency. This paper discusses evolution of the distribution industry, outlines few key trends in the industry and the imperatives for the distributors in shaping up their operations to leverage the opportunities created by these trends.

### **INTRODUCTION**

The high tech industry is known for its best in class supply chains across industries in both direct as well as indirect sales models, as is evident from some of the metrics like inventory turns, fill rates, cash-cash cycle time (tied up working capital), the leaders are typically high-tech industry players.

Interestingly, since distributors (and even contract manufacturers) are common across multiple value chains; their ability to optimize costs through inventory consolidation ("optimizing industry inventory") and augmented utilization of manufacturing facilities becomes a great strength in reducing the overall cost of the supply chain and resulting in better value for not only their customers but even the end user. With advent and success of 'Direct to Customers' model, the distributors have not only managed to sustain but have become a part of the direct model by offering relevant services supporting the same.

### **THE EVOLUTION**

Most of the electronics distribution industry players started as small firms providing buying and selling services, subsequently maturing to components trading exchanges. The focus at that point in time was on the surplus and/or shortage markets where in the players managed components inventory strategically i.e., making parts available to players at a lower cost during surplus cycle, while through hedging during shortage cycle. Short lifecycle of the electronic components and the volumes were the major drivers and through consolidation of demand these players optimized the inventory across intertwined supply chains. The distributors that survived through the cycles of downturns typically were those that had extremely efficient, flexible yet well controlled supply chain models. Their growth strategy at better times was basically acquisitions with an objective of acquiring new customers, entering new geographies and augmenting their product portfolios.

### **Specialized distribution roles in the high-tech industry**

Currently, the value chain is getting interestingly complex. If we trace an order across value chain, i.e., if "I am an order" then "I" am bound to "hit" a particular distributor multiple times offering different services across the end to end hi-tech value chain. Abstracting to a higher level the value/services offered can be categorized under component distribution services (upstream in the supply chain) and product distribution services (downstream in the supply chain).

Different stages in the high-tech value chain require specific competencies in the distribution function, and these players can be classified as below (as per Hoovers Industry Classification):

- **Electronic Components Distribution and Support:** Companies that distribute, supply, and/or support electronic components, semiconductors, cable, and other electronic parts; also includes supply chain management, logistics and freight forwarding services.
- **Computer Product Distribution and Support:** Companies that distribute, supply, and support computer systems, software, peripherals, network equipment, and other products.

Often distributors expand their offerings to cover both components as well as product distribution.

### Value add beyond distribution - evolving portfolio

Over the years the model has shifted from integrated supply chains to modularized supply chains. Further as the distributors grow they have attempted to move beyond the traditional core focus i.e., distribution and leverage the modular nature of the industry (figure 1).

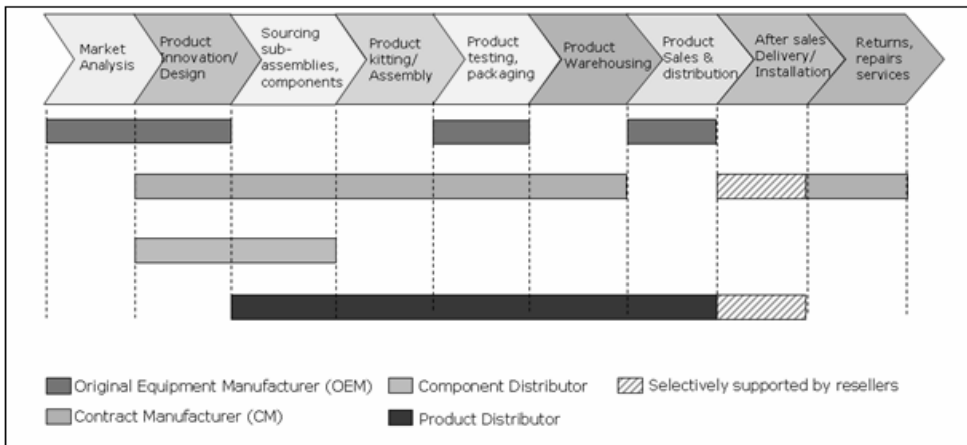


Figure 1: Overlapping & expanding value propositions across players in high tech value chain

Components distributors are stepping in as service providers to their partners in the area of Design services, New product introduction support, Inventory optimization services, Bonded inventory programs, Engineering services, Kitting, Education services. They are facilitating a robust collaboration in the supply chain offering unique functionalities like ship & debit, price protection, design win support (Supply & Demand Chain Executive 2007).

On the other hand, the product distributors have established their footprints in specialized service offerings like assembly, integration & testing, after sales installation, entitlements management, training etc. Also on the downstream, (especially product) distributors are exploring the possibility of offering hosted infrastructure supporting the installed base information for the Value Added

Resellers (VARs) who are their competitors. This evolution in the offerings footprint has also in part driven by the trends in high tech industry.

### **INDUSTRY TRENDS AND IMPERATIVES FOR THE DISTRIBUTORS**

As the distributors' role gain prominence in a broader spectrum of the value chain, their success depends on how best they read the trends, create and leverage potential opportunities. In other words these global trends are driving the strategies of the industry and playing a critical role in the evolution of the supply chain.

#### **Trend 1: Shift in market focus to emerging markets (Asia, Eastern Europe, Latin America)**

Increasing buying powers of the consumers in these countries, liberalization of political regulations for cross country trades especially in Asia have significantly contributed towards growing market base in Asia, Eastern Europe and Latin America. With new emerging markets the distributors have started looking beyond US and Europe.

To state an example, according to a report (Industry Week 2006) estimates that there is an opportunity to upgrade 90% of computers used in generation, transmission and distribution of electrical power in China, a total of about 7000 systems. The distributors can play a major role partnering with the Original Equipment Manufacturer (OEM) in this upgrade initiative.

Besides, the shift in the market focus in these regions, the low cost manufacturing option in few of these countries is driving set up of manufacturing and procurement facilities in these countries which is apparent from strategic shifts observed across some of the major players (Manufacturing insights 2006):

- IBM has moved its global procurement headquarters to China (Network World, 2006) to develop stronger and more collaborative supplier opportunities in China and more services suppliers to support IBM's growing global services division. Historically IBM has been sourcing in Asia for 40 years including components, software, development services, and labor.
- Dell opened second China Production facility in Xiamen doubling its production capacity in China to produce computers, servers, storage products for its customers in Japan, South Korea and Hong Kong.
- Flextronics has set some aggressive four year sales targets for next four sales cycles, much of which involves low cost manufacturing. They also have aggressive plans to recruit new employees primarily in China and India.
- Best Buy (Best Buy press release) is ramping up its operations in China with acquisitions. In 2006 it acquired Chinese retailer Five Star Appliances that has 136 stores in china. Recently they have created a new position, president and chief operating officer of Best Buy Asia.

This shift is giving boost to local distribution industry, resulting in interesting competition and dynamics in the distribution industry in emerging markets. The local players have incumbency advantage, i.e., they understand the local dynamics and also have established local relationships. They have also traditionally enjoyed government support. On the other hand, the big global players have a vast global network & infrastructure, established relationships with enterprise customers.



This market flux proposes a strong expectation of mergers and acquisitions between these different players bringing in their specific advantage that would further shape up the distribution industry in these growing economies. Ofcourse, the local policies, regulations and government support would control the degree of evolution of the distribution industry in these sectors.

**Trend 2: China's 11<sup>th</sup> five year plan, emerging focus on innovation & IP creation in China, a shift from low cost manufacturing**

China announced 11<sup>th</sup> five year plan (Manufacturing insights 2006) and among various details in this plan is a renewed emphasis on growth in high tech industry. Essentially the focus is on innovation, targeting more investment in R&D and design, a shift from low cost manufacturing. Chinese companies have been urged to work on homegrown technological innovation with increased technology partnerships. Initiatives to support the plan includes increased IP protection safeguard for foreign investors, world class manufacturing and supply capabilities, expected tax incentives for development of software and semiconductor products (Manufacturing Insights 2006).

The large distributors can leverage their expertise as supply chain collaborators (offering services like design win etc) along with their global relationships with OEMs, CMs to play an important part in maturing the high-tech industry in China. IP protection is going to be the biggest challenge that the distributors are expected to face especially while supporting design wins etc.

**Trend 3: Compliance Directives like RoHS, WEEE.**

A lot of manufacturers in Asia that do not sell into Europe & US, infer that compliances will not impact them and as such do not have any plan to address the directives. But since most of the manufacturers globally are converting their manufacturing/operation to comply with the directives and given global spread of high-tech supply chain, the directive is going to catch up with every manufacturing facility that feeds into a high-tech product.

With China coming up with their RoHS directive last year the products manufactured in China also require compliance. The distributors being at a strategic point in supply chain can play a major role here. Supporting the manufacturers at the time of crisis will enable the distributors to become trusted partners and hence establish long standing relationships. Some considerations include:

- Hedging the leaded parts and catering to manufacturing plants not required to be upgraded/compliant with the directives (these products will not end up in the countries invoking the directive) by leveraging the higher visibility and global reach (especially that big distributors enjoy).
- Educating and training the manufacturers/suppliers on the directives
- Offering solution/services to manufacturers in upgrading their infrastructure to conform to lead free directive. Compliance to ROHS directives typically require heavy investment in modifying the manufacturing processes and changes to sourcing. Distributors are playing and can play a major role in offering consulting services to their partners (especially the small and medium sized players) in making these players ROHS compliant.

## CONCLUSION

The term "distributor" in the high-tech industry value chain may have become more of a misnomer, as both components as well as finished product distributors have come a long way from just "distributing" and providing logistics, materials management support to being valuable partners in the industry. This was possible mostly due to the pro-active approach of distributors to sense, predict and formulate collaborative solutions to the emerging challenges of both their suppliers and customers, even if it meant supporting products outside of their core competency, like component distributors supplying finished products.

With the inherent global scale requirement of hi tech products, distributors are at a vantage point to bridge gaps across the supply and demand side - by providing demand visibility to component suppliers and cross pollinating new component technologies to small and big OEM's alike, and also across industries (like leveraging high tech needs of automotive industry). Thus they are expected to play much greater role in driving critical metrics like inventory investment/cash to cash cycle time, managing regulation & globalization and continue to drive the hi- tech industry into higher levels of maturity.

The overall complexity in the value chain has increased the number of touch points for the distributors. e.g. a component distributor may have to contact an Original Design Manufacturer (ODM) for design win, contract manufacturer for product ramp-up demand, OEM for establishing supply contracts, contract manufacturer again for inventory management. This gets compounded by the local regulatory compliances especially in Europe and Asia where the national boundaries change in close proximity. It will be interesting to see how the distributors overcome these challenges and evolve, as they always have.

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## **INTERMODAL TRANSPORT BETWEEN GREECE AND THE EUROPEAN UNION**

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### **ABSTRACT**

Specific European Union (EU) transport initiatives have either a modal or regional focus and rail has been given especially high priority largely because of the modal shift and environmental benefits that it potentially brings. The Trans European Networks – Transport (TEN-T) pan-European corridors which include Greece are corridors IV, IX and X. Greece is geographically peripheral within the EU and its rail industry has not yet been liberalised, thus currently falling short of EU directives. On the other hand, both road and rail links are being improved on key routes, helping to bind Greece more closely to the EU. In the area of intermodality, Greece is taking advantage of its position and encouraging the use of rail/Short Sea Shipping (SSS). The level of SSS is already high although there is room for further expansion, especially when port improvements and their land connections are completed. Shipping and road remain the dominant modes. Rail traffic growth will depend largely on the integration of neighbouring Balkan countries into the EU.

### **INTRODUCTION**

Greece's extreme south eastern location in the EU results in low transit volumes, few borders with other EU members, relatively underdeveloped transport infrastructure and relatively low value of commercial exports to the other members (Paravantis & Prevedouros, 2001). Three of the 10 pan-European corridors (corridors IV, IX and X) include Greece, running to Dresden, St Petersburg and Salzburg respectively (EC, 2005c). All aim to reduce the disadvantage of peripheral location. Greece exports goods mainly to the older Member States. Exports to the EU 25 account for 52.8% (in €million) of total exports for 2005. Exports to the EU 15 are only 7.6% less which means that the main trading partners are the central and west European countries. Of the exports to the EU 15, 12.3% went to Germany, 10.4% were to Italy, 6.7% to the UK, 4.1% to France, 3.6% to Spain and 2.4% to the Netherlands. The main modes used are road and SSS to Italy. For 2005 imports the difference between the EU 15 and the EU 25 was only 2.3%. Again the dominant country was Germany accounting for 13.2% of imports, followed by Italy (12.2%), France (5.7%), Netherlands (5.5%), Spain (3.9%) and the UK (3.7%), with most trade going by road or SSS.

### **TEN-T PAN-EUROPEAN CORRIDORS**

TEN-T corridors were created at the second Pan-European Transport conference in Crete in 1994 where nine long-distance transport corridors were identified as priorities for infrastructure development. At the third Pan-European Transport conference in Helsinki, in June 1997, a tenth corridor was added. The corridors have a total length of about 48,000 km, of which 25,000 km are rail and 23,000 km are road. Airports, sea-river ports and major terminals serve as intermodal nodes. Greece participates in three corridors: IV, IX and X (TV, 2002).

**Corridor IV** links Dresden, Prague, Bratislava, Vienna, Budapest, Arad, Sofia and Thessaloniki. The route consists of 4340 km of rail and 3640 km of road. The Greek rail section of the corridor is between Kulata, Promahonas and Thessaloniki and is 144 km long with maximum axle loads of 20 tons, and maximum freight train speeds of 120 kph. The road section of the corridor runs between Thessaloniki and Promahonas and is part of the new Igoumenitsa/Patras – Athens – Sofia – Budapest (PATHE) axis and is 104 km long. **Corridor IX** links Helsinki, St. Petersburg, Moscow, Kiev, Bucharest and Alexandroupolis. The route is composed of 6500 km of rail and 5820 km of road and is the longest of the ten Pan-European multi-modal Transport Corridors. The rail line between Ormenio and Alexandroupolis is 194 km, standard gauge; it allows a maximum freight train speed of 120 kph with axle loads of 22.5 tonnes. The road section from the Greek/Bulgarian border to Komotini is 25 km and from there to the strategically located port of Alexandroupolis is a further 65 km and part of the Via Egnatia. **Corridor X** links Salzburg, Ljubljana, Zagreb, Belgrade and Thessaloniki. The route comprises 2528 km of rail and 2300 km of road. The railway is 81.2% electrified and 100% single-track. The main part of Corridor X is Idomeni to Thessaloniki (77 km). Generally, the rail infrastructure here is considered poor with low levels of maintenance, especially on some sections. The road segments of the corridor are 77 km (Idomeni to Thessaloniki; 45 km of motorways and 32 km of highways) and 15 km (Mesonision to Florina; consisting of multilane motorways, highways and main roads). This corridor also ends at the Port of Thessaloniki (TV, 2002).

#### **TEN-T PRIORITY PROJECTS FOR GREECE**

Two TEN-T priority projects concern Greece. The PATHE motorway axis (project No. 7) is an 800-kilometre road, with four lanes for its entire length in Greece, and six lanes near Athens and Thessaloniki. It runs from southern Greece to the north, linking Patras to Promahon on the Greece–Bulgaria border via Athens and Thessaloniki. The Greece sections of both the Via Egnatia and PATHE motorways are largely completed except the Thessaloniki to Sofia section that will not be wholly in use until 2010. Both motorways will assist in drastically cutting journey times and will directly benefit 70 % of the population living in the cities along the routes. Also, for long distance, freight the new roads will provide faster more reliable transport especially to/from Albania, FYROM, Bulgaria, Romania and Turkey (EC, 2005). The Ionian/Adriatic intermodal corridor (project No. 29) will greatly increase sea-rail intermodal capacity by connecting the major ports of Greece with each other, and with main rail routes to the rest of Europe. This will also provide a landbridge between the port of Igoumenitsa, northwest Greece, Thessaloniki, Alexandroupoli (end point of corridor IX) and Piraeus. It is expected to be completed by 2012. A second line will connect the four Greek of Patras, Igoumenitsa, Kalamata and Astakos, developing complementary services, and balanced traffic flows with greater use of intermodal sea–rail links. The line will cover a distance of 475 km with construction expected from 2009 to 2014. This line will also provide a direct rail connection of the Igoumenitsa terminal with the port of Piraeus and the Athens railway hub at Thriasion (EC, 2005).

#### **TRANSPORT MODES BETWEEN GREECE AND THE EU ROAD**

Exports from Greece transported by road accounted for 843 million tkm while imports were 2.35 billion tkm in the year 2004. Germany is top for both imports and exports, followed by the UK and France for imports and Sweden and Poland

for exports. Cabotage transport (the carriage of goods in a country by hauliers whose vehicles are registered in another country), accounted only for 0.4% of the EU total. The Greek road network is generally poor and does not permit heavy loads, heavy flows or high speeds. The network has a total length of 39,039 km. 10,215 km of this are 'national roads' 78% of which are characterised as 'good', 14% as 'fair' and 2% as 'bad' (Sciullo and Smihily, 2006). The new TEN-T projects (Via Egnatia and PATHE Motorways) will provide the most productive and populated southern part of the country with motorways capable of handling heavy traffic. They will also shorten transport distances from the ports to the main cities. Finally, with the accession of Bulgaria and Romania to the EU, Greece's road transport to and from the EU will be facilitated via improvements to the core transport network in the Balkans (Patsiavos, 2005).

### **RAIL**

Despite the efforts of European policy makers to shift transport from road to rail, the Greek rail market is still resistant to EU legislation. Liberalization is non-existent since Hellenic Railways Organisation (OSE S.A) is the only train operating company in Greece and it is 100% government owned. Currently, freight on or via the mainland is mainly transported by road and there is no internal competition for rail freight in the national or international market. In spite of this, the OSE did not increase the basic freight rates during the period 1997-2003. Rather, the government attempted to encourage modal shift through rate discounts. Since around 2002, however, the decline in freight traffic has halted. Volumes were 647 million tkm in 1990, 456 million tkm in 2003 and 592 million tkm in 2004 (Steer Davies Gleave, 2006). The Greek rail network consists of 2576 km of lines of which 67.6% are of standard gauge and 27.4% of metre gauge. Only 4.7% of the standard gauge lines are electrified. This effectively divides Greece into two parts, making intermodality almost impossible. The line that connects Athens and Thessaloniki, for example, is of standard gauge (1.475 m) while the line from Piraeus to Peloponnissos is of metre gauge (1.071 m). The TEN-T projects that are now in the stages of construction will largely solve the gauge problems, at least for the western part of Peloponnissos and for the Kalabaka-Volos line. The rail bottlenecks are the high percentage of single line track, lack of homogeneity of track gauge, inefficient alignment, absence of intermodal connections at major ports (yards, ramps and freight-handling infrastructure) and many at-grade intersections with the highway network which forbid high-speed movement of trains (Paravantis and Prevedouros, 2001). Also, there are only two small combined transport terminals, one in Athens and the other in Thessaloniki (Abel and Ruesch, 2002).

### **SHORT SEA SHIPPING (SSS)**

Intermodal transport in Greece is conducted mainly through SSS combined with road or rail. The two major ports of Athens and Thessaloniki bear the majority of containerised and unitised cargo traffic along with Ro-Ro-services through the ports of Patras and Igoumenitsa while bulk products are generally transported by sea from large and small ports throughout Greece (Abel and Ruesch, 2002). Between 2001 and 2003, the share of SSS international intra-EU transport for Greece remained stable at around 23% of the total trade. National transport accounted for 33.4% and international extra-EU for 43.7% (Amerini, 2005). Piraeus is the biggest port in Greece and in 2005 handled 1,394,512 containers (NSSG, 2006), approximately 50% of which were for transshipment. Thessaloniki,

the second biggest port in Greece, handled 365,925 containers, mainly for imports of finished goods from Europe. Two of the most important ports for SSS are Patras and Igoumenitsa. They both offer Ro-Ro services to Ancona, Venice, Bari and Brindisi. For Patras, Ancona is the busiest link while for Igoumenitsa Bari is the most important. These links have been helped by well developed road and rail networks on the Italian side. Congestion at Patras, however, has prompted the need for new port facilities which should meet the needs of future cargo and passenger requirements. Using data supplied by OMEGA Transport-Logistics S.A., one of the largest independent Greek logistics companies, Abel and Ruesch (2002) identified four intermodal solutions for the Greece – Italy – Germany corridor, using road – sea; road – sea – rail or road – rail combinations. The study highlights opportunities to divert freight from the existing road – ferry services to road – SSS – rail via Italy or road - rail through the former Yugoslav territories

### **SUMMARY**

This paper highlights Greece's trade with the EU, the country's position in the TEN-T corridors and the priority projects pertinent to Greece. The paper shows how different alternatives in the choice of the mode and the use of infrastructure can potentially provide the optimal transport solution between Greece and other EU countries. Although there is still considerable progress to be made, Greece with the aid of the EU, has modernised and developed its transport infrastructure and is now able to offer improved better intermodal services than in the past.

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## **THE DEVELOPMENT OF THIRD-PARTY LOGISTICS IN JAPAN: POSSIBILITIES FOR 3PLs IN SMALL AND MEDIUM-SIZED TRUCKING COMPANIES**

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### **ABSTRACT**

This paper analyzes the possibilities for third-party logistics (3PL) in small and medium-sized trucking companies in Japan. The Japan Trucking Association (JTA) made a comprehensive questionnaire survey of 3PL businesses. The survey focused on small and medium-sized trucking companies. Through the survey, it became clear that one of the severe problems in 3PL for small and medium-sized trucking companies is the difficulty in maintaining a good relationship with customers. Other severe problems include companies' inability to secure highly competent human resources. However, these companies clearly realize the importance of human resources in remaining competitive in 3PL.

### **INTRODUCTION**

Third-party logistics (3PL), a new type of business that logistics service providers offer, has been successfully developed and implemented not only in the EU and U.S.A., but also in Japan. In Japan, several types of logistics service providers, such as trucking companies, warehousing companies, and freight forwarders, have already begun 3PL operations. Indeed in Japan, a small but significant portion of small and medium-sized trucking companies has already started 3PL business offerings. As pioneers in this new sector, they are facing several operational problems related to starting up 3PL. As 3PL will inevitably play a major role in logistic service providers' business operations, it is no exaggeration to say that further development of 3PLs in Japan depends heavily on the expansion and success of these pioneering companies. The purpose of this paper is to first clarify the existing situation of 3PLs operated by small and medium-sized trucking companies, through the use of a comprehensive questionnaire survey. Next, necessary elements related to the expansion and success of small and medium-sized trucking companies' 3PL businesses are analyzed based on the survey.

### **BACKGROUND OF THE SURVEY**

In Japan, 3PLs began to receive widespread attention in the latter half of the 1990s. In 1997, the Japanese Government released *Main Lines of General Policy for Logistics*, a policy outline in which the importance of 3PL was officially recognized. The outline placed strong emphasis on the seemingly promising ability for 3PLs to efficiently improve logistics systems, suggesting that 3PL implementation be encouraged for the advancement of logistics in Japan.

According to the simple definition given in *Main Lines of General Policy for Logistics*, in principle a 3PL is comprised of two types of operations. First, 3PLs offer consulting services to improve customers' logistics systems. Second, rather than just a single logistics service, 3PLs offer an integrated logistics system consisting of several logistics

operations, such as transport, storage, inventory control, information, packaging, etc. As opposed to trucking companies that provide only transport services and warehousing companies that provide only storage services, 3PL providers offer much more, in both their consulting services and integrated logistics systems offerings.

In Japan, the demand for 3PLs is rapidly growing. Recently, manufacturers and retailers encountering global competition have a strong tendency to outsource. They have been forced to concentrate their management resources on their core competencies in order to strengthen their competitiveness. Consequently, these companies see 3PLs as a better solution to their outsourcing needs, and are eagerly anticipating 3PLs' establishment and new logistics offerings.

