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# THE DEVELOPMENT OF A LEAN, AGILE AND LEAGILE SUPPLY NETWORK TAXONOMY BASED ON DIFFERING TYPES OF FLEXIBILITY

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**Abstract**
The paper explores the meaning of flexibility in the context of lean, agile and leagile supply networks and articulates a supply network flexibility framework. Two key 'sources' of flexibility are investigated: Vendor Flexibility and Sourcing Flexibility. The paper introduces an extension of the 'leagility' concept beyond the simple material flow decoupling point concept. Two new types of Leagility are put forward: (1) Leagile with Vendor Flexibility Systems, which combine the use of agile vendors with lean sourcing practices and (2) Leagile with Sourcing Flexibility Systems, which combine the use of lean vendors with agile sourcing practices. Case studies of two UK based specialist fashion retailers' supply networks are presented in order to gain insights into the sourcing strategies used and the sources of flexibility employed by retailers at supply network level. A new taxonomy that dynamically links Vendor and Sourcing Flexibility with lean, agile and leagile supply network strategies is proposed. We suggest that the proposed taxonomy can be used as a guideline for firms designing and managing parallel supply pipelines that match different operating environments. The findings add to the understanding of the ways in which the two sources of supply network flexibility (Vendor and Sourcing) interact in practice and provide evidence of the ways in which companies can strike balances between these sources, as well as the effects that can be achieved and some of the trade-offs involved.

**Keywords:** Flexibility, Leanness, Agility, Leagility, Supply Chain Management, Fashion.



## 1.0. Introduction

Since the advent of agility (Iacocca Institute, 1991) an academic debate has taken place in order to define it both as a manufacturing paradigm (Gunasekaran, 1999; Yusuf et al., 2003) and as a performance capability (Sharifi & Zhang, 2001; Prince and Kay, 2003), to distinguish it from the lean philosophy (Shah and Ward, 2003; Chase et al., 2004; Narasimhan et al., 2006) and to determine its applicability (Naylor et al., 1999; Vonderembse et al., 2006). In the broader supply chain context, two key concepts are consistently linked to agility: flexibility and speed (Goldman et al., 1995; Yusuf et al., 2003), while lean supply systems are often associated with cost effectiveness and level scheduling (Naylor et al., 1999; Christopher, 2000).

There is little consensus regarding the relationship between agility and flexibility in the literature. Agility, it has been argued, finds its roots in flexible manufacturing systems (Christopher, 2000; Sanchez & Nagi, 2001). Some researchers, however, have suggested that equating agility with flexibility is too narrow an understanding of agility (Goldman et al., 1995; Yusuf et al., 1999). As a result, Swafford et al. (2006) characterise agility as a capability and flexibility as a competence, where capabilities are derived from lower level competencies. Flexibility tends to be used at a lower, more operational level, whereas agility tends to be used at a more encompassing, business wide level (Baker, 2006). This particularly raises issues relating to the fit of a competence with the needs of an organization facing fast-changing demands in the marketplace (Chiang et al., 2012).

The postulation in this paper is that a fundamental difference between lean, agile and leagile supply networks is the fact that they have different requirements for different types and levels of flexibility. As argued by Naylor et al. (1999), agile systems must be flexible, and hence robust to changes or disturbances, whereas lean systems aim to minimize internal and external variation as much as possible, placing more rigid controls on flexibility types. The main objective of this paper is to investigate how different flexibility types, and the degree of flexibility required, relate to different supply chain strategies. This is supported by two aims:

- to add to the understanding of the ways in which different sources of supply network flexibility interact in practice;
- to provide evidence of the ways in which companies can strike various balances between the sources of flexibility employed and the effects that can be achieved.

In addressing these aims, a number of important contributions to the literature are made. Firstly, a framework for supply network flexibility is proposed, that is then used to develop a lean, agile and leagile supply network taxonomy. Two key sources of supply network flexibility are considered: Vendor Flexibility and Sourcing Flexibility. The lean, agile and leagile supply network taxonomy put forward highlights the fact that parallel value streams with different requirements for service levels will have different requirements for different types and levels of flexibility. As a result, different supply network strategies need to be employed. Secondly, we extend the Leagility concept beyond the simple material flow decoupling point concept put forward by Naylor et al. (1999). Two new types of leagility are proposed: Leagile with Vendor Flexibility Systems and Leagile with Sourcing Flexibility Systems. By doing this, the paper integrates the leagility concept with an existing framework for supply chain flexibility. Thirdly, the paper provides practical evidence with regards to the sourcing strategies used and the sources of flexibility employed by UK fashion retailers at supply network level. The literature on supply chain flexibility is still in its infancy, and most of the previous studies of flexibility in the wider context of inter-company collaboration have aimed to build conceptual frameworks and have lacked empirical validation (for a notable exception see Stevenson & Spring, 2009).