Responding to these demands, large-scale logistics service providers took the initiative in setting up and operating 3PL. A few have even built up steady and prosperous 3PL businesses. However, the problem is how small and medium-sized logistics service providers, especially trucking companies, can steadily expand into 3PL, in spite of their small size and vulnerability.

In Japan, the trucking industry is the largest sector of all logistics service providers: it consists of more than 60,000 companies and about 1.2 million employees. Trucks also move more domestic freight than any other transport method. Thus, it is no exaggeration to say that the trucking industry is a main player within the transport division of Japanese logistics. However, the sector overwhelmingly consists of the small and medium-sized companies that account for 99.9% of all registered trucking companies<sup>1</sup>.

Here, it should be said that since the 1990s the Japanese Government has begun to steadily deregulate the trucking industry. As the government phased out regulatory barriers that restricted entry into the truck transport market, the number of trucking companies increased rapidly, from about 40,000 in 1990 to more than 60,000 in 2003.

On the other hand, after the collapse of the bubble economy in 1990, Japanese industries began to suffer a long recession. As a result, this period is often called the "lost '90s". Influenced by this recession, the total domestic cargo volume decreased; at the same time, however, due to deregulation, the number of carriers increased. Eventually, competition among trucking companies became more and more intense, with excessive competition frequently occurring. This situation brought about the extremely low freight rates that we still see today.

Given this situation, it was hardly possible for trucking companies to expand their businesses, as long as they remained in the conventional area of simple truck transport. Naturally, they paid attention to 3PL as a new business opportunity; expectations ran high that 3PL would help remedy the sector's chronically low profits.

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<sup>1</sup> Definition of small and medium-sized companies in the transport industry in Japan: those companies where the number of employees is less than 300, and capital is less than 300 million Yen (about 1,875,000 euros).



### RELATED CASE STUDIES AND OUTLINE OF THE QUESTIONNAIRE SURVEY

Studies of 3PL are not so numerous in Japan, mainly because 3PL does not have a long history, and scholars have not been so interested in 3PL businesses. A limited number of reports by the Ministry of Land, Infrastructure and Transport (MLIT 2003, 2004), and *3PL Business and Logistics Strategy* (Saito ed. 2005), a technical book dealing with 3PL, are the only literature currently available.

However, those few reports and single book are limited mainly to successful case studies of large-scale trucking companies; very little attention has been paid to 3PL businesses operated by small and medium-sized trucking companies.

In response, the Japan Trucking Association (JTA) made a comprehensive questionnaire survey of 3PL businesses. The survey focused on small and medium-sized trucking companies; its main objectives were to analyze the actual situation of 3PLs, understand problems in the operations of 3PLs, and clarify the conditions necessary to grow these 3PL businesses<sup>2</sup>.

In this survey, questionnaires were sent to 5008 trucking companies: 1654 companies that hold less than 50 vehicles and 3354 companies that hold more than 51 vehicles but less 300 vehicles. 1474 companies completed the questionnaire, a rate of reply of 29.4%. The following analysis is based on this survey.

### THE FEATURES OF 3PL BUSINESSES

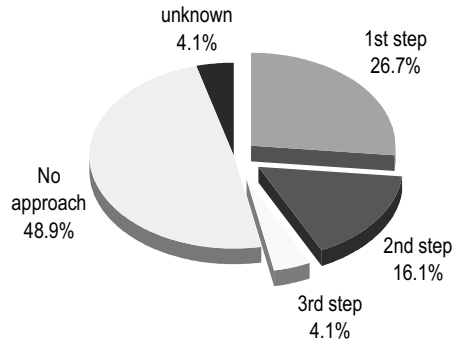
Needless to say, small and medium-sized trucking companies' bread and butter are their truck transport operations. From the data, it is clear that some of them would like to try to expand their businesses from simple transport to 3PL. In addition, it seems there are several variations in their approach to 3PL. In this survey, 3PLs are classified using three steps, according to the relative difficulty of the 3PL operations: 1. Simple and Easy, 2. Medium, and 3. Complicated and Difficult. Table 1 shows the content of these steps.

**Table 1** Steps of 3PL business

Step	Feature	Content of Operations
1 <sup>st</sup>	Simple and Easy	1. Simple operation such as putting labels on cargo 2. Packing and checking status
2 <sup>nd</sup>	Medium	1. Operations and control of logistics centers 2. Proposing improvements to a customer's logistics system
3 <sup>rd</sup>	Complicated and Difficult	1. Providing integrated logistics services 2. Consulting work regarding the location of logistics centers

<sup>2</sup>The Japan Trucking Association (JTA) organized a research committee for creating and implementing this survey. The author participated in it as a chairman.

As shown in Figure 1, of the 1474 trucking companies that completed the questionnaire, almost half of them (47%) answered that they had already begun some form of 3PL business. The 1<sup>st</sup> step of 3PL (simple and easy operations), accounts for 27%, the 2<sup>nd</sup> step (operations, with medium level of difficulty), accounts for 16%, and the 3<sup>rd</sup> step (complicated and difficult operations), accounts for only 4%.



**Figure 1** Approach to 3PL business

Logistics facilities, which are often called “Logistics Centers” or “Distribution Centers,” play an important role in 3PL business. Table 2 shows the average number of logistic facilities operated by trucking companies. The average number of logistics facilities increases with each step: 4.1 (1<sup>st</sup> step), 6.9 (2<sup>nd</sup> step), and 13.9 (3<sup>rd</sup> step). In this table, logistics facilities are reclassified as one of 3-types: facilities owned by trucking companies, rental facilities, and customers’ facilities. The facilities owned by trucking companies account for about a half share of the total facilities at each step.

	Own	Rental	Customer	Total
1 <sup>st</sup> Step	1.9	1.3	0.9	4.1
2 <sup>nd</sup> Step	3.0	2.6	1.3	6.9
3 <sup>rd</sup> Step	5.2	4.9	3.8	13.9

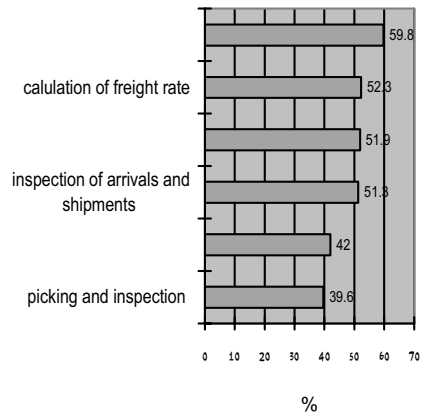
**Table 2** Average number of logistics facilities

	Yes	No	Unkn wn
1 <sup>st</sup> Step	59.4%	39.9%	1.5%
2 <sup>nd</sup> Step	84.7%	14.3%	1.7%
3 <sup>rd</sup> Step	86.7%	13.3%	0%

**Table 3** Introduction of IT in logistics

In general, 3PL businesses are classified as “asset-based” and “non asset-based.” The former is a type where logistics providers own logistics facilities, and the latter is a type where they rent logistics facilities from other companies. In a third type, commonly found in Japan, logistics providers utilize their customers’ logistics facilities.

Table 3 summarizes the introduction of information technology (IT) into logistics operations. Even in the 1<sup>st</sup> step, about 60% of trucking companies utilize IT. By the 3<sup>rd</sup> step, this percentage increases to almost 87%. Figure 2 shows the areas in which trucking companies



**Figure 2** Introduction IT in Logistics areas

have introduced IT. The areas where more than half of trucking companies have already introduced IT are inventory control, calculation of freight rate, exchange for order information, and inspection of arrivals and shipments. Through this survey, it became

clear that the trucking companies positively introduced IT into their 3PL business<sup>3</sup>.

### PROBLEMS OF 3PL BUSINESS

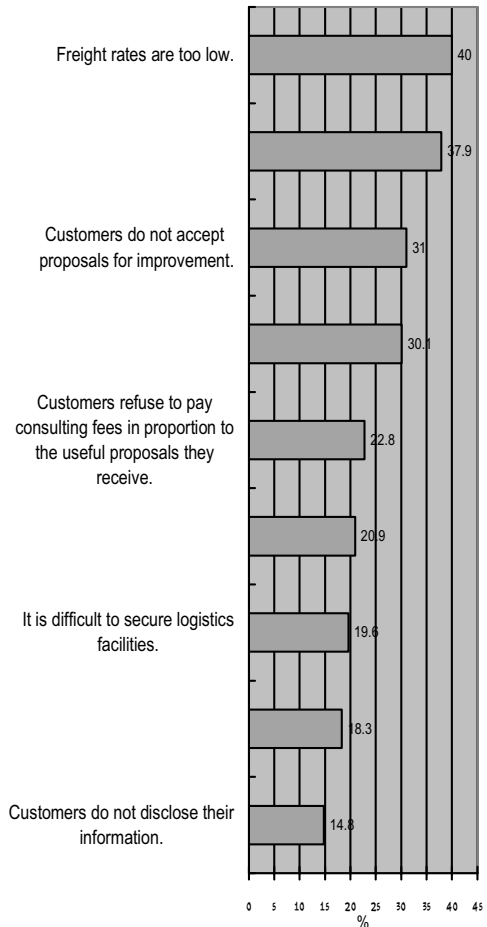
Small and medium-sized trucking companies are facing several problems in implementing 3PL, and Figure 3 summarizes those problems. Basically, it is possible to classify these problems into two categories: 1. The relationship between trucking companies and their customers, and 2. The trucking companies' own human resources.

Problems arising from the relationship between trucking companies and their customers are as follows: "Freight rate is too low," "Customers do not always accept proposals for improvement," "Customers refuse to pay consulting fees in proportion to the useful proposals they receive," "It is difficult to secure logistics facilities," "Customers are not aware of the importance of logistics improvement," and "Customers do not disclose their information."

In Japan, these customers (formally referred to as shippers)

are in a particularly strong position in relation to trucking companies. For example, shippers are able to easily substitute one carrier for another, due to the sheer number of trucking companies willing to do whatever necessary to both seek out and retain customers. In addition, shippers sometimes abuse their position by requesting unreasonably low freight rates, thus further encouraging competition.

One of reasons why trucking companies started 3PLs, is that they wanted to escape from long-established relationships with shippers. However, the old fashion mindset towards trucking companies still prevails among shippers, with several problems (e.g.



**Figure 3** The problems in 3PL business

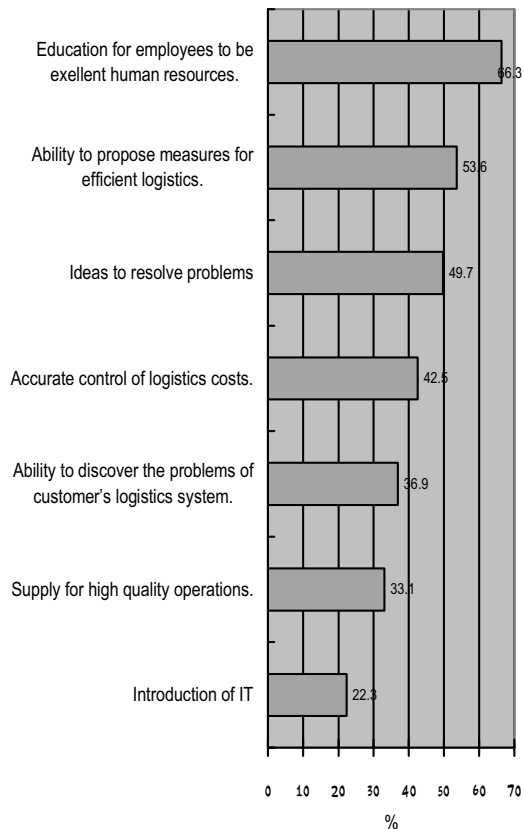
<sup>3</sup>Necessary IT in 3PL business is said to consist of EDI (Electronic Data Interchange), WMS (Warehouse Management System), and TMS (Transportation Management System); all are considered rather standard components of 3PL.

unreasonable requests for extremely low freight rates, refusal to disclose information, and plagiarism of a trucking company’s original ideas) rooted fundamentally in this outdated way of thinking. Although it is necessary for trucking companies to establish a *partnership* with customers in order to conduct successful 3PL businesses, for the most part they have not yet been able to accomplish this. This is certainly one of the factors impeding sound growth of 3PLs by small and medium-sized trucking companies.

The second category of problems is related to trucking companies’ human resources. As previously shown in Figure 3, the following items figure prominently in this category: “It is difficult to find administrators who can manage logistics centers,” and “It is difficult to secure information technology specialists.” From this survey, it became clear that many trucking companies are also facing human resource problems in 3PL. The reader might ask, “Why do human resources problems occur in the 3PL operations of small and medium-sized trucking companies?” In response, the author would like to point out two things.

First, when trucking companies expand into 3PL, they must also operate logistics centers. Although their professional competence lies in trucking, they now must face new challenges particular to logistics center operations. Although these centers house complicated operations partially performed by automated machines, they mostly still depend on a high number of competent workers. This in turn leads to the need for personnel with high-level management skills. It is difficult for these centers’ administrators to quickly build the know-how and skills necessary to ensure smooth operations of these centers. Therefore, the trucking companies must educate their employees, or hire new skilled managers. Neither of these options is walk in the park for trucking companies.

Second, 3PL-consulting services are currently facing a lack of excellent administrators. As already mentioned, one of the features of 3PLs is the presence of consulting services that make concrete proposals regarding the improvement of customers’ logistics systems. Of course, the smooth operation of such consulting services in turn requires a deep understanding of the operations in logistics centers and logistics IT; this understanding is based on previous long-term experience and achievements.



**Figure 4** Necessary items for maintaining competition

Therefore, a lack of excellent administrators has a great influence on consulting services. This is yet another severe problem for small and medium-sized trucking companies.

### **THE IMPORTANCE OF HUMAN RESOURCES IN 3PL BUSINESS**

While trucking companies are facing human resource problems, they consider this area to be the most important factor in remaining competitive in 3PLs. Figure 4 lists the important components that trucking companies consider necessary for remaining competitive in 3PLs. The most important component is "education for employees to be excellent human resources." Additionally, on many occasions trucking companies pointed out other items related to human resources.

Here, the point that we should pay most attention to, is that many trucking companies think of human resources as a more important factor in remaining competitive than software, such as IT, and hardware, such as logistics centers.

Competitiveness for 3PLs depends heavily on their capability to reduce a customer's logistics costs. The operation of logistics centers is one area in which trucking companies can reduce these logistics costs. In Japan, reducing costs often involves managers and workers putting their heads together in a joint effort. Different from a top-down approach, it is fundamentally the same as the *kaizen* process (which is commonly hailed as one of Japanese manufactures' strengths). In Japan, it all comes down to human resources; therefore, the trucking companies' approach to remaining competitive seems quite reasonable, as they fully realize the significance of human resources in 3PL.

### **CONCLUSION**

Several features of 3PL businesses managed by small and medium-sized trucking companies became apparent through the aforementioned comprehensive questionnaire survey. About half of these companies have already started 3PL in some form. They have positively introduced IT, and utilized an array of logistics facilities as part of their 3PL operations. Again, one of the severe problems in 3PL is the difficulty in maintaining a good relationship with customers. Other severe problems include companies' inability to secure highly competent human resources. However, these companies clearly realize the importance of human resources in remaining competitive in 3PL.

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## **A ROUTING SYSTEM FOR COLLECTION AND DELIVERY OF FAMILY FARMING PRODUCTS**

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### **ABSTRACT**

The purpose of this paper is to present the methodology and the partial results of a modeling project of a routing system adapted to organizations of family farming producers. The objective of the project is to provide a system that can help these organizations to reduce their costs and improve their performance in products collection and distribution. The development of the system involves choosing parameters that improve the performance and profits of the organizations studied. There methodology used to define the relevant parameters and the heuristic algorithms chosen are presented here.

**Keywords:** Family Farming, Vehicle Routing, Heuristic Algorithms

### **INTRODUCTION**

Family farming can promote social organization in rural areas and boost economic development. However, there are several obstacles to this development - the most significant ones concern transportation and distribution. The planning of logistics processes and the lack of support technologies are obstacles that family farming producers face when searching for market channels. When family economies make use of modern tools, it can help them to increase their income and to optimize scheduling. By using information systems, digital inclusion is also promoted. However, one research subject that is not yet well developed is the adaptation to the small enterprises context of some commercial programs normally employed by larger companies. The access of small producers to such systems is not possible on an individual basis due to high development and implementation costs, but when grouped in any kind of social organization, it becomes easier to benefit from those tools. Considering this context, we proposed some parameters and algorithms to be applied in a routing model to assist rural cooperatives, aiming to improve their cost management process, as well as their collection and distribution efficiency.

### **LITERATURE REVIEW**

For most of the rural organizations the use of logistics and supply chain concepts still remains a challenge. Integration of such chains demands the use of certain methodologies that, most of the time, are not available or are inadequate. So, the selection of a routing model adequate for organization necessities can improve efficiency and the usage of equipment, adding value to the chain management.

For Ballou (2001), the transit time of the products affects the number of departures of each vehicle and the transport costs for all the departures. Effectiveness in reducing the logistics costs reduces the time of the process and the number of people involved.

A good routing system leads to products of higher quality and more reliable services, the most important attributes for consumers. As costs are proportional to distance, organizations must seek the best vehicle cost itinerary in order to allocate more time and resources to attend the demands of their clients (Bell and McMullen, 2004).

There are several methods that deal with problems of cost minimization in routes and circuits. Boaventura Neto (1996) defines the Vehicle Routing Problem (VRP) as searching how to distribute to one or more vehicles the schedule of delivering, collecting or other services, related to defined points (clients) where the vehicles must return to their origin at the end of their itineraries.

From the graphs point of view, a basic VRP can be defined as the graph  $G(V,E)$ , where  $v_0 \in V$  is a vertex depot and where for each  $i \in V - \{v_0\}$ , there is a client related to the demand  $d_i$ . Hence, for each edge  $(i,j) \in E$ , there is a cost  $c_{ij}$  associated, that can be translated by the edge length. However, in our case, the cost is also a function of the truck's load; therefore, cannot be uniquely mapped to the edges length.

The VRP efficiency involves seeking a set of routes with minimal total cost, so that each delivery point (client) may be visited at least once. Each vehicle starts and finishes its itinerary in a vertex depot, provided that the whole demand serviced on each route does not exceed the vehicle capacity. There are situations where the basic VRP cannot satisfy the decision makers' needs. In these cases it is possible to include appropriate restrictions to improve and adapt the VRP resolution method to the organizational needs.

Since exact approaches are generally inadequate, heuristics are commonly employed. Vehicle routing heuristics are usually measured by using two criteria: accuracy and speed. Cordeau et al. (2002) add the simplicity and flexibility criteria to the essential attributes of good heuristics

## **METHODOLOGY**

In order to identify major routing problems, exploratory studies were carried out in two different cooperatives, both situated in Brasilia (Brazil) rural areas: a dairy products cooperative and another specialized in vegetable products. In the exploratory studies informal interviews with producers, clients, cooperative managers, drivers, and other employees were carried out. Observations were also made during the visits to the cooperatives. The selection of parameters to be used in the routing model was based on the following procedures:

- Measurement of the geographical coordinates of the cooperative plant, collection and distribution points, and routes mapping. The location of 84 clients in three distribution routes and seventeen producers during one collecting route were visited and registered.
- Survey of the main costs related to collecting and distribution processes, i.e. driver remuneration, fuel and maintenance.
- Compilation of the collection and distribution volumes.

## PROBLEM IDENTIFICATION

The dairy cooperative has an average distribution of 4,500 liters of milk per day, delivered mainly to Social Programs of local government and to small shops, most of them in the proximities of the organization. The second cooperative distributes vegetable products to local grocers in and around Brasília.

Besides information related to the costs mentioned and to production and distribution volumes, data used to present a description of the process related to collection, production and distribution were gathered, via interviews. The main obstacles were found in the collection and distribution process, as detailed below:

- Collection. The collection points are spread over a great area. As the organization has its transport capacity limited, the collection is done without planning. Normally, the vehicle passes by the closer points, collects the product and, before finishing the planned route, returns to the cooperative once the maximum load capacity is reached.
- Distribution. Delivery schedules are not kept, due to unloading delays. This problem is in part caused by the accumulation of duties allocated to the driver. Apart from products delivery, he receives payments and records new orders.

Partial results indicate that a previous development of the internal organization of family farming producers is required before initiating the implementation of any routing system. It was found that most of the problems presented in the use of those kinds of systems are related to the training of the producers and internal problems, and not to the system itself.

## ROUTING MODEL PARAMETERS AND ALGORITHMS SELECTED

The parameters applied to the system in rural areas are not very different from the ones used in urban sites. However, before and simultaneously to the implementation of the system, local features must be carefully considered.

### Parameter 1 – Travel Distance

The main objective is to find the best route to be used in final products delivery or in raw products collection. The situation is similar to the classic problem of the Traveling Salesman Problem (TSP) that needs to visit a group of cities. The difficulty consists in finding the sequence that the cities must be visited. Various algorithms solve exactly the TSP, though for numerous cities, the computational cost becomes prohibitive. In those cases, the heuristic algorithms are suggested.

Considering the restrictions and the kind of routes to be involved, the present routing problem is more complex than the TSP. Due to this complexity, the heuristic methods are more recommended, even when the vertex number is smaller. The proposed approach consists in defining a cost function that may be minimized by using a heuristic method.

### Parameter 2 – Routes cost

Among many factors related to a vehicle cost, those related to the total cost of a route can be divided into three groups:

- Personal Cost: this mainly refers to the payment of the driver, who is also responsible for loading and unloading the products. The driver is paid a monthly salary ( $S_M$ ) that corresponds to a  $T_D$  working hours per day. If the time necessary to finish a route ( $T_R$ ) is greater than  $T_D$ , the additional cost per extra-hour



is  $S_{HE}$ . We also consider the driver's preference in finishing the route in the minimum time. Even if this factor does not directly influence the route cost, its effect on the satisfaction of the employee cannot be neglected. It will be evaluated by the cost  $S_{Ht}$ , much smaller than the extra-hour value.

$$C_p = \frac{S_M}{22.5} + S_H T_R + S_{HE}(T_R - T_D)H(T_R - T_D)$$

where  $H(x)$  is the heavy side function:  $H(x) = 0$  if  $x < 0$  and  $H(x) = 1$  if  $x > 0$ .

- **Fuel cost:** as the fuel consumption per kilometer ( $L_{KM}$ ) depends on the road condition and on the total weight of the vehicle, the fuel cost can be calculated by the following equation:

$$C_F = P_L \sum_i L_{KM_i} d_i$$

where  $P_L$  is the price per liter of fuel and the sum is calculated for each road and load condition, each one measuring  $d$  kilometers. Archondo-Callao (1994) presents a detailed model for fuel consumption. Due to the impossibility of obtaining all the parameters, the following simplification is proposed:

$$L_{KM} = L_0(1 + aF)$$

where  $L_0$  is the fuel consumption in neutral,  $a$  is the energetic efficiency factor and  $F$  is the force required to move the vehicle. The main factors that affect that force are the rolling friction, ascents, descents and aerodynamics. The total force is the sum of these effects:

$$F = (R_R + I_R)M_T g + \rho_{Ar} C_{Ar} A_{Ar} V^2$$

where  $R_R$  is the rolling resistance,  $I_R$  is the sine of the road slope (positive for ramps and negative for declining surfaces),  $M_T$  is the total mass transported (vehicle mass plus load mass, in Kg),  $g$  is the gravity acceleration,  $\rho_{Ar}$  is the air density,  $C_{Ar}$  is the aerodynamic coefficient,  $A_{Ar}$  is the frontal area and  $V$  is the speed.

- **Maintenance cost:** lubricant oils and tires represent a maintenance cost that is considered dependent only on the travel distance. The oil substitution occurs every  $d_{oil}$  kilometers and its cost is  $P_{oil}$ . In the same way, each tire costs  $P_{tire}$ , including the acquisition price and retreading during the life cycle of the tire. During this period each tire travels  $d_{tire}$  kilometers., the maintenance cost of a vehicle with  $N_{tire}$  tires is:

$$C_M = \frac{P_{oil}d}{d_{oil}} + \frac{N_{tire}P_{tire}d}{d_{tire}}$$

There are other factors included in the vehicle maintenance cost, such as load deterioration, mechanic maintenance, insurance, depreciation, interest and taxes. However, these costs either are fixed, i.e., do not depend on the time or the distance of a given route, or they are much smaller than other costs.

### Parameter 3 – Time

An important parameter in route characterization is time. Although the Personal Cost ( $C_p$ ) defined above depends on the total route duration ( $T_R$ ), there are restrictions concerning the instant when the vehicle visits one of the loading and unloading stations. Consequently, it is important to estimate the vehicle speed at each point of the route. We will use the model presented by Archondo-Callao (1994) that defines that vehicle speed is approximately given by:

$$V = \left( \frac{1}{V_{drive}^{1/\beta}} + \frac{1}{V_{brake}^{1/\beta}} + \frac{1}{V_{curve}^{1/\beta}} + \frac{1}{V_{rough}^{1/\beta}} + \frac{1}{V_{desir}^{1/\beta}} \right)^\beta$$

where the parameter  $\beta$  determines the Weibull distribution format. Each one of the speeds is related to one limiting factor: the maximum motor power, the maximum capacity of the brake system, the incidence of curves, the roughness of the route and the velocity desired by the driver in ideal conditions.

When transporting liquid products, it is necessary to change the  $V_{curve}$  and  $V_{rough}$  calculation in order to include the effects of the liquid movement on the vehicle stability.

When calculating the instant when each route point is reached, it is necessary to include the vehicle loading and unloading times at the collection and delivery points and at the beginning and end of the route. These times depend on the facilities available at each point and on the volume of cargo involved.

### Candidate algorithms for the routing system

As already mentioned, a heuristic algorithm will be required to find the vertex sequence that results in the lowest cost. Over the last ten years much of the research effort has concentrated on the development of algorithms based on metaheuristics, using mainly two principles: local search and population search. Among the algorithms that we are investigating are: Simulated Annealing (Czech and Czarnas, 2002), Genetic Algorithm (Baker and Ayechev, 2003; Tong et al., 2004), Ant-Colony Optimization (Bell and McMullen, 2004; Montemanni et al., 2005), and Particle Swarm Optimization (Bin et al., 2004; Zhu et al., 2006). We can consider that the truck's load is constant between two points of collection or delivery. Due to this we are able to use an exact algorithm, like Dijkstra's (Cormen et al., 2001) or A\* (Luger, 2004), when looking for the lowest route cost connecting two points.

### CONCLUSION

The final implementation will probably use a metaheuristic solution, employing two or more of the above algorithms in different stages of the search for the best solution. It must be emphasized that, despite the importance of implementing a good routing system, it is first of all necessary, to evaluate the chain process that could represent obstacles to its application.

Nevertheless, this implementation must be followed by a revision in the proceedings and process currently practiced. It will make a better adjustment in the routes possible, considering the parameters related to cost, time and sales volume. The processes inside the organization also need to be reviewed. Chain managers and other people involved in the utilization of the system must also be trained.

To validate the model system it is still necessary to interview producers and consumers about their satisfaction with the new routing process.

We are building a geographic information system complying with the OGC (2005) standard. That system will consist of the geo-referenced data of the area superposed by layers describing the roads and the points of collection and distribution.

This ambient will be used to present the routes discovered by the optimization module. The whole system is being developed following the free software methodology and will be distributed according to its rules.

### ACKNOWLEDGMENTS

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## **BARRIERS FACED BY ALEXANDRIA PORT IN OPERATING AN EFFICIENT GLOBAL BUSINESS**

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### **ABSTRACT**

With increased globalisation and offshore sourcing, global supply chain management is becoming an important issue for many businesses. Global supply chain management usually involves a number of different countries, each with its individual challenges that need to be resolved. The purpose of this paper is to investigate the barriers faced by Alexandria Port, Egypt in operating an efficient global business and the need to implement an e-business supply chain model. This paper highlights the importance of enhancing the trust of all parties involved in electronic business transactions. The paper analyses the current global logistics operations within Alexandria Port and evaluates the need for an e-business model with certain considerations for the local culture and environment. The paper illustrates the main barriers faced by Alexandria Port and the main benefits of implementing an e-business supply chain model. The paper is evaluative, qualitative and inferential, supplemented by a case study of Alexandria Port in Egypt.

### **INTRODUCTION**

High speed, low cost, communication and collaboration with the customers and suppliers are critical success factors to effectively manage the supply chain in general and the global supply chain in particular. E-Supply Chain is very likely to become part of any organisation in the future. The essence of Supply Chain Management is effective information and material flow throughout a network of customers and suppliers. The potential for improved productivity, cost reduction and customer service is enormous. Therefore, the benefits are based on effectively employing the right processes and supporting information technology. Providing the right amount of relevant information to those who need to know it and when they need to know it is, in fact, effective Global Supply Chain Management from the information point of view (Poirier & Bauer, 2001).

With respect to the Alexandria Port case study, the above mentioned elements are essential to obtain a competitive advantage to participate and survive in global competition, especially when global supply chain management is a powerful, comprehensive tool for aiding decision making in global logistics and supply chain issues (Bayles 2001).

### **BARRIERS TO TRADE IN EGYPT**

#### **Tariff Escalation Barriers**

Although one of the major global concerns is the elimination of tariffs as a barrier to trade between nations, Import duties in Egypt vary considerably from 5 percent to 40 and 125 percent on different raw materials, components and products based on the degree of processing. High tariff rates are maintained on some products including passenger cars, tobacco and alcoholic drinks (Egyptian Ministry of Trade & Industry Website). The highest rate reaches 3000 percent for luxury items. However, Egypt's tariff structure clearly reveals a positive escalation, with an average of 4.8 percent on raw materials, 10.6 percent on

semi-processed goods, and 28.2 percent on fully processed goods. Special tariffs are also added to fabrics, textiles, and garments.

### **Customs Procedures Barriers**

According to the Egyptian Customs regulations, to ensure the release of the consignments to Egypt, all documents including invoices, certificates of health, analysis reports and certificates of origin should be notarised by the local notary offices and should be verified by the embassies and consulates general of Egypt in the exporting countries (A.P.A. Website). Such sets of documents are completely different from the other sets of customs documents required upon arrival in port which will be covered later in this paper. Documentary red tape in customs procedures substantially increases the cost of imports (RAFIMAR Website).

### **Technical Barriers**

The Egyptian government controls many service industries. Recent government policies allow private sector involvement in ports, maritime activities, and airports, an opening that has led to significant interest and activity in the private sector. However, services provided by Alexandria Port such as loading, discharging, warehousing, and container handling do not reach the international standards required to compete globally with other ports. Other technical formalities like imported goods must be marked and labelled in Arabic with the brand and type of the product, country of origin, date of production and expiry date, and any special requirements for transportation and handling of the product are required (A.P.A. Website). An Arabic language catalogue which has to accompany imported tools, machines and equipment is also mandatory. In addition, the government mandates for cars imported for commercial purposes must be accompanied by a certificate from the manufacturer stating that they are suited for tropical climates, and according to a 1998 Ministerial Decree, imports of automobiles are restricted to the current model year in any given year. Many of these standards are at odds with World Trade Organisation agreements prohibiting technical barriers to trade.

### **Import restrictions**

Egypt maintains import prohibitions for economic, environmental, health, safety, sanitary, and phytosanitary (food safety and animal and plant health) reasons. It does also have quotas or tariff quotas on some of the imported items (A.P.A Website).

### **Documentation Barriers**

Many documents are required by the port authority such as customs, health, and immigration. Figure 1 considers an example of the documentary barriers which adversely affect global supply chain management in Alexandria Port. Each step is lengthy and bureaucratic. This causes a great loss in time and money and puts Alexandria Port behind its competitors (UNCITRAL, 2001), which again indicates that the introduction of an electronic system is a necessity.

In Egypt, the Import inspection process remains confusing despite the designation of the General Organisation for Export and Import Control (GOEIC) as the coordinator of all import inspections. Over 130 categories of imports are subject to mandatory quality-control inspections, including foodstuffs, appliances, electrical products, and auto parts. Imported refrigerated containers of foodstuffs typically take 25 days to be cleared from customs (UNCITRAL, 2001). While two-month delays were common in the past, overall customs-clearance times are improving, and import inspections now typically take three to four weeks. However, 25 days is still too long and it is not even close to the

international standard which ranges between 6 and 8 hours for containers (Egyptian Ministry of Trade & Industry Website), demonstrating the importance of the E-Business proposed model to speed up the process in Alexandria Port to cope with global market standards.

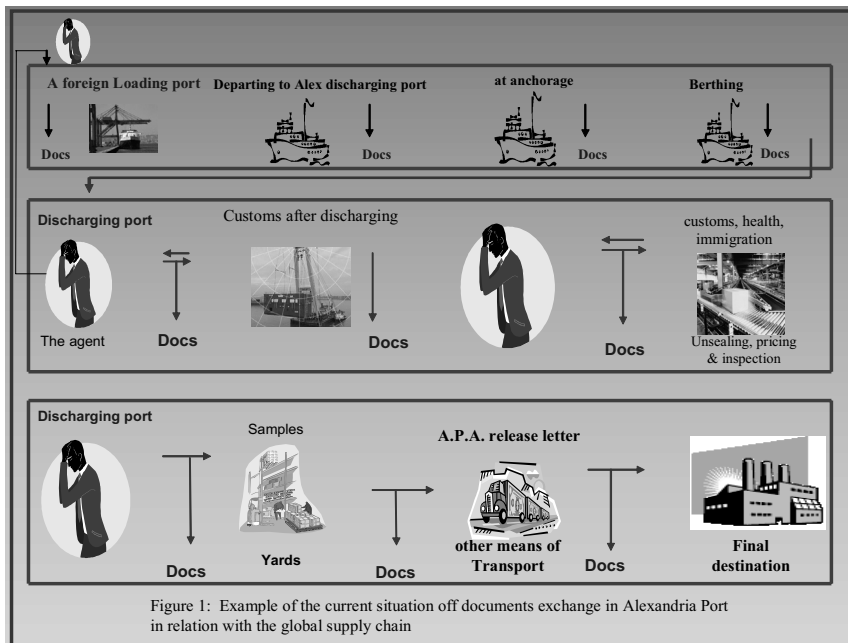


Figure 1: Example of the current situation of documents exchange in Alexandria Port in relation with the global supply chain.

**A REVIEW OF APPLIED E-BUSINESS MODELS IN THE MARITIME INDUSTRY**

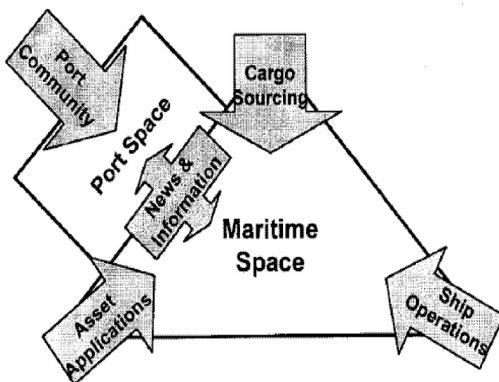


Figure 2: E-Business Market Entry Strategy  
Source: Martin and Thomas, (2001)

The E-business model developed by Martin and Thomas, (2001) is designed mainly to electronically book a space for a container in the port, or in the warehouse, and arrange the required services for it. With the involvement of the port community five organisational groups are identified, namely Providers of port infrastructure and facilities; Providers of cargo handling services; Maritime transport operators; Inland transport operators and Representatives of the cargo.

The market entry strategy of these new players is to gain a foothold in the maritime or port E-Business space through offering a specific service within one of the elements present in Figure 2.

Another E-Business model introduced by Hart (2001) and shown in Figure 3 illustrates that the main interrelated elements of the e-business model are: E-Commerce, Customer Relationship, Business Information, Supply Chain, and Enterprise Resources.

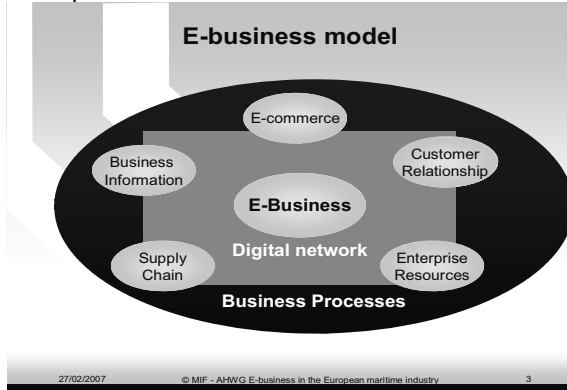


Figure 3: E-Business in the European Maritime Industry, Source: Hart, (2001)

It is designed to be used as an E-business model in the European maritime industry.

The cultural element does not have any weight in this model. The local strategies, policies, and regulations of e-business as well as logistics and ICT skills are not considered either. The above applied model did not include elements such as local strategies and policies that are particular to the local environment which in our view are vital elements required in the development of an e-business model.

There are other e-business models such as the one presented by Bertolazzi et al., (2001) which focuses on three main pillars: **(1) the infrastructure and the network of partners** that is necessary in order to create value and to maintain a good customer relationship. **(2) the products and services** a firm offers, representing a substantial value to the customer, and for which he is willing to pay. **(3) the customer relationship** the firm creates and maintains with the customer, in order to provide satisfaction and to generate sustainable revenues. Another E-Business framework illustrated by Auramo (2005) offers **three categories** of benefits: **strategic, informational, and transactional**. Each of these categories is further divided into three components. Transactional issues are related to operational management and help cut costs within the supply chain. Informational issues provide the information and communication infrastructure to the supply chain, while strategic impacts are related to the changes in how an organization or supply chain competes.

### THE PROPOSED E-BUSINESS MODEL

In the proposed model, the researchers seek to demonstrate that e-business can only be effective if it is regarded as part of an overall corporate information security risk management policy. In addition, there should be strategies and policies tailored for the local environment to overcome the difficulties within the local culture. Proper intensive training courses should be made for both employees and workers to obtain the necessary logistics and e-business skills and qualifications and local regulations that govern e-business needs to be considered. The proposed model is as shown in Figure 4. The basic elements of the proposed e-business model are e-security, strategies and policies in compliance with the local culture, the logistics skills, and in conformity with local regulations.

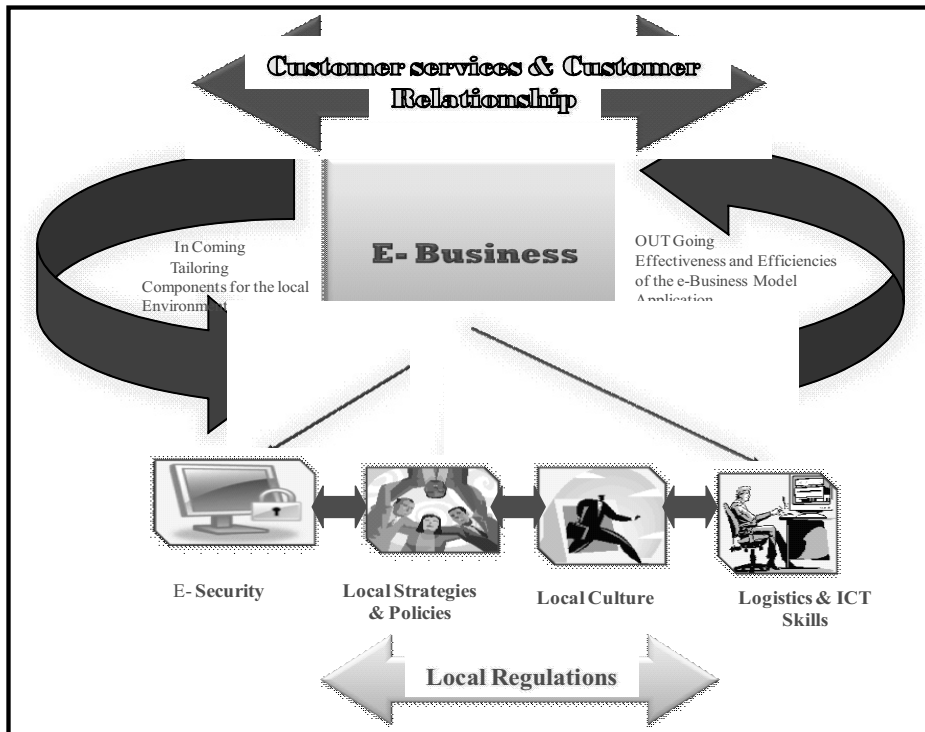


Figure 4: The Proposed E-Business Model for Alexandria Port

E-security is one of the critical elements in any e-business model. It is essential to ensure that only the authorised persons have access to the system and to ensure that all documents sent or received are not altered in any way. Specific strategies and policies should be part of the development plan for any e-business aspect of models to suit each local culture. In Alexandria Port, the workforce has held the same jobs responsibilities for many years and there is a reluctance to change. The strategy should gain the acceptance of such employees. This implies taking into consideration the local culture which, as an element, did not have much value in most of the existing models applied else where.

Logistics and Information and Communications Technologies skills are important elements which should be part of the e-business model. Training is seen as vital at this stage to upgrade the skills of the present employees and workers to cope with the new way of adapting the business and to have professional technicians and workers to run it. Additional factors concerning country specific implementations for e-business and e-commerce should also be considered in the development stage of an e-business model

The proposed model is expected to reduce both time and cost to the minimum level and accordingly support an efficient global supply chain that leads to increased port productivity.



## CONCLUSION

To achieve the benefits offered by e-business, organisations must find ways to effectively address the associated information security implications. The implementation of integrated information security across an organisation is a very complex process, requiring appropriate management. Whatever precautions are taken, security risks will always be associated with computer systems and the issues of managing the array of technologies associated with e-business further increase the information security problem. The individual and the society culture is another essential element that should be taken into consideration to set the adequate strategies, policies and regulations. And we can not deny the importance of the logistics and ICT skills.

Alexandria port of Egypt needs to adapt an e-business model to speed up processes, eliminate red-tape, increase efficiency and productivity, and cut down the time and cost to the minimum to be able to compete globally.

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## **DEVELOPING A SUSTAINABILITY INDICATORS FRAMEWORK FOR SHIPPING IN THE SUPPLY CHAIN**

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### **ABSTRACT**

There is an increasing necessity for business organisations to exercise a responsible attitude to sustainability issues and environmental governance. Transport systems are no exception and shipping, often forming a major component of international supply chains, is of particular significance in trying to enhance the performance of such chains. The general approach that business has focused on to improve 'sustainability' has been to address performance in three key areas: environmental, economic and social. Sustainable performance could, however, also consider technological, institutional and operational matters. In this context, therefore, which factors could constitute key indicators for measuring sustainability in shipping as part of the logistics chain? The aim of this paper is to evaluate the principle of sustainability in the context of the shipping industry and develop a theoretical framework of the different constituents that can play a role in sustainable shipping logistics.

### **INTRODUCTION**

Interdependence between business and the environment has changed and evolved over centuries from one where economic activity followed nature, to one that exploited nature and more recently to one where environmental trends seem to be shaping and dictating economic developments. Environmental concerns are relevant to all people as they are connected with issues of health and degradation of societal welfare. The new conceptual frame that has been promoted for assessing industrial and social development as well as business activities encompasses the notions of sustainability and social responsibility. The challenge each industry faces is how to continue to fulfil their vital role within modern society consistent with the principles of sustainable development while satisfying the economic, legal and ethical requirements imposed on them. The shipping industry is no exception.

Assessing transport sustainability is a complex task which covers: a wide range of areas and actors both across and within sectors with often conflicting interests; a variety of measures many of which are not easily quantifiable and which are often subjective rather than objective; and monitoring progress towards targets which appears to be difficult and problematic to determine both in absolute and relative terms. Shortage or unavailability of appropriate data can also create an additional obstacle in such an assessment. This paper focuses on a number of issues ranging from direct environmental impacts (e.g. water pollution) to the more intangible social effects (e.g. community viability or political power) with a view to investigating, developing and analysing a theoretical framework of the different constituents that can play a role in sustainable shipping logistics.

## **SUSTAINABILITY AND SOCIAL RESPONSIBILITY DEFINED**

Sustainable development has largely been defined as 'development that meets the needs of the present without compromising the ability of the future generations to meet their own needs' (Brundtland, 1987), a concept which stresses the interdependence between economic growth and environmental quality as well as the notion of intergenerational equity. Due to the interdependence of organisations, society and the environment, the term sustainability has more recently been broadened to encompass economic and social considerations in addition to its environmental components. Today, sustainability as a goal for business adheres to the notion of an extended set of organisational goals which includes the goal of adding economic value as well as the goal of adding environmental and social value – the so-called 'triple bottom line' notion (Elkington, 1999). From the environmental perspective, the basic principle that emerges is the effective management of natural and physical resources so that they are preserved for the future. Economic sustainability is concerned with achieving the business' long-term positive economic performance, while the social perspective on sustainability incorporates issues of social welfare, health and justice.

However, other commentators extend this framework to include three further dimensions to which the above three relate, these being technological, operational and institutional (Spangenberg, 2002, Janic, 2006). In the technological arena issues concerning the development of the most effective forms of transport arise e.g. propulsion technology, fuel efficiency etc,. The operational dimension concerns the operations and processes which govern how transport systems are used and determines whether they are safe and efficient. Institutional activities bring the various actors together to enable a more comprehensive approach to sustainability to be developed (Janic, 2006).

## **SUSTAINABILITY IN THE CONTEXT OF THE SHIPPING INDUSTRY**

Is a discussion of sustainability relevant to the international shipping business today? The issue of sustainability is something that must be considered and achieved at multiple levels, at the enterprise level, within the business sector, within the community, the nation and ultimately the whole world. It is difficult to think of the shipping business as an isolated industry separate from society and the environment, as all its activities take place within the context of society and the physical environment. Its social responsibilities arise from this interdependence. In shipping all corporate activities have social impacts, whether positive e.g. trade promotion, employment, etc., or negative e.g. pollution and consequent impairment of communities' livelihoods. The shipping industry also has an abundance of technical, administrative and financial resources which could be put to use to solve or prevent problems with an effect on society and ultimately on itself, too. Today, more than ever, it is far less acceptable for a business to declare that its only purpose is to make as much profit as possible. Corporations rely on the contribution of a much wider variety of constituencies in society than just their shareholders and they should thus have a responsibility to take into consideration their interests and needs. In the effort, therefore, to develop a framework of parameters which are instrumental in evaluating the principle of sustainability in the context of the shipping industry, attention must initially be given to identifying the key-stakeholders of

the industry, that is, those entities on which performance of the industry in the six areas outlined above can readily be depicted and therefore assessed.

An organisational stakeholder is any group or individual that can affect or is affected by the achievement of the organisation's objectives (Freeman, 1984, p.46). Such groups may have more conflicting interests than allied ones. For a shipping company the number of stakeholders to be taken into account can create a quite complex system and even differing one in diverse situations. However, the variety of interests to be considered broadly to fall into six groups: Investors, Customers, Employees, Community/Environment, Government/Legislators, and Others. Stockholders and investors provide the essential capital funds for the firm's operation and are concerned with earning profits. The economic health and success of the company is critical to them as their personal wealth is at stake. Such economic results are directly connected not just with the actual earnings of the company but also with its ability to obtain loans and retain investment and to obtain insurance cover at competitive premiums, and they are also demonstrated in the company's expenditure with regard to money paid to cover costs resulting from fines, lawsuits, clean-up costs, claims, delays, lost freight, and any other costs incurred due to non-observance of corporate responsibility principles. The responsibilities of a shipping company to its customers extend beyond the mere supply of shipping services. By responding successfully to the customers' demand for quality, safe and free of environmental damage shipping services, ship operators can gain customer loyalty and retain clientele and increase business. Towards its employees the shipping company is expected to do more than just fulfil the terms and conditions of the employment contract, by, for example, treating them fairly, providing them with safe working environment and quality of working life, giving security of employment, enhancing job satisfaction and respecting their needs. Taking into account that for seafarers their place of work is also their place of social life for long periods of time such issues become even more pertinent. Shipping companies also have an obligation to the local community which provides them with the necessary infrastructure for their operation; they must comply with national and international law which set the necessary framework for them to develop and prosper; and they must have consideration for the natural environment and in connection to that the welfare of the wider general public and of the generations to come. The international character of the shipping business makes imperative the attention to the critical area of social responsibility relating to the protection of the environment. The 'others' group consists of suppliers, social activists, business associates and even competitors and examples of relevant responsibilities include, honouring the terms and conditions of contractual agreements, engaging in fair competition, and keeping the public informed on issues with an impact on it.