The paper is organised as follows. In Section 2 we review the concept of flexibility in relation to the lean, agile and leagile paradigms, drawing mainly on the literature available in the area of manufacturing systems. In Section 3 we summarise the current literature on supply chain flexibility and put forward a conceptual framework for supply network flexibility. Section 4 illustrates how the supply network flexibility framework put forward could be used to extend the concept of leagility. Section 5 presents the methodology and the data collection procedures employed. In Section 6 we present the findings of two primary case studies, highlighting ways in which companies operating in the UK fashion sector strike various

balances between the sources of flexibility employed and the effects achieved. A taxonomy that illustrates how different flexibility types, and the degree of flexibility required, relate to different supply chain strategies is proposed. Finally, in Section 7 we present our conclusions and suggest avenues for further research.

## 2.0. The role of flexibility in lean, agile and leagile systems

Though there is a vast amount of literature available dealing with manufacturing practices and performance in the context of lean and agile strategies, there is considerable confusion over these two paradigms as to their content and any temporal dependencies that there might be in their implementation (Narasimhan et al., 2006). Furthermore, as time has now become a key factor in competitiveness due to customers becoming increasingly reluctant to accept long lead-times for products and services, various authors (Bower & Hout, 1988; Stalk, 1988, Reichhart & Holweg, 2007) argue that the importance of speed and responsiveness in today's industry settings have blurred the boundaries of related concepts, such as agility (Goldman & Nagel, 1993; van Hoek et al., 2001; Yusuf et al., 2004) and lean thinking (Womack & Jones, 1996; Hines et al., 2004).

When discussed as paradigms, authors tend to treat lean manufacturing and agile manufacturing as systems of practices, also containing philosophical values and cultural elements. There also seems to be confusion, when addressing lean and agile manufacturing at paradigmatic level, of '*what*' their underlying values and principles are with '*how*' they should be implemented. Krishnamurthy & Yauch (2007) state that there are 3 general positions with respect to the lean and agile paradigms: those who believe that they are mutually exclusive or distinct concepts that cannot co-exist (Harrison, 1997; Goldsby et al., 2006), those who believe that they are mutually supportive strategies (Naylor et al., 1999; McCullen and Towill, 2001; Gunasekaran et al., 2008) and those who believe that leanness must be a precursor to agility (Hormozi, 2001; Jin-Hai et al., 2003). As such, while both strategies appear to address the same competitive priorities (cost, quality, service, flexibility), they each emphasize different elements (Narasimhan et al., 2006) such that clear dividing lines can be drawn between the two (Gunasekaran et al., 2008). In an attempt to further identify important differences pertaining to the 2 strategies' constituent performance dimensions, Narasimhan et al. (2006) conclude that while the pursuit of agility might presume leanness, in contrast the pursuit of leanness might not presume agility. The authors of the same study also identified that one of the greatest distinction between agile and lean performers appears to be in the flexibility performance dimensions.

From this perspective, Naylor et al. (1999) previously argued that the lean and agile paradigms differ most importantly in their emphasis on flexibility for market responsiveness (see Table 1). The authors noted that agile manufacturing calls for a high level of rapid reconfiguration and will eliminate as much waste as possible but does not emphasise the elimination of all waste as a prerequisite. Lean manufacturing states that all non-value adding activities, or muda, must be eliminated. The supply chain will be as flexible as possible but flexibility is not a prerequisite to be lean (Naylor et al., 1999). As such, out of the seven different criteria used by Naylor et al. (1999) to compare the two paradigms, the 'muda' and 'reconfiguration' characteristics are argued to be similar for both paradigms, while the issue of flexibility leads to the differentiation highlighted by the latter two characteristics, namely 'robustness' and 'smoothing demand'. Agile supply chains must be flexible, and hence robust, to the range of market changes the supply chain is expected to cope with (Stevenson