### **SUSTAINABILITY INDICATORS**

The question now arises as to what are the factors that could constitute the key indicators for measuring sustainability in shipping as part of logistics chains. It has already been suggested that there are six key areas of responsibility in this context – environmental, economic, social, operational, institutional and technological. Within these groups the parameters for shipping are not likely to be dissimilar to other forms of transport, and shipping as part of most global supply chains, must work towards reducing the impacts of its operations in all

areas. There is however, as Janic (2006) points out, no universal definition of what constitutes a sustainable transport system, and this therefore, by implication, makes the development of a sustainability framework difficult. The consideration of such issues has been on the agenda since the 1980s (Brundtland, 1987) and consideration at the individual nation level has been developing since at least the mid 1990s (see for example SEPA, 1996). However, there are some overall concepts which are relevant to the discussion.

In an environmental context the direct impacts of shipping operations can be measured just as with any other transport mode. The OECD (2001) suggests that sustainable transport should use renewable resources below their regeneration rates and renewable resources below the rate of development of renewable substitutes (see also CEC, 1999; Whitelegg J, 1993)). Ecosystem health should be maintained while the impacts of the use of land [and sea], noise generation and emissions should be minimised. Fuel consumption must be sustainable into and indefinite future (CEC, 1999; Richardson, 1999). Economic sustainability is more complex but sustainable transport must contribute to the development needs of both individuals and society while being affordable, fair and efficient (CEC, 1999). Economic decisions must therefore form part of decisions affecting transport activity (Transport Canada, 1999). As with environmental considerations access to transport has to be economically viable into an indefinite future (Richardson, 1999). Social sustainability is probably the most difficult of all to measure and control but should still be accounted for in decision making (Transport Canada, 1999). Ensuring the needs of society into the future requires that equity exists not just between individuals and societies in the present but that such equity also exists between current and future generations (CEC, 1999).

Technology is concerned with the physical structure and operation of the transport system, the vehicles [ships] that operate in the transport system and their components. Many of the characteristics of these aspects are measurable and impacts and long term changes can thus be seen. Reducing environmental impact is, in many cases, fundamentally related to changes in technology. Operational impacts determine how effectively systems operate and are often governed by a complex set of rules and procedures. Effective operations can contribute directly to increased efficiency and improved sustainability. Economic sustainability is linked to both technological and operational aspects while social sustainability is clearly linked to operational activity. Finally, the institutional aspect facilitates the bringing together of the various actors in transport systems and sets the basis for expected behaviour and outcomes (Spangenberg, 2002, Janic, 2006). In all six areas the successful implementation of sustainability measures can only be achieved if targets are developed to which organisations can target improvements in their activities. Successful sustainability must include quantitative targets for specific impacts which can be monitored and refined over time and in each of the impact areas outlined above there will be measures which can be assessed in some way (e.g. Janic, 2006). Indicative measures which could be used in such a framework are shown in Table 1.

### **A Sustainability Framework**

Clearly there are many components to any system which attempts to measure sustainability. At the highest level sustainability can only be achieved if there is

societal agreement in respect of how it can be achieved. For most transport modes this will at least have to be defined at national level but given the international nature of shipping international agreement will be the most effective approach. Once this is achieved the development of a sustainability framework must incorporate the actor level as without agreement here the implementation of any system will be unsustainable. Given the differing interests of stakeholders, achieving common ground at the conceptual level and in terms of actual measures will be important and will of necessity be grounded in regulation (and self regulation). Having chosen the actors, e.g. the stakeholders of a shipping company as described above, then the specific indicators groups, the measures to be used and actual targets can be defined. These clearly have to be agreed at international level for shipping and the relevance for individual actors will have to be clarified. If this is achieved then the collection of data, its recording and comparison to targets and feedback to individual actors can take place. Figure 1 shows the structure of a sustainability framework as described above. For each individual actor the components for measuring their activity in the overall framework will be different compared to other actors.

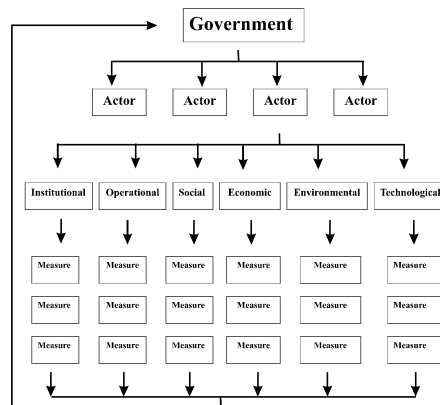


Figure 1: A sustainability framework for shipping (Source: Authors)

## CONCLUSIONS

In order to improve the overall level of sustainability in the supply chain there is a requirement for each of the actors in the chain to play their part. Improvements in technology go some way towards achieving this aim, however economic growth can negate this by increasing transport requirements. Long term sustainable transport requires compatibility between man's transport activities and the environment as well as economic and social structures and transport systems may require substantive adjustments by 'many actors' over a long period (see, for example, SEPA, 1996). In order for such measures to be successful there is clearly a need to understand what the problems are and in this paper we have started to attempt to develop a framework which could assist in this understanding. In terms of improving sustainability many opportunities exist in shipping sector across the six indicator groups that have been outlined (see e.g. Worsford and Dickinson, 1992).

Environmental Indicators	Social Indicators	Economic Indicators
Sea Pollution	Accident fatalities	Freight transport demand
Energy consumption	Onboard injuries	Freight transport earnings/profits
Air pollution (SO <sub>x</sub> , NO <sub>x</sub> , CO <sub>2</sub> )	Suicides	Total ship losses / repairs
Raw materials consumption (e.g. ship construction / recycling)	Health of people working ashore (construction/dismantling)	P&I claims
Biodiversity: (ballast water management)	Fair working conditions (e.g. ITF wage scale)	Contribution to national economic indicators
Land pollution (from ship dismantling)	Community economic enhancement: (e.g. shore based job generation)	Investments in transport infrastructure
Noise pollution (e.g. affecting communities near ports)		External costs (e.g. capital, operational and voyage costs)
		Real change of transport price by mode
Technological Indicators	Operational Indicator	Institutional Indicators
Degree of automation	Fleet productivity e.g. load factor for ships	Institutional cooperation on transport and the environment
Average age of vehicle fleet	Cost minimization	Implementation of strategic environmental assessment
Size of the vehicle fleet	Employee turnover	Integrated transport and environmental strategies
Energy efficiency for freight transport	Loss ratio	Implementation of strategies at international/national level
Adoption of air / water pollution prevention technology (e.g. emissions: per tonne-kilometre; proportion of fleet meeting emission standards / double hull standards)		International /regional /national transport and environment monitoring systems
Uptake of cleaner fuels and number of alternative fuel vessels		
Cargo handling infrastructure (aboard/ashore)		

**Table 1.** Shipping Sustainability Indicators (Source: Authors; Janic, 2006)

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**BEHAVIOURAL DECISION MAKING OF OWNER-MANAGERS  
AND THE  
DEVELOPMENT OF TRANSPORT LOGISTICS VALUE ADDING SERVICES**

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**ABSTRACT**

An understanding of transport service providers' corporate objectives and motivations would provide important insights into road haulage operator's behaviour, future direction and industry structure. The paper concentrates on owner-managers and discusses the implications of this on the theoretical framework, contrasting Neo-classical Economic Theory to Behavioural Economics with regard to decision-making of firm's.

This paper partly addresses the initial challenges of advancing transport logistics from a behavioural decision making framework. The European Union has made a commitment to promoting sustainable mobility through advanced transport logistics. One of the principal areas to be addressed is the potential barriers to advancing transport logistics and the attitudes of industry to this advancement. It has been recognised that there is currently insufficient research in regard to these barriers and that there is a need to establish a measurement and benchmarking process. The paper's main focus is the attitudes to change and development of owner-operated hauliers in the Republic of Ireland. It attempts to justify the application of the Theory of Planned Behaviour (TPB) in a logistics business decision domain.

Preliminary qualitative findings are presented of eight semi-structured interviews of hire and reward owner-operators in the Irish road haulage industry.

Barriers to development and decision-making methods of owner-manager's in the haulage industry are discussed.

**INTRODUCTION**

The Irish economy experienced a tremendous increase in economic growth during the 1990s and early 21<sup>st</sup> Century (Celtic Tiger). This economic boom was export driven and the Irish road haulage industry transported the majority of products produced at some stage, if not a number of stages in the logistics tunnel (Forfás, 1995). There was a 230% increase in tonne-kilometres over the ten-year period from 1995 to 2005, fleet size increased by 163% from 1995 to 2005. Vehicles that were used mainly for hire-and-reward transport of goods were responsible for 57% of the total weight of goods carried in 2005 (CS0, 2006)



Freight transportation within the Republic of Ireland, in comparison to many other OECD (Organisation for Economic Co-operation and Development) countries, is highly dependent on carriage by road, with approximately ninety percent of freight (Tonne-Kilometres) carried in this manner. The Irish road haulage industry exhibits a structure dominated by owner-operators of a single vehicle, performing basic transport services in contrast to other OECD countries (Boylaud and Nicoletti, 2001). This has implications for Ireland's economy by reducing the efficiency of businesses and the future attractiveness of Ireland as a location for foreign direct investment. As Ireland is essentially dependent on road freight, it has the potential to gain significantly from decoupling it from economic growth.

The European Union has made a commitment to promoting sustainable mobility through advanced transport logistics. One of the principal areas to be addressed is the potential barriers to advancing transport logistics and the attitudes of industry to this advancement. It has been recognised that there is currently insufficient research in regard to these barriers and that there is a need to establish a measurement and benchmarking process (Commission of European Communities, 2006).

### **OBJECTIVE**

Considering the industry's fragmented structure, what implication has this for future development?

An understanding of transport service providers' motivations would provide important insights into road haulage operator's behaviour, future direction and industry structure. A theoretical framework is discussed with regard to advancing transport logistics from a behavioural decision-making framework. The main focus includes: attitudes to change and development of owner-operated hauliers in the Republic of Ireland and whether the Theory of Planned Behaviour (TPB) can be successfully applied to this domain.

### **LITERATURE**

Neo-classical theory has a number of assumptions, such as: perfect and costless knowledge, maximisation of self-interest and profit, and resources being limited to land, labour and capital. Many criticise neo-classical economics as unrealistic and that the decision process that takes place inside a firm is not in fact a maximisation decision.

Behavioural economics has emerged as a response to the deficiencies in traditional economics. Its principles were aimed at developing a more realistic process of economics. It deduces principals of economics from human behaviour. One of the main criticisms of neo-classical economics was its over simplification of rational agents. It introduced social psychology, Simon's theory of bounded rationality and concentrated on the behaviour of economic agents, that is, human factors (Hosseini, 2003).

Under the view of behavioural economics, the elements of strategy and cognitive processes of decision-makers in the industry become an important component and have implications in its development. The issue of cognitive inertia has come to light in recent studies. An important component in the development of

an effective strategy is the decision-makers mental model of the competitive arena. If they become out of step with the changing conditions of the market place, they are unlikely to formulate an effective strategy (Hodgkinson, 1997).

The underlying theoretical theme is that the decision to pursue change rest not solely on the desire for profit as depicted by neo-classical economics, but rather the decision to pursue change is complex, a decision that reflects the opinions of others and the owner's perceived ability to marshal the necessary resources.

Business owners who profess growth and other change intentions are anticipated to uniformly value community contribution and public or industry recognition more highly than those with lower growth aspirations. The opinions of a business partner, spouse, and banker are also expected to rank highly. The perceived availability of resources (such as capital, time and administrative support) is also crucial to the growth decision (Orser, 1998).

Business owners are believed to trade-off positive rewards and negative consequences of change. Important positive rewards associated with growth include the respect of others and financial consequences.

Negative consequences include stress, loss of management control, loss of familiarity with employee work habits, and the challenges of balancing work and family due to time away from the household. Growth and non-growth orientated business owners are expected to weigh the negative consequences similarly. Hence, the growth decision is more sensitive to differences in how owners value the positive rewards (Orser, 1998).

While most research on motivation has focused on owner's internal drive (for example, need for achievement), evidence suggests that the growth decision may, in fact, be externally motivated or intricately linked.

As economic theory is evolving to assimilate a behavioural context, with the increased view that people make the decisions in the organisation, an understanding of human behaviour, attitudes and their influencers, are key to understanding the organisation.

While understanding the key influencers alone is not in its own right the answer to future strategy, an in-depth analysis is vital in strategy development. It is recognised that the level of knowledge or awareness is a determinant of attitude. The underlying inference in this study is that better information will tend to lower barriers to acceptance. This has vital implications for future and past aspirational and ideological policies.

Powerful cultural influences may also have significant effects in shaping attitudes. Governments must be aware of how highly people value business ownership and sustaining competitive advantage in order to design effective communication strategies.

There appear to be significant gaps in our understanding of how, when and why people acquire knowledge, and the connection between this and the shaping of opinions (Lyons et al, 2004). Research is weak about the dynamics of attitude

formation over time, and the factors that influence this. The whole question of how perceptions and attitudes are influenced by the media, personal contacts and government information campaigns, remains a largely un-researched area and a major inter-disciplinary challenge (Lyons et al, 2004).

Wiklund and Shepherd's (2003) study of the moderating role of firm resources and opportunities identified non-economic personal goals as a prime motivator for growth in small organisations. The study applied the Theory of Planned Behavior by Ajzen (1991), a well-validated theory, purported to explain and predict specific behaviour in specific circumstances. The study by Wiklund suggests that motivational differences may be an important influencer in the varying outcomes in small firm's growth.

Thus, the application of behavioural decision theories appears justified in extracting these influencers. The Theory of Planned Behaviour (TPB) by Ajzen and Fishbein is proposed. As suggested by Fishbein, adaptations are made to the theory to increase context specificity and extract the internal influencers of change in the Irish road freight industry.

## **METHODOLOGY**

The Theory of Planned Behaviour's premises are that attitudes determine intention and that intention determines behaviour. Considering the research objectives, aims and the unit of analysis on an individual level, the use of TPB seems appropriate. It has been previously used in multiple disciplines, and is the most comprehensive theory on relating motivation to behaviour and extracting perceived barriers (Leone et al, 1999).

Qualitative findings are presented of eight semi-structured interviews of hire-and-reward owner-operators in the Irish road haulage industry. The interviews were analysed and the main themes extracted through the use of content analysis.

With human factors playing an important role in motivation, organisational decisions and competitive advantage, the behaviour, intentions and attitudes of key personnel are of significance in understanding the development of the road freight industry. Individuals in the organisation are the decision-makers; therefore, it follows what influences their decisions are vital in gaining an understanding of organisational decisions.

The Theory of Planned Behaviour (TPB) has been used in previous studies to elicit attitudes, extract barriers and develop an understanding of significant influencers on behaviour (Ajzen, 1991). TPB has initially been applied to the field of health science, but more recently has entered the transport research domain, principally in the area of transport planning and public transport user choice.

Prior to a statistical survey and the measurement of attitudes by the use of Oskamp's (1977) Semantic Differential (SD) technique, a list of relevant beliefs must be developed for inclusion in a structured questionnaire (modal of salient beliefs (Oppenheim, 2000)); therefore, an initial qualitative approach was undertaken. Hence the research strategy is that of a "dominant-less dominant design" (Creswell, 1994: 177).

A limited amount of primary research was initially undertaken. The method used was qualitatively-based in order to gain understanding of the complex issues. Thus, an approach that obtained "deep" data was required. Semi-structured interviews were used, as they are the best technique for the collection of the data characteristics.

Eight semi-structured interviews of owner-managers in hire-and-reward haulage firms were completed. Hauliers were identified from the hire-and-reward licence database and a commercial directory of road freight operators. An explanatory postal letter was used to make first contact, emphasising the importance of the research and respondent's participation. This was followed by phone calls to schedule the interviews and to verify that they were in fact in the correct category.

Firms were interviewed from different sectors of the road haulage industry. They were predominantly small-to-medium haulage firms that were not involved in value adding services, with the exception of two firms that were involved in warehousing and collaborative networks. The participants had many years of experience in the road freight industry, with one interviewee having thirty years experience, while another had approximately five years, with the majority of interviewees having approximately ten years experience as an owner-manager. Many of the interviewees also had previous experience as an employee in the road freight industry, prior to establishing their own firm.

The owner-managers had a wide-ranging age profile from approximately sixty to thirty-five years of age. The highest level of education of the interviewees was second level, two of the interviewees had partially completed second level and the remaining five interviewees had fully completed second level education. However, family members who were university graduates were advising a number of owner-managers. It is worth noting that three of the interviewees did not directly hold the Certificate of Professional Competency (CPC). Two firms paid a small fee to people outside the organisation that held a CPC, in order to document them as the firm's transport manager, the other firm's CPC was held by a family member. The interviewees' businesses were located throughout the country.

The recordings from the interviews were transcribed. Content analysis was then applied in order to breakdown the responses into key themes.

## **FINDINGS**

As anticipated, positive rewards associated with business development by owner-operators included; the respect of others and an improved financial position. Perceived negative consequences were; increased workloads, loss of control, and the challenge of learning new tasks. However, the most emphasised consequence was the negative implications for quality family time.

Owner-operators seemed to traded-off positive rewards and negative consequences of change. The respondent's ability to master new skills appeared to be interlinked with the risk of undertaking a new project, with negative repercussions for the change decision.

Four of the respondents identified other people's opinions, principally their family's, as having a significant effect on their decisions. The age profile of the interviewee may have a part to play in this, as it tended to be the respondents with old or young families.

Three of the respondents had other businesses that tended to take their attention away from their haulage business, for a period of time. Management time as a resource tended to be limited in those circumstances. It could therefore be seen as a limiting factor in the development of their logistics business. Many of these managers also considered the ease of return on their investment, which can probably be linked to perceived risk.

The issue of opportunities frequently arose, while no statistically significant results are available at this time, it is speculated that this will be closely linked to firms that have developed services beyond point-to-point transport. That is, it appeared to be linked to the respondents who were involved in warehousing and collaborative networks. These respondents stated "being open to opportunities" and "putting yourself out there" as important components to developing their business.

### **CONCLUSION AND FUTURE RESEARCH**

The decision to pursue change by owner-operators in the Irish road freight industry rests not solely on the desire for profit as depicted by neo-classical economics. The decision to pursue change is complex. It reflects the opinions of others and the owner's perceived ability to marshal the necessary resources.

An intervention scheme based on an education programme could be provided by a state agency. The potential benefits of this would include, creating an awareness of the positive aspects of providing value adding transport logistics services and reducing apprehensions of negative consequences.

The qualitative results presented in this paper are being utilised to develop a statistical research instrument, based on the Theory of Planned Behaviour (Ajzen, 1991) and Osgood's Semantic Differential technique (Oskamp, 1977), with the purpose of measuring operators' intentions and extracting information about barriers to developing value-adding services. Increased understanding of the decision process, motives and challenges will aid logistics development and should lead to increased vehicle utilisation, improved sustainability and economic competitiveness.

### **ACKNOWLEDGEMENTS**

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## **DEVELOPMENT OF A PERFORMANCE MEASUREMENT SYSTEM FOR THE BENCHMARKING OF GROUND HANDLING SERVICES AT EUROPEAN HUB AIRPORTS**

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### **ABSTRACT**

The liberalization of ground handling in Europe has forced airports to assess their performance in comparison to their competitors in order to gain long-term competitive advantages. Together with main European hub airports, research was conducted for one year using the action research approach to develop a wholistic performance measurement system for ramp services. Hence, a validated basis for competitive benchmarking activities according to the dimensions input, process and output could be created, which reflects the supply chain of airport logistics.

### **INTRODUCTION**

Rapid changes in the aviation business environment impact all members along the value chain. Competitive pressures not only occur on the "air side" of the value chain but are also increasing on the "ground side". Therefore, a more intense focus on airports and airport logistics service providers has become vital for the industry (VDI, 2001). In particular, ground handling service business units are currently confronted with structural changes within this industry. A trend towards liberalization was induced by deregulation mechanisms implemented at the European level, in particular the latest EU directive: 96/67/EC which increases competition and cost pressure especially in the ramp service market (SH&E, 2002). Today, "organizations need to change in the face of deregulation . . . to become competitive, market-oriented and customer-driven." (Chan et al., 2006) In the future, it will be of "paramount importance for airports to provide the best possible services in the most efficient manner" (Oum et al., 2003). In addition, airports will have to rethink their strategies and structures as well as their scope of work (Müller et al., 2005) in order to maintain or gain long-term competitive advantage.

As a result of liberalization, it is particularly important for airports to improve their ability to assess their own performance in comparison to that of their competitors (Oum et al., 2003). In such a context, benchmarking is frequently considered an appropriate performance measurement tool for the identification of best practice solutions (Francis et al., 2002). A sole performance measurement system would not be "able to answer one of the most fundamental questions of all - what are our competitors doing?" (Neely et al., 1995). Within the scope of this article, performance measurement and benchmarking are integrative approaches, whereby the performance measurement system acts as the source of information for benchmarking activities (Gleich, 2001). An efficient

performance measurement system for analyzing the performance of ground handling business will be developed.

### **LITERATURE REVIEW**

Although it has been established that a performance measurement system is required, it remains unclear how ground handling service business units can implement such a system to improve their efficiency. As the literature review revealed, there is an abundance of literature, in particular benchmarking studies, which focus on a process perspective of airports (Francis et al., 2002) or ground handling organizations and their supply chains. Today's airport performance measurement approaches mainly deal with the airport as a whole organization.

A large number of studies have been conducted with focus on financial, qualitative, political or ecological perspectives, whereby most research concentrated on financial performance indicators (Doganis et al., 1995; Gillen et al., 1997; Murillo-Melchor, 1999; Parker, 1999; Sarkis, 2000; Martin et al., 2001; Abbott et al., 2002) or quality-based performance measures (Ashford et al., 1995; Hegendorfer and Tyler, 1999; Hegendorfer and Morris, 2000; Tyler, 2000; Adler and Berechman, 2001; Yeh und Kuo, 2003). Some authors follow a combination of economic and quality driven perspectives (ATRS, 2003; Pels et al., 2003; TRL, 2003). However, the most contemporary subject of investigation concerns liberalization and deregulation of the airport market (Civil Aviation Authority, 2000; Templin, 2005) as well as the analysis of ecological influences of airports, such as noise or exhaust emissions (Graham et al., 1999; Upham et al., 2005).

### **RESERACH DESIGN: ACTION RESEARCH**

According to Yin (2003), qualitative research methods should be used to answer "how" and open questions which are directly related to the subject of research (Burrell et al., 1985; Yin, 2003; Silverman, 2004; Flick et al., 2005).

Since performance measurement systems for benchmarking ramp services have rarely been investigated, it seems appropriate to approach this topic with action research (AR). This type of research allows researchers to "spend time in organizations and research logistics in action. Only by being out in the 'real world' can we gather first-hand information to develop knowledge and gain extreme relevance" (Näslund, 2002). In this context, logistics research requires more action research-driven approaches (Mentzer and Kahn, 1995 and Dunn et al., 1993) to cover all relevant perspectives on the investigated research objectives and to generate added value by adopting real-world problems (Alvesson, 1996, S. 455). Furthermore, AR supports the creation of a new system as with the development of a performance measurement system (Kaplan, 1998, S. 12). Fahrni, Völker et al. (2002) explicitly recommend, in the context of competitive benchmarking, a multi-phase adjustment for all performance measures with all benchmarking partners.

Therefore, this paper follows a collaborative approach of science and practice (Moser, 1977), which also suits the scientific understanding of practical-oriented research by Ulrich (1982). The AR for this paper was conducted by the Aviation Competence Center of the Supply Management Institute SMI<sup>TM</sup> together with European airports. Based on the AR model of Checkland (1985) and Checkland and Howell (1998), the research design for the development of the performance measurement system was developed. Within this type of research, the researcher shifts from his or her role as an observer to an active participant



within the research themes or topics (Näslund, 2002). AR is characterized by its collaborative and cyclical nature (Moser, 1977) which is reflected in the current literature (Altrichter, 2003; Kyrö, 2004) as a recurring cycle of planning, acting, observing and reflecting. Standardized methods could not be identified to conduct action research, but the four main methods in literature are observation, literature analysis, interviews and workshops or workshops. (Näslund, 2002; Silvermann, 1993) In line with prior research (Riempp, 2004; Rozenmeijer 2002), the following research design was chosen as shown in Figure 1.

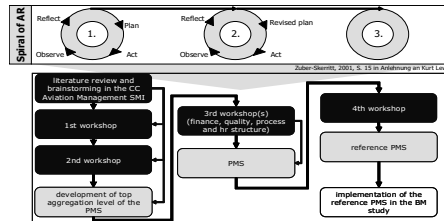


Figure 1: Research Design

## THE DEVELOPMENT OF RAMP SERVICES PERFORMANCE MEASUREMENT SYSTEM (PMS)

In order to develop a reference PMS for ramp service business, four workshops were carried out with management representatives and experts from European hub airports.

According to previous literature, the general consensus of authors links PMS to corporate or business unit strategy (Kaplan et al., 1992; Gleich, 2001). Therefore, within the **first workshop** with management representatives, main strategic objectives for the ground handling business were discussed. As expected, increasing cost pressures on logistic services at airports can be observed as well as the need to become more market-oriented and customer-driven. According to business unit strategy, in order to maintain or to achieve market leader status, two strategic aims of the business unit could be identified, namely increasing the profitability of ground handling business and improving the perceived quality of the services by the customer.

The **second workshop** was conducted with experts from the controlling, quality, HR and operations management department. All participants were asked to discuss their expectations of a PMS and the main drivers to meet strategic goals. The main drivers identified within the organization could be clustered in the dimensions "logistics process performance" and "input of the organisation", mainly representing organizational, cost and resource structure. The success of the ground handling organization itself can be evaluated from an economic and quality perspective via "financial output" and "quality-related output". According to the discussion held within the workshop, competitiveness of the ground handling business depends on all dimensions in the same manner. Similar to a service supply chain, the PMS was structured according to the dimensions "input", "process" and "output/outcome" (Gaismayer, 2004). This type of structure also fulfils the scientific demand for more process orientation in airport research (Francis et al., 2002).

Furthermore, success factors (SF) for all dimensions, which should be measurable by the reference system, could be identified in the workshop. The dimensions and their SFs were validated by a research team and related to the perspectives of the Balanced Scorecard (BSC) of Kaplan and Norton (1992), one of the most cited performance measurement systems. Following the cause-

effect-relationship model of the BSC (Gladen, 2002), the BSC perspectives: learning and employees' perspective, process perspective, market and customer perspective and financial perspective (Kaplan et al., 1992) were linked to the developed dimensions "organizational input", "logistics process", "outcome" and "output" within the workshop, as shown in Figure 2.

This first draft of a PMS with a proposal of potential performance measures derived from general BSC and specific airport performance measurement literature were presented in the **third workshop** and served as the fundament for further discussions. The workshop was divided in four sub-workshops, each concentrating on a different BSC perspective: "learning and hr performance", "internal processes performance", "quality to customer and market" and "financial performance". As experts within the certain fields, the participants were asked to add further relevant indicators to the proposed PMS. Afterwards, all proposed and collected performance indicators were evaluated along the dimensions "measurability" and "relevance", according to Durst and Binder (2006). Only performance measures with high relevance and high measurability were selected in order to meet the demand of low complexity. Furthermore, the cause-effect relationships of the single performance indicators could be identified. Using this information, researchers were able to map a wholistic PMS with all relevant performance measures.

The aim of the **fourth workshop** with experts from all benchmarking partners was to agree upon and evaluate the relations of the single performance measures to the performance perspectives at the top aggregation level (input, process and output) and determine their relative weightings by the analytic hierarchy process (AHP) approach (Korpela et al., 2001). The final adapted PMS was provided to all participants for a last verification before implementing it in the benchmarking study. An overview of the final reference PMS for the ramp service business is presented in Figure 2.

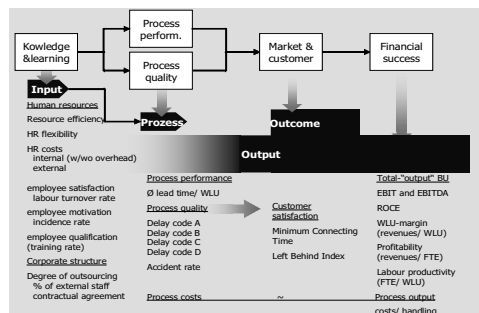


Figure 2: Ramp Service Performance Measurement System

### CONCLUSION AND IMPLICATIONS FOR FUTURE RESEARCH

Action research was successfully conducted together with main European airports in order to determine how a PMS should be designed to guarantee a wholistic basis for benchmarking ramp services. Related investigations with in-depth case studies in this field are advisable. Further validation of the PMS for ramp services could be supplemented by implementing the system in a real world benchmarking study. Further investigations would enrich the scientific community of airport logistics and would validate the developed fundament on which companies could base their own PMS for assessing and benchmarking their ramp service business.

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## **LEAN WAREHOUSING; APPLYING LEAN PRINCIPLES BY LOGISTICS SERVICE PROVIDER MENLO WORLDWIDE**

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### **ABSTRACT**

Menlo Worldwide, a global logistics service provider, tries to implement lean warehousing to outperform its competitors in its volatile market. However, Lean emerged in a manufacturing setting in Japan, so it has to be adapted to be applied in a service setting in a Dutch subsidiary of a US-owned firm. We combine lean (i.e. lean bundles of activities) and warehousing activities to construct a theoretical model. This model serves as a role-model for analysing leaning warehouse activities at Menlo Worldwide. At first the approach (Kaizen events) and solutions were too 'Western': focused at grand solutions by experts instead of small incremental improvements by the work floor.

### **INTRODUCTION**

Lean production as a production system emerged from decades of experience in manufacturing at Toyota. Womack et al. (1991) claim that lean production combines the advantages of craft and mass production and does everything with half the inputs used in the other production systems.

Because of the proven success of Toyota, many other firms, such as Ford, Alcoa and Boeing, are trying to implement this production philosophy. In addition to that we see a few attempts to apply the philosophy also in more service-oriented sectors such as health care, software, insurance and construction. Allway and Corbett (2002) describe a number of key requirements for lean service. Arbos (2002) made an overview of critical factors and how to deal with them when leaning services.

Menlo Worldwide is a full-service contract logistics firm specializing in cost-effective design and management of product transportation, storage, distribution and integrated logistics services ([www.Menloworldwide.com](http://www.Menloworldwide.com)). Menlo Worldwide employs over 4,300 people, does more than 3 million shipments a year and manages over 10 million square feet of warehouse space. It serves more than 30 world-class global customers such as: Nike, Dow Chemical and, Sears. The logistics services they provide differ from customers to customer, indicating different levels of outsourcing by the customers. Because of the market situation in its industry Menlo Worldwide has to improve its processes or it will perish. That is why management decided to go lean.

One of the functions of logistics service providers is to store and control inventory for their customers. One of the principles of lean is zero-inventory. These and other dilemma's raise the question as: *"How can logistics service providers get lean to serve their customers better than their competitors do?"*

To deal with this research question, we perform a theory-based case study. First we deal with literature on lean and on warehousing to build a theoretical model. Based on Shah and Ward (2003) we summarize lean into bundles of activities:

JIT, TQM, TPM and HRM. However, because of our logistics and external perspective we added two bundles distinguished by Olsen (2004): customer involvement (CUS) and supplier communication management (SCM). We then apply these bundles to the functions we find in warehouses as described by Grant et al. (2006). Confronting these two perspectives give a description of how a lean warehouse looks like.

This theoretical model we then apply to a Menlo subsidiary in Eersel, the Netherlands. Consequently we study the implementation of a Japanese philosophy in a European subsidiary of an American MNC. As continuous improvement is a key element in implementing lean, we follow that line in our case study as well. We analyse 'Kaizen-events', the methods Menlo applies to improve its operations in the direction of lean warehousing.

Finally we confront the findings from our case study with the model developed to come up with lessons for further improvement at Menlo as well as a research agenda for lean logistics.

### **A THEORETICAL MODEL FOR LEAN WAREHOUSING**

Warehousing consists of a number of sequential processes starting with receipt of goods and finishing with shipping of goods. Various authors distinguish: receipt, put away, storing, picking and shipping (see e.g. Ballou, 1999 and Grant et al., 2006). Receipt normally involves activities like unloading the carrier and checking on quality and completeness of the order. Then the accepted goods are brought to a specific location in the warehouse to be stored. Once stored, goods wait for the moment they are needed. Then they are picked as an order and, maybe, packaged before, finally, being shipped. Other processes can be value addition (assembly or some other type of customisation), cross docking (prepare for shipment without storing) and returns.

Firms themselves can carry out these activities but they can outsource them to logistics service providers as well. As warehousing is not considered to be a core activity, many firms outsource it and receive the goods just-in-time for their operations (production or sales).

Going lean is not removing stocks from an outsourcer to a service provider but rather removing stocks from a supply chain. However, stocks can be needed to bridge gaps in time (seasonal products), place (low cost countries) etc. In these cases, stocks cannot be avoided but have to be kept at a minimum and be handled as lean as possible.

Lean can be treated in various ways. For our purpose Shah and Ward's approach of bundles is very adequate (2003). Based on an extensive literature review they develop bundles of interrelated lean management practices. They distinguish four bundles: JIT (just-in-time), TPM (total preventive maintenance), TQM (total quality management) and HRM (human resource management). However, when dealing with logistics it makes sense to add two additional bundles as Olsen (2004) does: SCM (supplier communication management) and CUS (customer involvement). These bundles stress the content of the external relationships in logistics, inbound the communication with the supplier and outbound the role of the customer. Suppliers are crucial to organize an uninterrupted flow throughout the supply chain: inputs arrive in-time, right quality etc, are conditional for the flow. Customers initiate the actual flow through the chain as they pull the orders. Consequently, the order decoupling point sets the boundary between the

bundles. JIT in its turn also deals with the content and is more internally oriented, as it serves the uninterrupted flow through the firm. Key is to avoid any type of waste and remove its causes, whenever it occurs. Act only when it is needed, to the extent it is needed to add value for the customer, either internal or external.

TPM, TQM and HRM have a somewhat other perspective as they provide conditions under which the first three bundles can function optimally, or put differently these are aspects of the content-oriented functions. TPM deals with marked areas organized according to 5S with cleaning and maintenance programs. TQM deals with continuous improvements removing causes of problems right at the source and in a standardized way. Small groups of shop floor workers involved deal with a problem, on request of management and the latter will decide whether solutions presented will be implemented. Solutions are incremental and try to re-align processes, whereas in Western approaches 'grand' solutions bring radical transformations. HRM involves training of people both in work processes and in problem solving in teams.

#### The model

When applying the lean bundles to the warehousing functions, we can define how a lean warehouse should get organized over time. Lean should not be treated as a blueprint to be implemented, but rather as a philosophy that should be applied to improve processes and their relationships.

TPM, TQM and HRM have the same content for all warehouse-activities distinguished above. The content is the same as indicated above as they reflect aspects of the content-oriented functions they support.

SCM deals only with the inbound activities: receiving and storing, whereas CUS deals with the outbound activities: picking, value-adding, packaging and shipping. For 3PL's customer is an ambiguous term as it refers both to the outsourcing firm as well as to the customers of the latter. In the managerial aspects the outsourcing firm is the customer, whereas in operational aspects the outsourcing firm's customer are the 3PL's customer as well.

JIT in receiving should be balanced with the capabilities of the storing process to create an uninterrupted flow. However, shipments from the supplier often arrive at irregular moments because of lengthy distances and economies of scale in transport. So, SCM is an important set of activities to solve, or at least adapt to, the problem of irregularity. Synchronize delivery to demand of customer, guarantee quality to prevent re-work are important tools.

JIT in storing basically deals with controlled buffers and reduce handling (e.g. transportation, motion) both in storing and in subsequent customer-order picking. Tools, both physical and ICT, can be used to reduce cycle times in handling. SCM should provide information on the value customers expect; to make sure the 3PL can live up to their expectations.

JIT in picking is dependent on (value adding and) packaging, i.e. 'when needed' and handling should be reduced, i.e. 'what is needed'. Tools and standardization reduce cycle times. CUS is important to create small orders to allow for continuous capacity utilization rather than idle capacity and over-utilization.

JIT in value adding is dependent on packaging (time) and customer needs (content) and is organized as pull production in U-shaped cellular settings. CUS is crucial to organize this function.

JIT and CUS in packaging resemble these activities in value adding, but are dependent on shipping.

JIT in shipping is dependent on transportation, which maybe outsourced to yet another 3PL than the warehousing. The latter case requires even more external coordination and, consequently, CUS. Shipping is not just on physical activities but information processing is at least as relevant to facilitate JIT in transport and for receiving at the customer.

### LEAN AT MENLO WORLDWIDE

To introduce lean in the organization, Menlo Worldwide developed an extensive lean training programme. Managers at all levels, throughout the organization got this two-day training to familiarize them with lean and more in particular with waste and its elimination. Shop floor workers just got a one-hour lecture on lean ideas. In addition to this, posters throughout the firm, showing what lean means at Menlo worldwide, should improve awareness.

Although cross training existed before, it now became a focus in HRM at Menlo Worldwide. Progress was shown in people-capability matrices per department.

Next step was implementing 5S (sort, set in order, shine, standardize and sustain), the housekeeping part of TPM; visualizing performance, also on the shop floor, in terms of relevant KPI's derived from (internal and external) customer demands and; value streams were identified and mapped throughout the organization.

Within this framework, Kaizen events should create lean warehousing at Menlo Worldwide. In these events executives from different hierarchical levels and internal consultants involved in a process showing problems cooperate to identify causes and propose solutions to create an ideal process.

In table 1 the first three Kaizen events held in Eersel are summarized and compared to show the effectiveness of the implementation of lean warehousing at Menlo Worldwide.

Issue\Kaizen event	1	2	3
Warehousing processes	Outbound: picking and packaging	Inbound: receiving and storing	Inbound: receiving and storing
Fte in warehouse operation/process	5/2	20/5	95/6
Fte of process in kaizen	2/2	0/5	1/6
Warehouse space	1250	1800	10600
# SKU's	3120	6400	1810
Complexity	Low	Medium	High
Problem (before situation)	Picking and packaging are not levelled, packaging only when picking is finished completely.	No ETA of inbound. Storing after full completion of reception in inbound area. Also picking from inbound area without storing.	Each sub process (paperwork, checking, labelling) is done manually and one after the other Storing after full reception.
Kaizen team	Facilitator, team leader (supervisor), 3 members: supervisor, picker, packer	Facilitator, team leader (office), 2 members: picker, office	Facilitator, team leader (planner), 4 members:, business analyst office, operators (inbound, all round)



Kaizen process	Group: packaging is bottleneck; members: solutions; facilitator: controlled buffer!	Group: inefficient reception; picker: reduce walking distance, facilitator: controlled buffer!	Group: inefficient reception; inbound agent: reduce waiting and overtime, facilitator: controlled buffer!
Solution (after situation)	Created a controlled buffer. Five slots (kanban, TPM). Cross-trained people to manage the buffer (HRM). Check small batches instead of complete orders (JIT). U-shaped packing area (TPM).	Created two working cells with max number of slots (TPM). U-shaped inbound area (TPM). Sort and receive in small batches (JIT). Standardized receiving and storing procedures (TQM). Self-directed work team (HRM).	Reduced manual paperwork and calculations. Created a controlled buffer: limited number of slots (TPM). Standardized receiving and storing procedures (TQM). Self-directed work team (HRM).
Evaluation (maintaining)	Buffer is used in a proper way. Good cooperation between picker and packer. Remaining subjects are still to be tackled.	Buffer works not optimal in all actual situations. People on floor strongly resist change. Not self-directed. Remaining subjects are still to be tackled.	Buffer works not optimal in all actual situations. People on floor strongly resist change. Not self-directed. Remaining subjects are still to be tackled.
Savings	-Floor space reduction 58% -Cycle time packing reduction 20% -Walking distance decreased with 65%	-Floor space 46% decrease -Cycle time sorting inbound decreased with 20% storing inbound with 96% -Walking distance decreased with 45%	-Floor space decreased with 30% -Cycle time storing inbound with 95% -Walking distance decreased with 36% -WIP decreased with 75%

Table 1 Three Kaizen events compared

Among the results in day-to-day operations the Kaizen events yielded considerable improvements (see savings table 1).

## DISCUSSION

In this paper we addressed as our research question: *"How can logistics service providers get lean to serve their customers better than their competitors do?"* To answer this question we compare the way Menlo Worldwide implemented lean with the model we proposed.

Menlo Worldwide started the implementation with HRM training activities: cross training of workers, however only a one-hour lecture on lean and posters were applied to create awareness. Management seems to have underestimated the problems of implementing a Japanese philosophy in a warehouse in Europe as part of an American multi national. TPM, i.e. 5S the house-keeping part, was implemented as well before the Kaizen events started to improve on the other bundles by means of TQM.

When looking at the Kaizen events, we see remarkable differences with the Japanese quality circles. At Menlo Worldwide experts rather than shop floor

workers dominate the improvement groups. In the events two related processes were improved at the same time. Consequently, the solutions are quite radical in speed and scope. However, the first of the events differ: it is smaller, involves more workers and results in a more moderate solution accepted by the workers.

In the solutions the emphasis is on the conditional bundles HRM, TPM and TQM in all three events. From the other bundles only JIT principles are implemented. The measures yield considerable savings. The two bundles we added, CUS and SCM, are not applied. This will be caused by the role Menlo Worldwide, as a 3PL, plays in the supply chain.

From these observations we derive a couple of recommendations on how to improve the implementation process. Firstly, we suggest dealing more systematically with the condition-bundles HRM, TPM and, TQM. Workers should be trained in the relevant aspects of the bundles to enable to use them for the other bundles as well. Secondly we suggest dealing with the Kaizen events in a more Japanese way: involve workers more explicitly, go incremental changes instead of radical ones and, how to deal with follow-up activities. The measures were often radical as the team tried to remove all causes of a problem in one turn. The scope of the changes was often too broad too new for the workers causing resistance. Follow up activities were often neglected as new areas for Kaizen-events draw full attention. These lessons are in line with the Western attitude of going for 'grand solutions'. However, Menlo adapts its approach as it now goes for less staff influence and more incremental improvements.

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## **FACTORS CRITICAL TO THE SUCCESS OF A GLOBAL LOGISTICS HUB**

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### **ABSTRACT**

Globalisation and liberalisation of the trade have led to the growth of international container transport in the recent years. Currently, some governments have projects to transform their seaports/airports into logistics hubs for the region and for the world. This paper attempts to assess the factors that critical to the success of a global logistics hub.

### **INTRODUCTION**

A number of changes have been witnessed in international trade and transport in recent years. Especially, globalisation and liberalisation of the trade have led to the growth of international container transport and the development of efficient global logistics services demanded by multinational enterprises (Heaver, 2001). In order to provide a seamless global logistics service, international carriers have taken the lead in seaports terminal operations. In this regard, a number of governments have also adopted contestability policy to deregulate and privatise their seaports and airports and transform them into global logistics hubs forming a part of seamless global supply chains. Thus, the role of a seaport or airport is changing in today's logistics environment. It is becoming a centre for generating value-added activities, cargo re-processing and re-exporting but needs to cope with the demands placed by international freight transport and logistics.

Logistics hubs can be characterised into three categories in terms of load centres: a large international load centre that dominates world trade, a medium-sized load centre that controls regional exchanges, or a smaller load centre that influences national commerce (Notteboom, 1997). At present, some countries are endeavouring to transform their leading seaports and airports into global logistics hubs for national, international and the regional needs. Competition among these seaports or airports is intense. However, there is no guarantee that all these ports will be able to attract the global and regional cargo they are aiming for.

In this paper an attempt has been made to investigate the factors that are critical to the success of a global logistics hub. These factors have been identified using a questionnaire survey, a literature review and a series of

interviews with the managers of companies involved in international transport. The questionnaire survey was carried out with 168 senior managers and academics working in international transport field in Taiwan. Statistical Package for Social Science, SPSS, was used to analyse the data obtained from questionnaire survey.

### **STRATEGIES FOR A LOGISTICS HUB**

Hong Kong and Singapore are examples of the ports that have successfully transformed their positions from a transshipment hub to a leading global logistics hub. It is important to know the strategies that a logistics hub adopts and then to derive the factors critical for a logistics hub to gain competitive advantage.

To gain advantage over its competitions, a seaport or airport needs to have business strategies dealing with its organisational culture, institutional structure, operation systems, and facility provisions (Ircha, 2001). Strategic planning provides a vision or direction and develops specific goals, objectives and actions for achieving the desired vision. Before setting up business strategies, a clear appraisal of the seaport or airport is needed to identify its internal strengths and weaknesses and external threats and opportunities. This can help a seaport or an airport to know where it is now in relation to its environment, and with strategic planning it can decide where it wants to be and how to get there.

### **COMPETITIVE FACTORS FOR A LOGISTICS HUB**

What are the competitive factors that enable a seaport or an airport to become a logistics hub? **In air transport**, Martin and Roman (2004) noted that the potential to generate traffic at the cargo-hub, a central geographical location in relation to the markets, good airport facilities, good weather conditions, and strategic behaviour of competitors need to be considered when an airline chooses to develop an airport in its network structure. Zhang (2003) points out that there are two principal reasons for a shipper to select the air mode of transport as opposed to surface transport. First, the speed of air transport, especially over long distances, is critical for goods requiring a short delivery time. Second, air transport's low risk of losing or damaging shipments is an advantage for goods with a high ratio of value to size. Thus, airports that are closer to shippers and have lower total costs and lower delivery times inevitably are strong candidates to become a regional air-cargo hub. This implies that geographical location, costs, and delivery time are the main competitive factors in the regional and global competition among airports to attract cargo traffic. Other factors are infrastructure, customs, inter-modal transport, and international aviation policy. Park (2003) summarised the competitive advantage of an airport as seeming to depend on "five core factors": **spatial factors** are the level of regional development around the airport, such as international trade zones, logistics and convention centres, aviation-related industrial complexes and other facilities;

**facility factors** are the level of airport facilities and the expandability of the facilities at existing airports to increase capacity; **demand factors** are the level of origin-destination demand and that of transit and transfer traffic volumes for hub-and-spoke network development; **service factors** are the level of service to the users, the types of airport operations, and the levels of charges; and **managerial factors** are economical considerations, such as airport operating cost, productivity and revenue structure. In **sea transport**, Notteboom (1997) noted that the most common characteristics of a load centre port are related to its **location** (good foreland and hinterland accessibility and large hinterland), **operation** (high productivity, frequent ports of call, reasonable transportation and port-user costs, high cargo generating effect and high level of intermodality), **infrastructure** (state-of-the-art infrastructure and superstructure, large back-up-space on terminal) and **degree of integration**. Oum and Park (2004) examined the relative importance of location determinants for Multi-national enterprises (MNEs) choosing a consolidated distribution centre. The top seven items are market size, geographic location and market accessibility, transport facilities, political stability, skilled labour, modern logistics service providers and costs, and pro-business government and offices. Lu and Fang (2002) used 29 items to evaluate the competitive advantages of international distribution centres for Kaohsiung port. These items were categorised into eight factors: efficiency, cost, location, facility, service, economies, politics, and policy.