& Spring, 2007) and will, in fact, exploit this capability to achieve competitive advantage. In contrast, lean systems aim to minimise internal and external variation as much as possible.

| Keyword | Lean | Agile |
|---|---|---|
| **Use of market knowledge** | ❍❍❍ | ❍❍❍ |
| **Virtual Corporation / Value Stream / Integrated Supply Chain** | ❍❍❍ | ❍❍❍ |
| **Lead Time Compression** | ❍❍❍ | ❍❍❍ |
| **Eliminate Muda** | ❍❍❍ | ❍❍ |
| **Rapid Reconfiguration** | ❍❍ | ❍❍❍ |
| **Robustness** | ❍ | ❍❍❍ |
| **Smooth Demand / Level Scheduling** | ❍❍❍ | ❍ |

❍❍❍ = Essential, ❍❍ = Desirable, ❍ = Arbitrary

Table 1. Rating the importance of different characteristics of leanness and agility (Naylor et al., 1999).

The way in which flexibility could be used to distinguish between the lean and agile paradigms is further highlighted in Figure 1 (adapted from Naylor et al., 1999), who refer to the two axes as Demand for Variability in Production and Demand for Variety of Product. In order to directly relate these two variables to the flexibility literature, we explicitly refer to them as Volume Flexibility (the ability to change the level of aggregated output) and Mix Flexibility (the ability to change the range of products made within a given time period, while maintaining the same aggregated output) (see, for example, Slack, 1987). These 2 types of flexibility (mix and volume) are identified by Oke (2005) as 'external flexibility types', as they determine the actual or perceived performance of the company and are viewed externally by customers, as opposed to those flexibility types internal to the system, that describe system behaviour (internal flexibility).

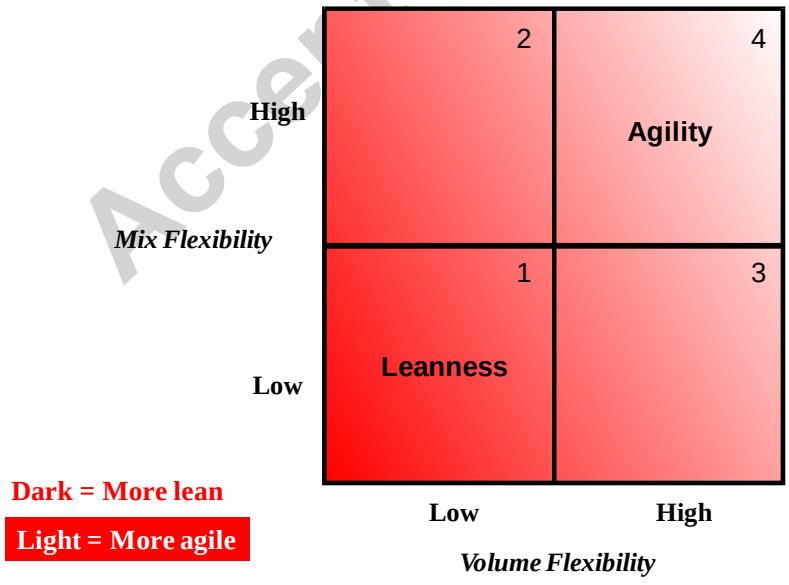


Figure 1. Satisfying demand through Mix Flexibility and Volume Flexibility (adapted from Naylor et al., 1999).

While the figure has four quadrants, Naylor et al. (1999) highlighted that the shading is a more important consideration. The darker areas in Figure 1 tend towards leanness and the lighter areas to agility. The dominant factor is whether there is a need for volume flexibility, hence where there is clear differentiation between agility and leanness. As can be seen from the degree of shading in the y-axis, lean systems may cope with a fairly high degree of mix flexibility, allowing for variability in product variety, but volume flexibility is low. In contrast, agile systems may cope with both volume and mix flexibility.

On this basis, it can be concluded that a *lean manufacturer* who, based on the definitions highlighted above, operates under stable demand conditions (low volume flexibility requirements) can exhibit either low levels of both mix and volume flexibility – Quadrant 1 in Figure 1 (for example a highly efficient, single product mass producer dealing with limited demand variability) - or low levels of volume flexibility but high levels of mix flexibility (aided by practices such as quick changeover and level scheduling) – Quadrant 2. On the other side, an *agile manufacturer*, faced with high levels of demand uncertainty, can exhibit either low levels of mix flexibility but high levels of volume flexibility – Quadrant 3 - or high levels of both mix and volume flexibility -Quadrant 4, depending on their product mix.