### **FACTOR ANALYSIS OF GLOBAL LOGISTICS HUB PARAMETERS**

There are 34 global logistics hub items shown in Table 1 and these were to design the questionnaire to examine the factors that are relevant to the success of global logistics hubs. These items were obtained from the review of the six papers mentioned in the previous section and have also been evaluated through the discussions carried out during the pilot stage of the questionnaire design. A SPSS tool *Factor Analysis* was used to analyse the questionnaire responses on global logistics hub items. Seven factors were extracted from the analysis. However Cronbach's Alpha values, which determine the reliability of these seven factors, show that the last factor (item 34) was the least reliable. Subsequently, the item "*the openness of foreign labour*" was omitted when conducting the factor analysis again. The importance level of this item was the least among 34 items and this item was not co-related to the item "*political stability*". The results of the second analysis are also shown in Table 1. In addition, *scree plot and an Eigen value* as shown in Figure 1 were used to determine the number of factors in each data set (Hsu, 2006). Seven factor groups emerged, accounting for 70.7% of the total variance, which may be adequate to represent these 33 items.

Global Logistics Hub Items		Component						
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	Factor 7
1	20. Logistics and trade centres	.798	.218	.131	.155		.144	-.130
2	19. Free trade zone	.796	.157	.152	.181		.283	
3	22. Seaport/airport services to users	.706	.228	.224	.235	.142		.219
4	23. Introduction of modern logistics services providers	.690	.204	.285	.308	.110	.127	.101
5	18. Seaport/airport facilities and expandability	.626	.232	.171	.229	.283	.189	.278
6	14. Level of inland transport and inter-modality	.581		.372	.155	.253		.187
7	12. International trade-related industrial complexes	.564		.111	.431	.153	.380	
8	*10. High cargo generating/value-added activities	.468	.174	.296	.422		-.116	-.245
9	*13. Regional development around seaport/airport	.432	.160		.401	.298	.382	.111
10	2. Efficiency of terminal operations		.832	.124		.272	.151	.207
11	1. Efficiency of seaport/airport operations	.211	.824	.111		.153	.119	.185
12	3. Labour quality and skilled labour	.170	.732	.277	.176	.178	.155	
13	4. Simplified seaport/airport process and documentation	.340	.697	.283	.207	.123		.152
14	5. Simplified Customs procedures	.122	.537	.463	.163	.145		
15	6. Seaport/airport management information system	.224	.209	.803		.107	.192	
16	7. e-business and community network integration	.334	.231	.722		.194		
17	25. Pro-logistics business government and office	.157	.231	.561	.434	.100	.123	.171
18	26. Government transport policy and actions		.260	.535	.347	.266	.142	.366
19	*21. ICT infrastructure	.502	.119	.511	-.185	.252	.288	.293
20	28. Organisational restructure of seaport/airport	.426		.141	.651	.316		.138
21	27. Privatisation of seaport/airport	.179	.140		.647	.219	.133	
22	30. Guarantee of foreign investment	.274	.131	.206	.595		.346	.159
23	33. Security of seaport/airport	.308	.437		.466		.225	.325
24	34. Simplification of trade process	.369	.363	.328	.420		.121	.281
25	8. Reasonable seaport/airport charges		.105	.200	.220	.836	.153	
26	9. Seaport/airport operating costs		.301	.245	.240	.680	.135	
27	16. Geographic location/market accessibility	.414	.288		.177	.625	.103	.310
28	15. Natural condition of seaport/airport (e.g. weather)	.401	.228	.100		.586		.356
29	17. Seaport/airport infrastructure	.337	.296	.294		.515	.148	.395
30	<b>29. Direct transport link to China</b>	.116		.205	.143		.711	.174
31	11. Market size/large hinterland/Origin-Destination demand	.343	.207	.103	.116	.294	.668	-.123
32	*24. Frequent sailing /flights	.354	.190	.456	.229	.158	.458	
33	<b>32. Political Stability</b>		.256		.232	.108		.726
34	31. Openness of foreign labour							
Eigen values		14.743	2.175	1.599	1.437	1.256	1.081	1.038
Percentage variable (total 70.7%)		44.7	6.6	4.8	4.4	3.8	3.3	3.1

Table 1: Factor Analysis of Global Logistics Hub Items

Source: Author

Note: These 34 items are taken from six sources, i.e. Martin & Roman (2004), Zhang Park (2003), Notteboom (1997), Oum & Park (2004), and Lu & Fang (2002).

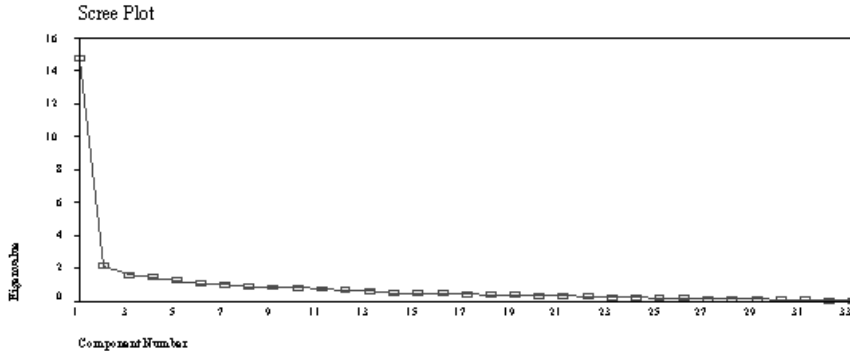


Fig 1: Factor Scree Plot of Global Logistics Hub Items

*Reliability analysis* was also conducted to examine these 33 items concerning the global logistics hub, as shown in Table 2. As some factor correlation values were less than 0.5, some adjustments were made before conducting the analysis. Table 2 indicates that Cronbach's  $\alpha$  for these six factors is 0.9218, 0.8951, 0.8570, 0.8327, 0.8683 and 0.7055 respectively: the seventh factor comprises only one item. As the Cronbach's  $\alpha$  values are more than 0.7, the factor dimensions can be assumed to be reliable.

Factors and Items	Rank	Imp. Mean	Factor Mean	Alpha	Rank	Sat. Mean		
<b>F1: Facilities</b>								
20. Logistics and trade centres	26	4.227	4.2568	$\alpha=0.9218$	18	2.991		
19. Free trade zone	24	4.255			22	2.964		
22. Seaport/airport services to users	22	4.291			8	3.2		
23. Introduction of modern logistics services providers	28	4.136			11	3.082		
18. Seaport/airport facilities and expandability	19	4.345			10	3.091		
14. Level of inland transport and inter-modality	23	4.291			12	3.055		
12. International trade-related industrial complexes	30	4.091			13	3.036		
*21. ICT infrastructure	12	4.418			6	3.245		
<b>F2: Operations</b>								
2. Efficiency of terminal operations	4	4.618			4.5473	$\alpha=0.8951$	2	3.436
1. Efficiency of seaport/airport operations	5	4.609	3	3.355				
3. Labour quality and skilled labour	15	4.4	9	3.173				
4. Simplified seaport/airport process and documentation	8	4.473	15	3.027				
5. Simplified Customs procedures	3	4.636	30	2.709				
<b>F3: Service</b>								
6. Seaport/airport management information system	6	4.536	4.4618	$\alpha=0.8570$	19	2.973		
7. e-business and community network integration	7	4.482			16	3.009		
25. Pro-logistics business government and officials	9	4.473			31	2.691		
26. Government transport policy and actions	13	4.409			29	2.727		
*24. Frequent sailings/flights	14	4.409			32	2.636		
<b>F4: Government</b>								
28. Organisational restructuring of seaport/airport	33	3.927	4.1453	$\alpha=0.8327$	27	2.826		
27. Privatisation of seaport/airport	32	3.927			24	2.955		
30. Guarantee of foreign investment	25	4.245			14	3.036		
33. Security of seaport/airport	20	4.327			7	3.227		
34. Simplification of trade process	10	4.445			25	2.955		
*10. High cargo generating/value-added activities	31	4			21	2.964		
<b>F5: Cost</b>								
8. Reasonable seaport/airport charges	17	4.364	4.3255	$\alpha=0.8683$	20	2.973		
9. Seaport/airport operating costs	16	4.373			17	2.991		
16. Geographic location/market accessibility	21	4.3			1	3.545		
15. Natural conditions of seaport/airport (e.g. weather)	27	4.155			4	3.355		

17. Seaport/airport infrastructure	11	4.436			5	3.318
<b>F6: Market</b>						
29. Direct transport link to China	1	4.709			34	1.909
11. Market size/large hinterland/Origin-Destination demand	18	4.355	4.3939	$\alpha=0.70$ 55	26	2.909
*13. Regional development around seaport/airport	29	4.118			23	2.955
<b>F7: Political Stability</b>						
32. Political Stability	2	4.664			33	2.091
31. Openness of foreign labour	34	3.473			28	2.809

Table 2: Reliability Analysis of Global Logistics Hub Factors

Note: Imp. Mean: Importance Mean represents the mean importance ratings of each item  
 Factor Mean represents the mean importance ratings of items in each factor  
 Sat. Mean: Satisfaction Mean represents the mean satisfaction ratings of each item

Seven factors emerging from the factor analysis of the 33 items concerning the global logistics service hub are renamed for further analysis. The first factor (F1), named as **Facilities**, and comprises eight items. The second factor (F2), named as **Operations**, and comprises five items. The third factor (F3), named as **Service**, and comprises five items. The fourth factor (F4), named as **Government**, and comprises six items. The fifth factor (F5), named as **Cost**, and comprises five items. The sixth factor (F6), named as **Market**, and comprises three items. And the seventh factor (F7), named as **Political Stability**, and comprises only one item. As seen in Table 2, out of the seven factors namely *facilities, operations, service, government, cost, market, and political stability*, '**operations**' is the most important factor, with a mean of 4.5473.

**CONCLUSIONS**

Traditionally a seaport or an airport used to be the node for cargo transfer from one mode to another. A modern seaport or airport has become one set of links in a global logistics chain acting as a collection-distribution centre or logistics hub where many value-added activities are conducted. At present, many countries are interested to transform their leading seaports or airports into global logistics hubs. Competition among these seaports or airports without doubt is intense and there is no guarantee that the global or regional cargo traffic will increase through their ports.

The questionnaire survey analysis in this research was used to identify and then examine the seven factors that are considered critical to the success of a global logistics hub; these factors are *operations, facilities, services, market, cost, government and political stability*. The results of factor analysis suggest that "*Operations*" is the most important factor to the success of a hub. In addition, suitable government transport policies that can help to establish logistics hubs play an important role for the hub to succeed.



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## FOURTH PARTY LOGISTICS: WHAT, WHY, HOW

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### ABSTRACT

This paper takes an overview of the development of the 4<sup>th</sup> Party Logistics concept. A cursory glance at today's supply chains suggests that they are typically more challenging than in previous decades being more complex, more globally orientated, more time sensitive, more competitive and aim to satisfy more demanding businesses and end-customers. Yet, perhaps paradoxically, there are also more opportunities to be smarter in terms of technological applications, changing organisational structures and more flexible and leaner business systems. One example of this is the emergence of a new logistics entity, the 4PL or Fourth Party Logistics Provider. Although the term was coined over a decade ago and had a troubled inception it appears in some sectors to be being adopted again as a realistic supply chain solution rather than an idealistic invention. This paper takes a fresh look at the 4PL concept asking questions such as what it is, why it is attractive, and how concerns can be managed. It concludes by posing a range of questions for future research, which may also be useful for companies contemplating embarking on a 4PL initiative.

### INTRODUCTION

Building on the trend to outsource logistics activities to a third party, which has led to the generation of the large and growing third party logistics (3PL) sector (Hertz and Alfredsson, 2003) a new enlarged form of outsourcing is emerging where an even wider span of supply chain responsibility is outsourced to a fourth party. The emergence of the 4PL as an agent to deliver this role, aims to consolidate the logistics needs of multiple companies (SCEB, 2005). It represents a major development in the organisational structure and systems inherent in modern supply chains. In a recent survey it was forecast that the 4PL market will grow in Western Europe from revenues of approximately \$5.8billion in 2002 to \$16.1billion by 2010 (Frost & Sullivan, 2004). However, 4PLs are still misunderstood within the logistics field (Gattorna, 2006). This paper looks at some of the key issues surrounding the concept and asks how relevant is the 4PL idea to modern supply chain management? It sets out a synthesis of the literature in this area and contributes new analysis and thinking around the 4PL concept. It also develops some key questions that parties contemplating or undergoing a 4PL initiative should ask, or researchers may use for future study.

### WHAT IS A 4PL?

Over the last decade there has been much debate surrounding the concept known as the Fourth Party Logistics Provider or 4PL. Part of the confusion may be traced back to the original definition and description of a 4PL which was fairly generic. Consultants, who first instigated the term in 1996, defined a 4PL as, "*An integrator that assembles the resources, capabilities and technology of its own organisation and other organisations to design, build and run comprehensive supply chain solutions*" (Bumstead and Cannons, 2002). To support this definition and to clarify the 4PL model the same authors asserted that it must, "assemble four key components or roles to create a solution". The four components have been conceptualised in Figure 1 for ease of reference.

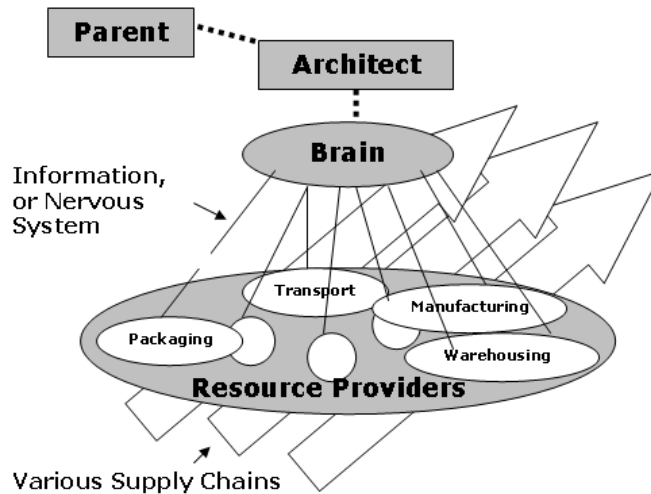


Figure 1: A model of a typical 4PL structure developed from Bumstead and Cannons' (2002) "Four Key Components"

At the outset an "Architect or Integrator" is required to develop the vision for the 4PL and to facilitate its launch. This instigator's role is an on-going one in that they must continue to sponsor and oversee the 4PL by constantly challenging it, ensuring it remains neutral and fair and to ensure parent stakeholder value is optimised. Next the 4PL needs a "brain" which is the decision making element or "Control Room". Finally, "Resource Providers" are required to carry out the work involved. These are the organisations that control the assets which carry out the delegated activities and work. Crucially there needs to be a data feed to the "Control Room", which is termed a "Supply Chain Infomediary", or nervous system (Bumstead and Cannons, 2002).

The spectrum of activities a 4PL can oversee remains relatively flexible and needs to be clearly delineated at the inception of each 4PL contract. Some so-called 4PL initiatives are in practice little more than what many observers would term as a 3PL activity. That is, extra bolt on responsibilities are added to the core logistics process that the 3PL already operates for a customer. For example, a packaging task is added to transport. This is not what should be classed as a true 4PL, which is more holistic in its conception. Another form is where a 3PL takes on the management of other 3PLs on the current contract as well as continuing to provide logistics services itself. This is the so-called 3.5PL model, but has a danger in that "the lead provider also has a vested interest in keeping a chunk of business for themselves" (Henry, 2004). Inevitably perhaps, there is a blurred demarcation between what clearly can be labelled as a 3PL role and what can be termed as typical of a 4PL player. The 3PL to 4PL Spectrum drawn up in Table 1 serves to illustrate this issue. The scope of responsibility can therefore vary quite considerably but still be termed a 4PL. An additional term – the 5<sup>th</sup> Party Logistics Provider (5PL) has been used to differentiate firms that manage more activities than traditional logistics services such as transport, warehousing, packaging and so on. A 5PL would be responsible for managing a more extended physical supply chain which might include manufacturing,

managing purchasing of raw materials as well as the conventional logistics and distribution activities.


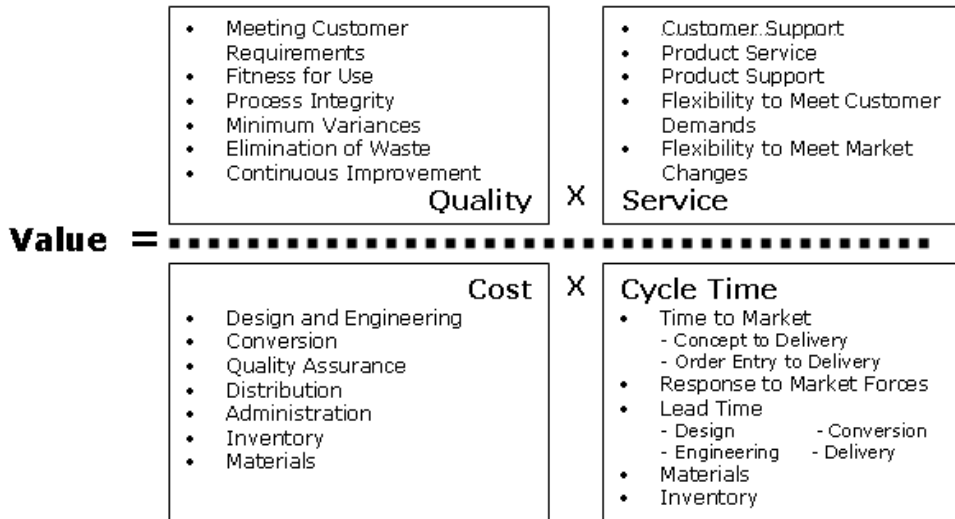
Characteristic	3PL	<p style="text-align: center;">The 3PL to 4PL Spectrum</p> 	4PL
Responsible for Logistics Operations	Invariably		Always
The Logistics Operations is Likely to Span Several Echelons	Rarely		Invariably
Responsible for Other Carriers	Invariably		Always
Responsible for Other 3PLs	Never		Always
Asset Based (own trucks and/or sheds) Operations	Always		Never
Interest Aligned to Supply Chain Improvement	Sometimes		Always
Technology Provides Complete Visibility of Logistics Operations	Sometimes		Always
Relationship Characteristic with Customer <ul style="list-style-type: none"> <li>• Transactional</li> <li>• Coordination</li> <li>• Alliance (or vertically integrated)</li> </ul>	Sometimes Sometimes Rarely		Never Never Always

Table 1: Highlighting the Main Differences between a 4PL and a 3PL Operation

**WHAT ARE THE MOTIVATING DRIVERS BEHIND 4PLS?**

The roots of thinking behind the 4PL argument are grounded in the supply chain management concept. This focuses on how to extract more value out of the supplying process to become more competitive or to preserve margin and hence profitability or both. The idea which is rooted in system theory is to optimise value from the whole system rather than its constituent parts. If Johansson et al’s (1993) “Customer Value Criteria” (Figure 2) are assumed it can be seen that value is built up of a number of facets – quality, service, cost and cycle time, each of which a single 4PL operation can impact upon both positively and negatively. The trick, which often is severely questioned by connected parties, is to generate a collective belief through all interested groups that sustained improvements in this value equation can be realised over the medium to long term for their end customers as well as their collective benefit. Bade and Mueller (1999) in anticipating the development of the 4PL in the next millennium argued that the, “key area that enhancements should be likely to be realised comes from the synchronisation of supply chain planning and execution activities across supply chain participants, or increased collaboration between independent supply chain participants”. For the supply chain concept to succeed often a powerful player or an external agent is needed to influence all players toward the common goal of improved end customer value rather than the more blinkered ideal of self interest. Hence the 4PL can be envisaged as the integrator bringing together as a neutral catalyst interested parties to build more comprehensive supply chain end to end system solutions.



**Figure 2:** Customer Value Criteria, Johansson et al, 1993

Additionally, the 4PL ideal envisages that synergies can also be extended beyond the focus value chain across parallel supply chains. This adds to Hammer's (2001) observation that firms need to, "think beyond the boundaries of the firm" to a new concept that, "supply chain members need to think beyond the boundaries of their supply chain"! The 4PL should not be confined to overseeing operations in the supply chain of one company. The idea is also to seek synergies between parallel supply chains (Mason et al, 2007a) and to leverage economies of scope horizontally to develop further savings.

Additional areas of value creation stem from cost savings centred on economies of scale as the 4PL becomes a consolidated entity as a single link point including:

- The rationalisation of the management control of several echelons and connected processes into one administrative hub point.
- Improved buying power reducing the cost of service provision.

This is becoming increasingly attractive as entities try to simplify their business relationships in supply chains which are tending towards more complexity, and the growth in outsourcing of non core operations such as warehousing, packaging and transport provision.

Other motivating factors beyond a cost reduction focus include:

- *Risk transfer* – the 4PL in not owning physical assets is less vulnerable to demand fluctuations threatening asset utilisation and payback issues
- *Access to new technology* - In an age where there have been rapid developments in technology the switch to a 4PL can provide more rapid access to the latest logistics software and technology. For example Nortel Networks cited this as one of their principle reasons behind the appointing of Kuehne & Nagel as their lead logistics supplier (Freibairn, 2003).
- *Possibilities of longer term contract partnerships with the shipper* – more adversarial links once traditional in logistics have limitations for both the shipper and the carrier. A more stable longer term relationship has the potential to deliver a platform which encourages investment in assets such as advanced technology to support superior performance.

### **ICT DEVELOPMENT AND ADOPTION – A MAJOR ENABLING FORCE**

The commercial pressures that are encouraging more openness towards the 4PL concept have been highlighted but there is also a highly significant enabling factor – the advances in information communication technology or ICT. In recent years there has been a wide number of ICT based “enablers” which provide the tools for the 4PL to successfully operate in a way that would not have been possible when the concept was initially drawn up in 1996.

Abdul (2006) has pulled together a list of these ICT advances which if adopted can provide substantial advances in capabilities. They include tactical tools such as tracking advances. 24 x 7 shipper portals now provide shippers and carriers with real-time visibility of shipments. Events management programmes and online PODs/BOLs again have streamlined processes and enabled more inter-connectivity. Other relevant advances include:

- Automated rating and bidding
- Vehicle Utilisation/Delivery on Time Software
- Holistic web portal of supply chain network
- Load Plan, Build and Routing Optimisation
- Automated Dispatch
- Continuous Move Opportunities Update
- Radio frequency identification (RFID) to support visibility of physical flows

In essence in the 4PL model information is fed into a transport management system (TMS) which may include data of 3PLs, including their track record, geographical coverage areas, performance indicators, payment rates, modes of transport, and agencies used if international movements are required. This is then linked to the customer’s ICT systems so that production, ordering and delivery requirement data is known. The TMS then will look to allocate the best solution and may be able to organise the contracts automatically. Delivery performance and times for each contract is then collated and fed back to the customer by exception.

### **4PL CONCERNS**

Whilst the 4PL concept clearly has many potential benefits in many circumstances and is becoming more attractive as certain advances in ICT are developed and adopted there are also many difficulties and concerns. A range of these are summarised in Table 2.

<b>Area</b>	<b>Concern</b>
<b>Communicating The Parent Customer’s Requirements</b>	Clearly, the customer wants value to be maximised. But this may not just be lower costs (see Figure 2 – Johansson et al, 1993). Developing mutual understanding with the 4PL and its sub-contract base on the balance of cost reduction and other value drivers such as on-time delivery in decisions that are delegated to the 4PL can be problematic if a close partnership is not developed.
<b>4PL Scope</b>	Given the range of possible logistics processes that could fit under the 4PL’s responsibility it is vitally important that this is determined and clearly communicated at the outset. There may be confusion in that shippers may be reluctant to hand over full control to an outside party such as a 4PL. The distribution activity is crucial in that it links the product to the customer – something that companies intuitively want to retain control over (Cottrill, 2004) and possibly a certain in-house skill base.

<b>Agreeing the Allocation of Inputs and Outputs</b>	There are substantial costs and many risks attached to setting up a 4PL, but potentially too there are many gains that can be gleaned. Agreeing the appropriation of these elements at the outset requires careful planning and contingency thinking – should there be benefits for all participating companies – how does the end-customer benefit?
<b>Maintaining Success</b>	Whilst initial gains may be fairly impressive as the immediate opportunities are taken, maintaining a strong impetus of consistently improved value generation is a considerable challenge that can lead to disappointments and frustration if expectations, relationships and delivery are not astutely managed.
<b>Achieving any Success!</b>	The introduction of a 4PL can become merely a cosmetic exercise rather than a smart strategic move. Typical reasons may be: <ul style="list-style-type: none"> <li>• An inflated expectation which was ultimately undeliverable</li> <li>• A very steady incremental approach so as not to upset vested interests, thus missing out on the bigger picture savings</li> <li>• Too restrictive a scope for the 4PL</li> </ul>
<b>Exit Strategy</b>	If operations and relationships do not go as hoped, a pertinent question to ask from the outset is how easy is it to revoke the alliance and to engage an alternative 4PL or pursue an alternative strategy?

**Table 2:** A Range of Difficulties and Concerns to be Managed in a 4PL Initiative

In addition to this list a further area of concern may be the impact on the current pool of logistics providers. The introduction of a new intermediate player, or 4<sup>th</sup> party, will add a further complicating factor which may be disruptive. A simple diagram (Figure 3) shows the various relationships that exist in moving inventory from a seller to a buyer for a single value chain and indicates that where logistics is outsourced to a third party there are typically three dyadic relationships among the Shipper, the Carrier and the Consignee (Mason et al, 2007b). Many logistics providers have developed close links with their customers in recent years particularly as service performance and matters such as safety have become more important necessitating a more collaborative approach (Bask, 2001). In turn, the diagram indicates that third party providers managing logistics contracts have invariably developed partnerships with other supporting logistics companies, who provide, for example, transport to cover peak periods (Naim et al, 2006) and shows that the imposition of an extra fourth party adds many extra dimensions to this relationship network for each value chain.

This can mean that transition to a 4PL is difficult to manage and effective on-going partnering relations between the sub-contracted logistics providers and their customers are harder to maintain. For simpler logistics activities such as transporting finished products from point A to point B this might not be too challenging a factor. But where logistics operations are more complex requiring greater flexibility and faster response, for example for where production performance is uncertain, or where just in time deliveries are required this may be a problematic factor. Crucial in minimising this impact is to have open dialogue with senior representatives of all companies, safeguards in place to protect the share of business and a long term plan to bed in the new processes and relationships beyond the financial plan. Even so important relationships can be severely strained and the trust and relationship culture potentially nurtured over many years can be irrevocably damaged leading to poorer value for customers despite the inherent logic behind the 4PL concept. Recent 4PL initiatives have begun to acknowledge this important aspect – for example the TDG/Corus 4PL platform (Meczes, 2006).

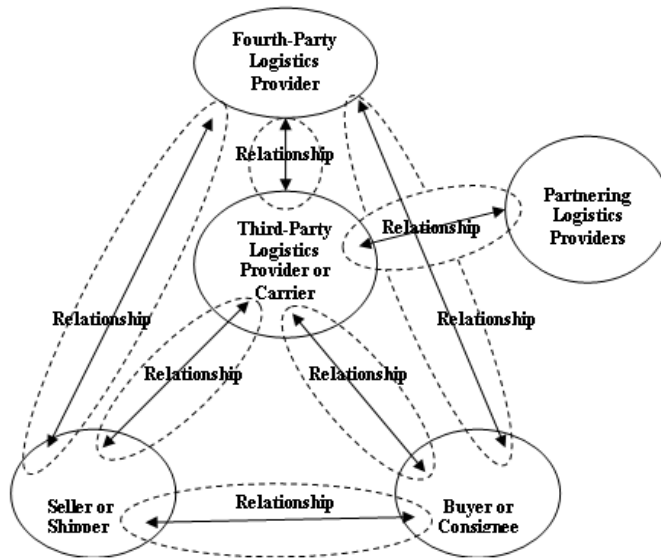


Figure 3: How the Introduction of a 4PL may Complicate Relationships

**CONCLUSIONS**

As competitive pressures build in supply chains and technology advances open up new possibilities for value extraction it is perhaps not surprising that the 4PL vision of an outsourced technology based on centralised control is being revisited. As has been highlighted there are a range of potential sources for value improvement, although in any assessment of the strategy these need to be weighed against the potential concerns. The key is to set the 4PL operation up in the correct manner ensuring 4PLs have a strong alliance with their customer, are focussed on sustained success in supply chain development across all value criteria, and are able to be neutral and fair in their positioning and managerial style. A summary range of questions emerge from the paper that may be useful for companies embarking on a 4PL initiative to consider or for researchers to examine in studies of 4PL operations in the future (Table 3).

<b>Determining a 4PL Strategy</b>	What are the motivations behind companies wishing to appoint a 4PL? How should the 4PL be defined and delineated? Should the 4PL be an in-house or an outsourced operation? On what criteria should the 4PL be selected? What are the principal risk factors which threaten a successful 4PL engagement?
<b>The Early Days</b>	How should the transfer be managed? How involved should the parent company be? How should expectations be managed?
<b>Operating a Successful 4PL</b>	How should 4PLs be measured? Should success be judged solely in cost savings? How is value delivery to customers measured? What ICT is available and how will it be integrated into a central transport management platform? How should the 4PL be remunerated - If gain-share is involved how should it be managed? How should connected parties be communicated to? What happens when plans do not go to plan? Should an exit strategy be planned for?
<b>Managing</b>	How are successful partnerships developed between the parent and the 4PL?



<b>Relationships</b>	What is the impact on relationships in the parent's existing logistics operations?
<b>Further Research Issues</b>	What are the wider environmental and social impacts of a 4PL initiative? How successful are 4PL initiatives? Can 4PLs exist in any setting in all sectors, or is their success dependent on certain contingent factors?

**Table 3:** A Range of Questions Which May be Considered in the 4PL Debate

There are also potentially some deeper more strategic issues to consider. For example, the consolidation of transport management is likely to provide the 4PL with substantially increased power than preceding 3PL providers - it will have a more entrenched position with the client, greater buying power and a stronger position to dictate terms with customers. The 4PL may choose not to exert this power and retain it as latent power - for example not forcing down rates to the market lowest in order to build key relationships, especially in the initial years, but the question remains how should this power be best managed and deployed?

The paper has provided an initial summary of the 4PL probing into, "What" they are, "Why" they are emerging and "How" they work. Perhaps naturally, given that they represent a largely new business model and are fairly complex, debate surrounds the concept and this has prompted a wide range of questions and potential areas for future research.

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## **THE USE OF VARIABLE TRAVEL TIME INFORMATION TO VEHICLE SCHEDULING – A UK EXAMPLE**

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### **ABSTRACT**

Most current commercial vehicle routing and scheduling techniques are based upon minimising mileage; operators complain that the accuracy of the associated time calculations is poor, particularly when vehicles travel through congestion zones. These mathematical models are often incapable of supporting all of the constraints inbuilt in a transport problem. When, scheduling tankers transporting hazardous materials, the legal constraints placed both on the driver and the loading of the tankers are often simplified to ease the modelling. Models have only recently been proposed which can include the considerable amount of complexity that comes with using time dependent travel time data. This research is intended as an application of scheduling using variable travel time information and designed to examine the possible advantages that using variable travel time could bring to the logistics industry and particularly the movement of hazardous products in road tankers.

### **INTRODUCTION**

Research into vehicle routing problems (VRP) has been carried out since 1959[1]. Since then VRP has been the focus of large amounts of research, the survey by Bodin et al.[2] present an early and comprehensive survey on the various forms the VRP can take. Toth and Vigo [3] provide an updated survey on VRP problems and solution techniques. The majority of research into VRP has focussed on building effective or optimal routes using static or fixed travel times between locations. Multiple objectives can be applied to the VRP problem including, minimising cost (fixed and variable), ensuring the workloads are evenly spread between vehicles or maximising the usage of the vehicles. Many constraints have also been included within the VRP some of the more commonly applied constraints include, time windows on service, capacity of vehicles and legal driving allowance.

Despite the multiple possible objectives and constraints, research has only just started to focus on improving the robustness of the schedule produced. This new research ensures that schedules produced are more reliable by including all available information about the congestion effects on the roads into the scheduling process. Research into VRP has included trying to avoid congestion by redirecting routes around known congestion or just accounting for the known congestion effect in current planning [4-7]. Research into congestion effects suggests up to 80% of delays on the road are caused by known<sup>1</sup>, repeating congestion. Advanced knowledge of where congestion is most prevalent have allowed techniques including the Road Timetable™ [8] to be developed so that routing and scheduling packages can make allowances for congestion.

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<sup>1</sup> Personnel communication with Alan Slater of Added Value Logistics

The focus of this research project is to take the Road Timetable™ [8] and apply it to a real life situation, to determine what the effective benefits from scheduling using variable travel time data. This research based on vehicle used by a UK Chemicals and Petroleum distribution firm. Chemicals and Petroleum distribution or Tanker scheduling has additional specialist constraints that are not normally applied to VRP problems and additional implications.

### **TANKER SCHEDULING**

Within Tanker scheduling there are three very different problems; multi-drop, single-drop and tramping. The multi-drop problem consists of having more than one drop on the vehicle as it leaves the starting depot, this problem is the focus of the research project.

The multi-drop problem has a series of constraints; some of these are specific only to tanker scheduling. Loading and unloading sequences for a tanker is more important than for conventional vehicles. A tanker trailer is split into separate pods unloading these in an incorrect order would lead to balance issues for the vehicle during the remaining trip, making the vehicle unstable and potentially dangerous. This sequence needs to be determined before the tanker leaves the depot and must be adhered to as swapping the contents of the pods while away from the depot is impossible. Swapping the Pod contents requires the pumping in and out of the contents and the cleaning of the destination pod before pumping begins.

Some of the more common constraints considered in practical VRP relate to multi-commodities. In the food retail industry this constraint insists on separating chilled, frozen and ambient food stuffs. In the tanker industry each pod can carry a separate commodity type, normally related i.e. petroleum or food stuffs. Some companies carrying particularly petroleum insist that the final pod carries a less combustible chemical for safety reasons.

Many VRP have time window constraints imposed to ensure that service begins within a certain time horizon; this applies equally to tanker scheduling. Another standard constraint within most VRP is a capacity constraint of some kind. Within tanker scheduling this constraint can be a very simple, as the capacity of a tanker is based only on the number of pods. Each delivery made by the tanker has to be for an integer number of pods.

Another common VRP constraint that is included within tanker scheduling is the use of an heterogeneous fleet. This is important in two main ways; it is often cheaper to dispatch a smaller vehicle as opposed to a large vehicle and some locations requiring a delivery will only be able to receive a delivery from a certain type of vehicle.

Depending on the goods being transported extra legal constraints may need to be included. These should be included on a case by case basis as it may not always be necessary to include more constraints and restriction on top of the heavy goods vehicle (HGV) driving restrictions.

Benefits that scheduling alone offer to haulage operators can be extended, by included variable travel time information, to include more efficient use of fleet, reduced fuel costs, a more robust schedule less likely to be disrupted by congestion and a more accurate estimation of the true costs involved in implementing the schedule. From an holistic stand point avoiding congestion should reduce fuel consumption and the carbon footprint made by the haulage industry. *"The pollution attributed to a heavy goods vehicle stood in congestion is*

five times that of a heavy goods vehicle not caught in congestion<sup>2</sup>. Looking at tanker scheduling specifically, keeping vehicles transporting dangerous chemicals away from congested areas of the road network should hypothetically reduce the risk of transporting these chemicals.

### PROBLEM FORMULATION

The problem explored consists of only a single depot but could be extended to a multi-depot option. The set of customers is denoted by  $N$  and the set of vehicles by  $K$ . Each customer,  $i \in N$ , has a delivery pod requirement  $p(i)$  with an expected delivery time of  $s(i)$ , a time window  $[e(i), l(i)]$  for arrival and a vehicle type  $type(i)$ , indicating only vehicles of this type or smaller can make this delivery.

The set of vehicles  $K$  represents a heterogeneous fleet of vehicles. Each vehicle  $k \in K$ , has a capacity allowance  $C_k$ , a starting time  $\tau_k$ , a maximum driving time  $D_k$ , a working time  $U_k$ , a vehicle type  $V_k$  and a loading time  $load_k$  is also required for the depot. Although the break times throughout the day are based on the driver's requirements, in this definition the driver and vehicle are coupled together so there is also  $drive_k$  and  $break_k$  which represent the amount of time driving ( $drive_k$ ) of vehicle  $k$  before a break of length ( $break_k$ ) must be taken.

The traveling times between locations are all known and dependent on the starting location and the ending locations as well as the time of departure.  $c(i, j, f)$ , this is calculated from the recorded tracking data from ITIS holdings Plc, is defined as the traveling time from  $i$  to  $j$ , starting at time  $f$  for any pair of locations  $\{i, j\} \subset N \cup \{0\}$ .

The vehicles make up a heterogeneous fleet, therefore each vehicle must be treated as unique so a single vehicle route for vehicle  $k$  is defined as  $R_k = [t_1^k, \dots, t_{n^k}^k]$  as the ordered trips to be made by vehicle  $k$ , where  $n^k$  represents the number of trips on vehicle  $k$ .  $t_i^k = [v_{i,0}^k, \dots, v_{i,m_i^k}^k]$  is defined as the path of customers required to be delivered to by vehicle  $k$  in trip  $i$ ,  $m_i^k$  represents the number of stops on the complete path, including depot stops, for vehicle  $k$  in trip  $i$ ; by convention,  $v_{i,0}^k$  and  $v_{i,m_i^k}^k$  are identified with 0, that is, the trip starts and ends at the depot.

The arrival time at a service location for a customer  $i \in N$  is denoted by  $a(i)$ , each service also has a variable  $b(i)$  representing the break taken before the delivery commences. The arrival time is defined as the leaving time from the previous location plus the travelling time; by convention  $a(v_{i,0}^k) = \tau_k$ ,  $a(v_{i,0}^k) = a(v_{i-1, m_{i-1}^k}^k)$  and  $s(v_{i,0}^k) = 0$ ,  $s(v_{i, m_i^k}^k) = load_k$ .

$$a(v_{i,j}^k) = a(v_{i,j-1}^k) + b(v_{i,j-1}^k) + s(v_{i,j-1}^k) + c(v_{i,j-1}^k, v_{i,j}^k, a(v_{i,j-1}^k) + b(v_{i,j-1}^k) + s(v_{i,j-1}^k)) \quad [1.1]$$

The break time previous to each delivery is defined either as; zero, the waiting time due to arrival prior to time window opening or a required driving break.

$$b(v_{i,j}^k) = \max \left\{ \begin{array}{l} e(v_{i,j}^k) - a(v_{i,j}^k) \\ 0, \\ req\_break(v_{i,j}^k) \end{array} \right\} \quad [1.2]$$

<sup>2</sup> Personal communication with a member of the UK Department for Transport.

The required break due to travelling  $req\_break(v_{i,j}^k)$  is further defined using equations 1.3 ,1.4 and 1.5.

$$req\_break(v_{i,j}^k) = \max \left\{ \left( \left[ \frac{travel\_time(v_{i,j}^k)}{drive_k} \right] break_k \right) - break\_taken(v_{i,j}^k) \right\} \quad [1.3]$$

The break taken up to this point the vehicle route,  $break\_taken(v_{i,j}^k)$ , is calculated using equation 1.4 and the travel time used up to the point in the vehicle route,  $travel\_time(v_{i,j}^k)$ , is calculated using equation 1.5.

$$break\_taken(v_{i,j}^k) = \sum_{l=1}^{i-1} \sum_{p=0}^{m_l^k} b(v_{l,p}^k) + \sum_{p=0}^{j-1} b(v_{i,p}^k) \quad [1.4]$$

$$travel\_time(v_{i,j}^k) = \sum_{l=1}^{i-1} \sum_{q=1}^{m_l^k} c(v_{l,q-1}^k, v_{l,q}^k, a(v_{l,q-1}^k) + b(v_{l,q-1}^k) + s(v_{l,q-1}^k)) + \sum_{q=1}^{j-1} c(v_{i,q-1}^k, v_{i,q}^k, a(v_{i,q-1}^k) + b(v_{i,q-1}^k) + s(v_{i,q-1}^k)) \quad [1.5]$$

The only constraint applied directly to each individual customer is that the delivery is started within the given time window. This is a time window for the start of delivery and not on completion.

$$e(i) \leq a(i) + b(i) \leq l(i), \quad \forall i \in N \quad [1.6]$$

The amount of time a vehicle is allowed to operate is restricted both in terms of driving and working time. Therefore constraints are required to ensure that vehicles obey these maximum working time constraints, 1.7 and 1.8 enforce the restrictions on driving time and working time respectively.

$$\sum_{l=0}^{n^k} \sum_{q=1}^{m_l^k} c(v_{l,q-1}^k, v_{l,q}^k, a(v_{l,q-1}^k) + b(v_{l,q-1}^k) + s(v_{l,q-1}^k)) \leq D_k \quad (\forall k \in K) \quad [1.7]$$

$$\sum_{l=0}^{n^k} \sum_{q=1}^{m_l^k} c(v_{l,q-1}^k, v_{l,q}^k, a(v_{l,q-1}^k) + b(v_{l,q-1}^k) + s(v_{l,q-1}^k)) + s(v_{l,q}^k) + b(v_{l,q}^k) \leq U_k \quad (\forall k \in K) \quad [1.8]$$

Constraint 1.8 includes the break time within the working time allowance. This is important to ensure that time spent waiting is not used elsewhere, for example waiting for three hours for a time window to open should not allow the driver to continue his shift by an extra three hours. This does not follow the current UK interpretation of the Working Time Directive, which allows the use of "periods of availability" POA to be excluded from the working time calculations.

The departing capacity of the trip needs to be calculated and checked against the capacity of the vehicle. As shown in constraint 1.9.

$$\sum_{q=1}^{m_i^k-1} p(v_{i,q}^k) \leq C_k, \quad (\forall k \in K, i=1, \dots, n^k) \quad [1.9]$$

The final constraint enforces the requirement that the vehicle selected to make the service is able to do so. The vehicle type for every service scheduled in every trip must have a  $type(i)$  greater than or equal to the vehicle type  $V_k$ .

$$type(v_{i,j}^k) \geq V_k \quad (\forall k \in K, j=1, \dots, m_i^k-1, i=1, \dots, n^k) \quad [1.10]$$

As with many VRP problems, the objective function simply involves minimising the cost involved in delivering to a number of customer locations, the cost in this formulation is based on travelling time as opposed to travelling distance.

$$\text{Min } \sum_{k \in K} \sum_{l=1}^{n^k} \sum_{p=1}^{m^k} c(v_{l,p-1}^k, v_{l,p}^k, a(v_{l,p-1}^k) + b(v_{l,p-1}^k) + s(v_{l,p-1}^k)) \quad [1.12]$$

### SCHEDULING ALGORITHM

This algorithm is a two phase algorithm. The first phase is a constructive phase, creating a feasible solution using a parallel insertion algorithm based on the method described in Potvin and Rousseau [9]. The second phase is a tabu search algorithm similar to the approach by Gendreau et al. [10].

### INDICATIVE RESULTS

This research project is ongoing where the indicative results shown here are taken from two previous pieces of research [11,12]. Research by Beggs [12] indicates that, particularly within tanker haulage, congestion is having an increasing effect on the trips operated. Beggs [12] defines any route whose trip time is over an hour longer than planned as having been effected by congestion. Of the results shown, the number of trips effected by congestion depends a lot on the path the trip takes but congestions typically effects between 8%- 26% of the trips studied. This research looks only at the completion times of planned trips.

Research by Maden [11] looks at the effects congestion has on service levels throughout the day. Using recorded congestion data a new algorithm was designed to schedule using this information. The algorithm was then tested on a series of controlled datasets against schedules produced using static traveling time information, which do not have any congestion effects included within it. Two series of static traveling times were used Quick and Slow. Quick is representative of the traveling times recorded when the roads are free of congestion. Slow is representative of extending travel time to allow for congestion.

When the routes, generated using either of the two static time and distance matrices, have real recorded travel times, with congestion effects, retrospectively applied 50%-80% of the routes generated had errors associated with them. These errors included time deliveries being missed, overtime payments required or orders being bumped to the next day in order to avoid legal constraints being broken. This study looked at the effect at every point through out the day and set no acceptable limit on congestion effects.

This survey also suggested that in direct comparison between the solutions generated using the three different data sources, before congestion was taken into account, the solutions using the congestion data were 6.1% more costly in traveling time than using the quick data and 4.8% better than those using the slow data. Once congestion factors were added to the solutions the solutions generated using the congestion data proved to be 2.2% and 3.1% better than the quick and slow solutions.

### CONCLUSIONS

Although the results are only indicative they show that there is a potential of between 2.2% and 3.1% economic and fuel savings, leading onto environmental savings. The robustness of the schedule produced is increased as currently 50%-80% of schedules are negatively affected by congestion often in very minor ways but these minor effects cause 8%-26% of all trips in the case study [12] to be significantly effected by over an hour.

## ACKNOWLEDGMENTS

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## **THE RELATIONSHIP BETWEEN COLLABORATIVE MANAGEMENT AND TRANSPORT SOURCING IN SUPPLY CHAINS**

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### **ABSTRACT**

In a certain way, the development of collaborative transportation management in supply chains is a trend opposed to transport outsourcing. The first is related with fostering links between transportation managers, carriers and their customers, another one has mostly started with vertical disintegration. However, the both of them are of strategic importance for each enterprise and also have been the most important trends in supply chains in recent period. This paper addresses their relationships in volatile markets, which can be faced in developing countries, by using case of Serbia. The collaborative transport management development is considered arguing different starting points, which are related with transport sourcing concept in enterprise and supply chains on the whole. In that purpose, the case study methodology is used.

### **INTRODUCTION**

In a certain way, collaborative transport management (CTM) is a trend opposite to transport outsourcing. Transport outsourcing has usually started as an arrangement whereby a carrier performs services for a firm that have been originally performed in-house (i.e. vertical disintegration) – see for wider discussion Harland et al. (2005). On the other side, CTM is treated as a tool for strengthening links between carriers or logistics providers and their customers. CTM introduces carrier or integrator as strategic partner in supply chains, who contributes to value-adding process in supply chains and therefore arrangements between them are of strategic importance for each enterprise. According to Tyan et al. (2003) CTM is “new business model for integrating transportation management with supply chain management”.

In this paper, the focus is on relationship between transport outsourcing and collaboration between partners in supply chains in volatile markets, which can be faced in developing countries. The purpose of the paper is to examine how successful enterprises manage the transport outsourcing in varying circumstances, during business processes integration inside and outside the particular organization.

In next Section, the literature gap about this issue is pointed out. In third Section, the empirical discussion and brief parallel overview of outsourcing and collaboration trends in developed countries and Serbia are presented. The methodology used in paper is described in next Section, while in fifth Section the main findings are briefly shown. Final remarks and conclusion are in the last Section.