Naylor et al. (1999) further highlighted how the best of both worlds could be achieved by the prudent integration of the two concepts in order to develop what they ultimately decided to call 'leagility'. Using a personal computer supply chain as an example, the concepts of decoupling and postponement were utilised as means through which the two different strategies could be combined. The processes upstream of the decoupling point were characterised as lean and those downstream as agile. The general applicability of the concept was illustrated by making reference to generic strategic models of supply chains such as make-to-order, make-to-stock and assemble-to-order.

A form of flexibility not directly considered by Naylor et al. (1999) in their paper is that associated with switching between suppliers. Naylor et al. (1999) addressed the issue of supply chain and virtual enterprises by simply referring to the fact that both the lean and agile paradigms gave due consideration of the extended enterprise. However, Pires et al. (2001), building on the research of Christopher & Towill (2000) among others, clearly distinguished between lean supply chains and agile virtual enterprises. The former establish long term partnership relationships between dyads while the latter creates a temporary network of organisations that can be reorganised quickly with low cost penalties.

As such, while acknowledging that both leanness and agility are larger encompassing concepts than flexibility alone, this section has illustrated that the concept of flexibility is important in distinguishing between lean and agile strategies. We aim to highlight in the following sections how flexibility could be used for establishing supply network taxonomies.

## 3.0. Supply network flexibility

Flexibility is generally perceived as an adaptive response to environmental uncertainty (Gerwin, 1993). More specifically, it is a reflection of the ability of a system to change or react with little penalty in time, effort, cost or performance (Crowe, 1992; Upton, 1994; Morlok & Chang, 2004). Hence, flexibility may be seen as a proactive attribute designed into a system, rather than a reactive behaviour that may in fact result in a detriment to time, effort, cost and performance (Naim et al., 2006). Slack (1987, 2005) defines flexibility as the

capacity to adapt across two dimensions: range and response. Range flexibility refers to the states or behaviours a system can achieve, whereas response refers to the ease of changing from one state to another, often expressed in terms of cost or time (Naim et al., 2006). Lummus et al. (2003) contend that supply chain flexibility refers to the promptness of a supply chain in responding to customer demand and the degree to which it can adjust its speed, destinations and volume in response to various market changes.

Furthermore, Oke (2005) suggests that models for supply system flexibility should distinguish between two different elements: those internal to the system, that describe system behaviour (internal flexibility) and those that are viewed externally by customers, which determine the actual or perceived performance of the company (external flexibility). In this context, Naim et al. (2006) define five different external flexibility types: *new product* (the range of, and ability to accommodate the production of new products), *mix* (the range and ability to change the products currently being produced), *volume* (the range of, and ability to accommodate changes in production output), *delivery* (the range of, and ability to change delivery dates) and *access* (the ability to provide extensive distribution coverage).With regard to internal sources of flexibility, early studies of flexibility focused on the value of flexible manufacturing systems, establishing the importance of flexibility as a manufacturing capability and attempting to define it (Collins & Schmenner, 1993; Gerwin, 1993; Upton, 1994; Slack, 2005). This has been followed by a number of papers seeking to establish more detailed definitions of flexibility types and dimensions (Koste & Malhotra, 1999; D'Souza & Williams, 2000; Vokurka & O'Leary-Kelly, 2000; Zhang et al., 2003; Koste et al., 2004; Oke, 2005).

More recently, the flexibility debate has refocused towards supply chain flexibility, suggesting that manufacturing is too narrow in its scope and that flexibility must be conceived in the broader context of the supply chain (Vickery et al., 1999; Duclos et al., 2003; Pujawan, 2004; Sanchez & Perez, 2005; Swafford et al., 2006; Stevenson & Spring, 2007). Firms are now beginning to look towards their supply chain partners as additional sources of flexibility that can further enhance the performance of their existing internal flexibility capabilities (Swaminathan, 2001). However, the supply chain flexibility field is still at an early stage, and consensus regarding definitions, scope, meaning and application has not yet been achieved. De Toni and Tonchia (1998), Bernardes and Hanna (2009), Malhotra and Mackelprang (2012), for example, argue that the lack of research treating supply chain flexibility as an entire system could be due to weak conceptual foundations detailing what exactly should be included in the systems view of supply chain flexibility, but also how it should be measured. The difficulty of quantifying flexibility has also been highlighted earlier by authors such as Slack (1983 ), Parnaby (1987) and Stevenson and Spring (2007), the former arguing against attempts to develop a single measure for flexibility.