### **THE LITERATURE GAP**

Current focus of academics is on collaborative relationships both between main players in supply chains and between logistics operators and their customers. The first one is mostly related with Collaborative Planning, Forecasting and Replenishment (CPFR) and related concepts. The second one, collaboration



between logistics, especially transport providers and customers, known as Collaborative Transport Management (CTM), has been formalized as “complementary” (Mason, Lalwani, 2005) and “an independent and yet concurrent” (Tyan et al., 2003) process to CPFR. It has been recorded a rising interest for the collaborative relationship between carrier(s) (or his/their intermediary) and supplier/buyer in supply chains in recent period (for example, also see Esper and Williams, 2003, Steffanson, 2006 etc.). The authors set out numerous benefits of collaboration between transport managers and their customers. The most cited are better vehicle and fleet utilization (Tyan et al., 2003, Esper and Williams, 2003, Mason and Lalwani, 2005) improved delivery service level (Tyan et al., 2003, Esper and Williams, 2003) reduced transportation costs (Esper and Williams, 2003), increased visibility (Esper and Williams, 2003, Mason and Lalwani, 2005) etc.

The both, transport outsourcing and business processes integration are critical issues for enterprises. Therefore, a huge amount of literature has been written about both of them in the recent period. However, the number of papers which focus to links between collaborative management and transport sourcing issues in supply chains is almost neglected, especially with reports from developing countries.

The gap in available literature is observed in several aspects: collaborative relationships issues are rather found in theoretical discussions than papers with empirical evidence, especially from developing countries. Furthermore, available papers, with small number of exceptions, are rather focused to operational transport planning and scheduling in supply chains than to strategical issues, such as capacity planning, transport contracts and transport sourcing decision-making. Furthermore, although the most of stories are about supply chains collaboration, the focus in articles are mostly on one-to-one relationship between carrier and customer, or sometimes on logistics triads supplier-buyer-logistics provider (for example, see Steffanson, 2006). Also, it is the rare case that sourcing of transport management is separated from transport capacities sourcing in analysis. This paper represents an attempt to cover these gaps.

## **EMPIRICAL BACKGROUND**

The evidence from developed countries show that experts have started to herald the emerging outsourcing trends (vertical disintegration) since mid of 70's (Harland et al., 2005). As non-core activity in most enterprises, transport with other logistics activities has been among the first candidates for outsourcing. Some western experts (Lynch, 2000) has noticed three stages in logistics outsourcing trends: the first period of outsourcing euphoria, the second one is the period of recording outsourcing pitfalls (and courage to talk about) and the third, and still lasting one, period of sobering thinking and real expectations. On the other side, since the mid- 80s, there have also been recorded different initiatives toward business processes integration and collaboration firstly within the enterprises and than throughout the entire supply chains. These include, among others, CPFR, CTM, VMI, VMT etc. However, the reports from industry show that fully integrated successful supply chains are still rare even in most development countries. The experiences from developed countries also show that IT spreading, which are the basis for SC integration and collaborative

relationships, show significant differences in logistics and non-logistics enterprises (Patterson et al., 2004).

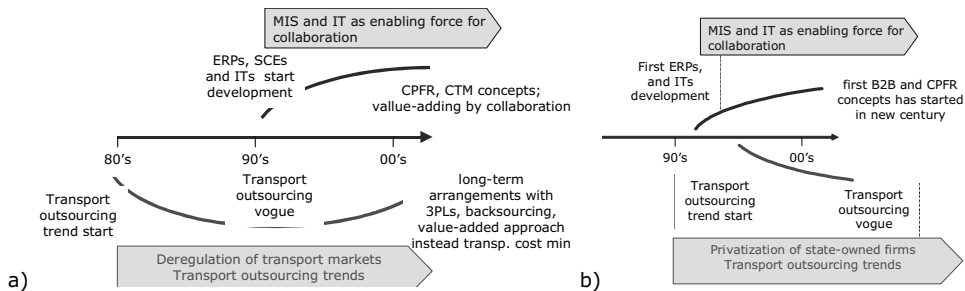


Fig. 1: The comparison of transport outsourcing and SC collaboration trends in developed countries (a) and Serbia (b)

In Serbia, the dynamics of outsourcing trend and adoption technologies which enable business processes integration within and between enterprises wasn't the same as it has been in most developed countries (see Fig. 1). The trigger for transport outsourcing trend has mostly been privatisation of state-owned firms. Before the process of privatization, many public enterprises have owned transport fleet for distribution; after privatization, most of them outsourced, or at least reduce own fleet. Currently, the road freight transport fleet in Serbia is, in average, very old.

Although the first ERPs developed by Serbian providers has been recorded during 90's (Gajic et al., 2005), real ERP adoption in enterprises has started in early 2000's. Looking to the fastest and most successful enterprises, they have mostly followed the path: privatisation-transport fleet outsourcing-introducing ERP and starting internal and external business processes integration. All of this has been mostly reached only in couple of years after 2000. Recent research also show that there are differences in ways and dynamics of IT adoption between logistics and non-logistics enterprises, similar as in developed countries (Gajic et al., 2005). This discrepancy is one of the preconditions for independent and different dynamics in development between collaborative logistics provider-customer relationships and collaboration between non-logistics enterprises in supply chains.

### CASE STUDY METHODOLOGY

The aim of survey was to better understand the relations between transport sourcing concept in distribution and ways toward development of collaborative transport management in Serbian business environment. Three main criteria were used in the selection process of the case-study enterprises: 1) the enterprise represents the „successful story“ before and after privatization and is either manufacturer or trade enterprise; 2) the enterprise has firstly been established in Serbia, and it is not a public enterprise, i.e. process of privatization is finished and 3) the enterprise should have recorded the first experiences in introducing collaborative management.

Due such limitations, the comprehensive survey with big sample has not been possible. Hence, we rather choose the case study methodology to obtain the better insight into the problem. The three case studies of different enterprises, which doing business in Serbia are shown and discussed in next Section. The enterprises are selected from completely different industries. The data has been collected during the interviews with representatives, mostly leading managers in three focal enterprises. In that purpose, a common set of questions has been prepared for all enterprises, including firm's size, industry, changes related with process of privatization, distribution system features, MIS features etc. Due to limited size of article, here is presented only a selected part of obtained results.

## **CASE STUDIES AND MAIN FINDINGS**

### **Case A**

The first focal enterprise is one of the most successful brewery on Serbian market. The brewery has also successfully passed process of transition at the beginning of new century and now it is a part of Danish giant Carlsberg. The way and timing of ownership transformation, transport outsourcing and introducing ERP mainly follows trend shown in Fig 1b. Currently enterprise has middle-term agreements with small carriers for distribution on local market. Main reasons for transport outsourcing have been company's strategy and costs reduction.

The enterprise is responsible for manufacturing, distribution and sales. It collects the information about the sales from customers/retailers by using the POS system and then send needed quantities to contracted distributors. Their ERP solution include TMS module integrated with other ERP modules, such as order management system (OMS) and Warehouse Management System (WMS). However, they are still not integrated with big distributors on market. Also, distribution can be organized both by brewery and local distributors and transport planning is not integrated vertically within supply chains, too.

### **Case B**

The second observed enterprise is the manufacturer of carpets and related products. The enterprise is a part of bigger group, which core business is production, sales and distribution of floor covering (FC group). The FC group includes several manufacturers of all types of floor covering products (i.e. carpets, targets, etc.), wholesaler/distributor and retail enterprise. Now the group is a part of a global target company. In 2000, the group has outsourced own transport fleet and create a number of small carriers on local market (the same as the Case A), with revolving middle-term agreements with them. Transport and inventory management in distribution is the task of wholesaler/distributor within the FC group. In 2003, the enterprise has started to implement an ERP solution, which enables integrated order, inventory and warehouse management, not only in focal enterprise, but also in the FC group and within global company on the whole. However, there is still not any module for transport management (TMS), although the FC group has the excellent basis for collaborative transport management development. Transport planning and scheduling for the whole distribution system are still performed manually, based on experience of dispatchers.

### **Case C**

The third enterprise is distributor of computer equipment and part of a stakeholding group, which consists of several enterprises – distributors for Serbian and some markets in neighbour countries, retailer, IT consulting etc.

Actually, enterprise has developed own distribution and retail network to the end customers, but also agreements with another distributors and retailers. Now it is one of the biggest licenced distributors of computing equipment in Serbia, and offered products come from world famous manufacturers such as HP, Fujitsu Siemens Computers, Asus, MSI, AMD, Kingston, Maxtor, Sony, Teac etc. The enterprise has shown high sensitivity on market demands and flexibility to adapt to different market challenges.

This enterprise/group has been among the first who transferred complete business on Web and also represents one of the first examples of successful B2B solutions in Serbia. Beside ERP, they have developed own B2B and B2C portal in the recent period. This service is dedicated only to registered users and today almost all transactions have been realized over portals. The distribution enterprise use own fleet, which consists of new vehicles, customized for enterprise needs. For webstore shopping, the express service delivery is used, with main slogan "customer must not wait". This type of service include delivery within 24 hours to all customers in Serbia. The enterprise is an example how win-win solution in collaborative management is possible in Serbian market.

In Table 1, the main features concerned with transport outsourcing and collaboration initiatives in supply chains are summarized for all three case studies.

		CASE A	CASE B	CASE C
Industry		Food (brewery)	Textile (floor covering - FC)	Computing
Market		National market and neighbour cnt.	International (EE and SEE countries)	National and neighbour countries
Transport outsourcing level	Fleet	Outsourcing	Outsourcing	- Own fleet for B2B - Express delivery for web shopping
	Management	Insourcing	Insourcing, within the holding group	Insourcing
Agreements with carrier		Hiring a number of small carriers	Hiring a number of small carriers	/
Vertical collaboration		In progress	Within the FC group	Entire SC
Horizontal collaboration		/	Within FC group	Yes
SC strategy		Agile	Agile	Lean/agile

Table 1: Comparative overview of organizations' characteristics

If we compare three case studies shown above, we can find some similarities in doing business. All case studies have firstly reached the acceptable transport costs control and minimization and then shifted focus to increasing quality of transport service and/or responsiveness. Dividing sourcing of transport capacities from transport management is the option that has supported organizations to reach these objectives. Analysis of such results in given environment opens a new avenue for further research. The both, level of collaboration in supply chains, as well as SC strategy seem to be related with transport sourcing concept in case studies. However, it is important to say that transport capacity outsourcing has been simply explained in Case A and B as „company strategy after privatization“ and not much related with particular transport goals (cost minimization etc.). It is noticeable that IT supported collaboration between hired carriers and their customers does not exist. Transport management in all cases is

kept „in house“, so one of units within enterprise (Case A), or organization in supply chains (wholesaler/distributor in Cases B and C) plays the role of transport manager/intermediator. This is different from many of cases about collaborative attempts reported in available literature. Within such setup, the achieved benefits can be related, for example, rather with vehicle utilization, than with total fleet utilization, with exception in Case 3. Actually, there is not available evidence neither about hired carriers' benefits in such competitive setup, nor tendency to shift IT enabled collaboration toward them. Further related research should also addresses this issue.

### **FINAL REMARKS AND CONCLUSION**

The empirical results open an avenue for further research about relationships between transport sourcing concept and ways toward development different CTM models and solutions in supply chains in so specific business environment, such Serbia as. Refer to the case studies shown above, the first initiatives and attempts toward CTM developments are recorded as relationships between wholesalers/distributors, which often act as transport managers in supply chains, and other involved organizations, instead between third-party logistics providers/carriers and their customers. It can be concluded that transport sourcing concept, i.e. insourcing vs. outsourcing, as well as the kind of outsourcing arrangement have strong influence on improvement collaboration in transport. It is also reasonable to investigate the reverse impacts, i.e. how increasing demands for collaboration can influence transport sourcing and transport arrangements in supply chains in varying circumstances.

However, the empirical research described in paper has many limitations. The sample is very limited and more external and internal factors should be investigated more in-depth both, in shown sample and in other supply chains which have started with collaborative praxis. It would be desirable to supplement this research soon with a larger scale survey in the same environment to validate presented observations and results.

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## **ROLES FOR SEA PORTS IN THE CONTEXT OF VARYING SUPPLY CHAIN STRATEGIES: THE DEVELOPMENT OF PORT CENTRIC LOGISTICS**

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### **ABSTRACT**

The purpose of this paper is to examine traditional, current and emerging roles played by sea ports in the context of logistics and supply chain management practice and strategy. The paper draws its insights and conclusions from case studies, a review of the literature, and an analysis of current trends and data concerning the sector. The paper highlights the potential, which in many cases is still latent, of ports to evolve into higher value, more profitable areas of activity. The paper both highlights (given the fact that the vast majority of freight at some point transits sea ports) and extends our understanding of the role of sea ports within supply chains.

### **KEYWORDS**

Ports, maritime, logistics, supply chain management, port centric logistics, port clusters

### **PORTS AND SUPPLY CHAINS**

Sea ports (hereafter simply referred to as ports) and maritime transport have existed for some thousands of years and have developed to support the patterns of international trade which were inherent in shaping the modern world. Some six billion tonnes of freight moves by maritime transport each year and is estimated to comprise 45% liquid bulks, 23% dry bulks and 32% general cargo. Total freight movements vary according to region, commodity and freight origin/destination. In the EU, for example, the port sector handles more than 90% of the Union's trade with third countries and approximately 30% of intra-EU trade, as well as over 200 million passengers every year. According to the World Bank (2001) there are more than 2,000 ports around the world, from single berth locations handling a few hundred tonnes a year to multipurpose facilities, such as Singapore and Rotterdam, handling over 300 million tonnes a year.

It is generally accepted that supply chains, and not individual firms or products, are the basis of much marketplace competition (Christopher, 1992). Maritime transport (comprising ports as nodes and shipping services as links) is the dominant mode for international freight movements and is thus crucial to international trade and a vital component of many supply chains. This paper is concerned with the role of ports in supply chains, a role which can vary from that of simple transshipment hub to important logistics node, and which in turn is heavily dependent upon the supply chain strategies of those who use ports. A particular focus of the paper is the shift among many ports into what is

sometimes labeled 'port centric logistics'. The paper is structured as follows. Trends in maritime freight transport and shipping are reviewed and the major global trade corridors in terms of maritime containers are identified. This is followed by a discussion of various pertinent trends in the ports sector, in particular concerning the evolution of so-called global port operators. The development of port clusters and the emergence of an area referred to as 'port centric logistics' is next elaborated. Growing competition between ports and the integration of ports into supply chains is next discussed. The area of supply chain strategy is discussed and, using the global supply chain taxonomy developed by Christopher *et al* (2006), various roles for ports are suggested in the context of different supply chain strategies.

## **TRENDS IN MARITIME FREIGHT TRANSPORT AND SHIPPING**

The increased emphasis on the role and efficiency of ports needs to be viewed in the context of the considerable growth that has occurred in recent years in world trade in general and in maritime transport in particular. Today, many of the world's economies are becoming increasingly interrelated as a result of increasing trade and the growing trend towards globalization of production. Over the past half-century, most countries have seen an increase in exports as a share of GDP, with the vast bulk of these exports transported by sea. A number of trends affecting the ports sector have been central to efficiency and productivity gains in the sector. These include better, faster and larger vessels, and improvements in cargo handling at ports.

With fewer ports able to handle larger vessels, there is growing traffic concentration at certain ports. Increasingly, many mid-sized ports are playing a feeder role to the very large ports as hub and spoke networks have emerged. In these networks the larger vessels ply between the major transshipment hubs, with the result that the prosperity of the smaller ports is increasingly dependent on the route strategies of the major shipping lines. Global shipping companies have also increased significantly in scale. While global maritime freight has grown considerably in recent years, a particular feature of this growth is that it has been unevenly spread across different corridors. This has led to directional imbalances, with the result that large numbers of empty containers may flow in one direction along a corridor, while high freight rates will apply on the opposite direction along the same corridor as a supply-demand mismatch occurs. This is particularly acute with regard to container export traffic from Asia.

## **TRENDS IN THE PORTS SECTOR AND THE ROLE OF PORTS IN THE SUPPLY CHAIN**

Globalisation of shipping and trade is resulting in increasing pressure on ports to reduce container terminal costs and improve operational efficiency. Mega shippers of freight are generally seeking single supplier contracts looking for carriers that can provide efficient and cost effective services. In turn the carriers are seeking cost reductions and efficiency gains at the ports they utilise, with single sourcing across ports in terms of port terminal operations becoming more common. In response to this and to the need for integration in international supply chains a number of global port operators (GPOs) have emerged who

manage an increasing number of the world's ports. This has been helped by port deregulation and changes in ownership in many countries. Leading GPOs include Hutchison Ports Holdings (Hong Kong), PSA Corporation (Singapore), Dubai Ports World (Dubai), AP Moller – Maersk (the group's terminal operations are headquartered in the Netherlands) and COSCO (Beijing).

#### *Port centric logistics and port clusters*

Looking beyond the ports physical boundaries, Notteboom and Rodrigue (2005) argue for a new phase in port development, *viz* regionalisation, where the reach of the port extends beyond the port perimeter and involves, *inter alia*, market strategies and policies linking it more closely to inland freight distribution centres. Indeed some UK ports are actively encouraging companies to locate distribution centres at ports rather than in their traditional locations, which tend to be in geographically central, inland locations. They argue that current patterns of (inland) distribution centre location ignore the fact that most of the freight that passes through these distribution centres first passes through a port. Therefore they argue it is logical (and often times easier in terms of land cost, lack of congestion, etc) to site such distribution centres at ports. The term port centric is sometimes used to refer to this approach (Falkner, 2006).

It has also been recognised that the gateway position of major seaports offers opportunities for the development of value added logistics activities proximate to ports. Port clusters have thus evolved which Haezendonck (2001) defines as 'the set of interdependent firms engaged in port related activities, located within the same port region and possibly with similar strategies leading to competitive advantage and characterized by a joint competitive position vis-à-vis the environment external to the cluster'. With port clusters, a modern seaport becomes a node in a global logistics chain, acting as a collection-distribution centre or logistics hub where many value-added activities can be conducted.

Ports increasingly now recognise that higher profit margins can be made on some non core port activities and this is driving them to engage in activities beyond simply providing berths for ships and other core port services.

#### *Integration into supply chains*

The integration of ports in international supply chains has been difficult due to the fact that each member of the supply chain is trying to optimise their own economic value with resulting conflicts in respective goals. The demand for increased transport efficiency resulting from the drive towards international outsourcing and globalisation of markets has pushed the shipping and port industry to come out of its traditional way of operating and get into conceptual inventiveness and technological innovation.

Developments in logistics and supply chain management have also forced the container ports and shipping lines to re-think their function in the logistics process and this has led to the push towards larger container ships and the need to create major transshipment hubs (Drewry, 2004). International transport management is moving from a more fragmented approach towards integrated logistics systems which meet individual customer needs. Ports are required to



play an active role in the integrated logistics system while continued efforts are simultaneously needed to provide better port terminal services at lower costs (Hadi, 2005).

International supply chains place high demands on ports as they seek synchronization and integration, resulting in seamless operations and services meeting the needs of both consignors and consignees. The international commodity market is closely integrated and suppliers have to be responsive to the special requirements of their trading partners. As noted earlier, there is growing acceptance that supply chains as a whole compete with each other rather than individual companies. Customers have become very demanding not only for price and quality, but also for speedy and reliable product delivery. At the manufacturing end great effort might have been deployed to lean a plant's operations and to improve the quality of the products and services it produces (Womack et al, 1990), but shared processes between supply chain partners more usually will have been left unmanaged (Mason and Lalwani, 2006).

Transport is one of such shared processes between international supply chain partners. Transport performs a critical role in the more time sensitive, controlled and closely integrated modern supply chains and networks. Morash and Clinton (1997) suggest "to minimise total costs and maximise customer value, transportation integration is essential within the supply chain". This has meant that ports have to fully integrate within the supply chain and provide a service which meets the demand to deliver the right amount of product, at the right time, in the right condition and at the right price anywhere in the world.

## **SUPPLY CHAIN STRATEGIES**

The port is just one node in any particular supply chain and how goods flow through that node will depend upon the strategy adopted by that supply chain. This of course is to presuppose that all supply chains work to a particular strategy. It could however be argued that with regard to supply chain strategy sometimes theory is ahead of practice! Godsell et al (2006) for example noted that while theory suggested that supply chains should be demand-led, it has proven difficult to find empirical data in support of such an approach. Furthermore they suggest that the functional nature of many organisations (in our view this could also include ports) at an operational level acts as a barrier to aligning supply chains effectively with the markets they serve thus obviating against a customer responsive supply chain strategy being pursued.

Christopher *et al* (2006), building upon the work of Fisher (1997) and others, have put forward a taxonomy (Table 1) for selecting global supply chain strategies and which uses both predictability of demand for products and replenishment lead times. It also incorporates lean and agile philosophies as appropriate. They argue that a 'one size fits all' approach will not work and that companies need to continually assess their product range and market characteristics so that changing scenarios may be identified and appropriate supply chain designs configured. This is the approach also taken by other authors, such as Gattorna (2006), who argues for a dynamic capability in supply chain designs so that they can respond to any changes. Gattorna

argues against designing supply chains for specific products because, as he argues, different types of demand can in fact exist for the same product, even among the same customer base depending on when and why they want to buy the product.

<b>Supply demand characteristics</b>	<b>Resulting pipelines</b>
Short lead time + predictable demand	Lean, continuous replenishment
Short lead time + unpredictable demand	Agile, quick response
Long lead time + predictable demand	Lean, planning and execution
Long lead time + unpredictable demand	Leagile production / logistics postponement

Table 1: A taxonomy for selecting global supply chain strategies (Christopher et. al., 2006)

## CONCLUSION

Table 2 attempts to identify various roles for ports within the four supply chain designs illustrated in the preceding section. The roles identified for ports are neither exhaustive or mutually exclusive. What is important is that ports embrace the activities and strategies relevant to their context. For example some ports have plenty of idle land-side space available which in the absence of other uses can be used for container storage; others with limited space and good land-side transport linkages may choose to maximise the available space for warehousing and light manufacturing.

Shipping companies will also have their own specific requirements. Bulk vessels will typically take longer to load / unload and may also have variations in their schedules. Unitised vessels will typically require faster turnaround times. Ports have to decide how to serve these different customer groups. For example some ports with capacity constraints have decided to focus on unitised traffic where margins are higher and they seek to divert lower value bulk shipping business to alternative facilities or even in some instances to competitor ports.

Ports have evolved from being simple transshipment points and can provide a range of services and activities to support logistics activities. As well as being of benefit to supply chains by hopefully making them both more efficient and effective, this should also be of value to ports in helping them grow their own profitability. A useful follow on to this research would be take a number of supply chains and map out the activities undertaken at the port interface(s) within those supply chains in order to enhance our understanding of the changing roles of ports in supply chains.

Supply demand characteristics	Resulting pipelines	Role(s) for Port?
Short lead time + predictable demand	Lean, continuous replenishment	<p><b>Import:</b> Provision of relatively cheap warehouse space close to point of import for example for vendor managed inventory (VMI): supplier imports freight through the port and replenishes direct to customer from warehouse at the port.</p> <p><b>Export:</b> If the sea crossing is short, the VMI can also be managed at the export port.</p>
Short lead time + unpredictable demand	Agile, quick response	<p><b>Import:</b> Provision of warehouse space and cross docking facilities to allow rapid import, sorting and distribution of varying product lines</p> <p><b>Export:</b> Because of the short lead time and unpredictability of demand, suppliers may choose to also store goods at the port of export rather than at the factory.</p>
Long lead time + predictable demand	Lean, planning and execution	<p><b>Import:</b> Emphasis here on cost effective storage capabilities. Also due to long lead time, variation in ships arrival times may arise, berthage space must be available at the port when needed.</p> <p><b>Export:</b> port may provide facility to store export goods, especially if seasonality and variation in ship departure times occur.</p>
Long lead time + unpredictable demand	Leagile production / logistics postponement	<p><b>Import:</b> Provision of warehouse / manufacturing capabilities to allow postponed manufacturing / kitting / pick &amp; pack etc.</p> <p><b>Export:</b> capability to handle / store generic (i.e. non customized) product</p>

**Table 2 – Role(s) for Ports**

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