Based on the limited amount of literature available on flexibility of supply systems, we rationalise supply network flexibility as comprising of two key concepts: *Vendor Flexibility* and *Sourcing Flexibility*. Vendor Flexibility refers to the flexibility related to individual vendors within the supply system, while Sourcing Flexibility refers to the ability of the system's coordinator to reconfigure a supply chain network through selection and de-selection of vendors (Duclos, 2003; Gosain et al., 2005), enabling the supply system to adapt to market requirements (Vickery et al., 1999; Swafford et al., 2008).

### *3.1. Vendor flexibility*

By *Vendor Flexibility* we refer to the flexibility of the individual vendors within the supply network, which may be manufacturing, warehousing or freight transportation, with each node having its own internal flexibility capabilities (Gosling et al, 2010). Gosain et al. (2005) refer to this capability as 'offering flexibility', or the ability of a supply chain linkage to support changes in product or service offering in response to changes in the business environment. The plethora of research in this area, mainly focusing on manufacturing flexibility, has resulted in many perspectives but also some ambiguity as terminology changes, although the fundamental ideas are the same (Naim et al., 2006). In a review of empirical research on manufacturing flexibility, Vokurka & O'Leary-Kelly (2000) highlighted 15 dimensions of manufacturing flexibility, while Petkova & van Wezel (2006) identified at least 49 different manufacturing flexibility types, with 141 definitions linked to the identified terms. Other authors have focused on inventory (Griffiths & Margetts, 2000; Hines, 1998; Hoekestra & Romme, 1992), warehousing (Abrahamsson et al., 2003; Baker, 2006; Zhang et al., 2005) and transport flexibility (Naim et al., 2006) as potential sources of flexibility within a supply system.

### *3.2. Sourcing flexibility*

Over the last two decades, research on supply chain management has focused on a debate regarding the need for closer relationships between customers, suppliers and other relevant parties, in the search for competitive advantage (Dwyer et al., 1987; Lamming, 1993; Kanter, 1994; Handfield & Bechtel, 2002).Within this context, lean has emphasised the need to create supplier partnerships, reduce the number of suppliers, transfer of responsibilities upstream in the supply chain and empowerment (Sako et al., 1995; Rich & Hines, 1997; Ikeda, 2000). However, changing market conditions and higher levels of uncertainty have increased the need for organisations to become more agile and responsive to the needs of customers and, as a result, a common thread of the literature in the area of agility has been the focus on being able to compete within a state of dynamic and continuous change (Childerhouse & Towill, 2000; Lee, 2004). In this context, Swafford et al. (2006) highlighted the fact that defining the flexibility of a supply network as the flexibility of its individual nodes primarily focuses on the existing supply chain structure and reflects a narrow view of supply chain flexibility, which is consistent with the idea of rigid flexibility (Collins & Schmenner, 1993) and the concept of robust networks (Ferdows, 1997). By contrast, *Sourcing Flexibility* reflects the fact that the main source of a supply network's flexibility might not be a particular vendor's responsiveness capability, but the leading firm's ability to coordinate the entire supply chain and redesign the network quickly and at low cost (Tachizawa & Thomsen, 2007).

In this case, flexible sourcing involves the adoption of a larger supplier base and constantly redesigning and reconfiguring the supply chain, also known as adaptability (Easton & Rothschild, 1987). Gosain et al. (2005) refer to sourcing flexibility as the ease of changing supply chain partners in response to changes in the business environment, while Mello (2001) views supply chain flexibility as the ability to restructure the system quickly and inexpensively. Gereffi (1994), Lee (2002), Chung et al. (2004), Christopher et al. (2005), Masson et al. (2007) argue that in environments with high levels of uncertainty companies may need to develop multiple supply bases so that backup supply sources are available, allowing for greater organisational flexibility. In the fashion sector, for example, Christopher et al. (2005), highlights that retailers have to display similar behaviour to that of the director of a theatre play. They work with a team of actors closely for a while but the team will be

disbanded and a new one assembled for the next play. As such, once re- configured, the level of network flexibility achieved depends on the ability of the leading firm to coordinate and integrate the entire team (Lee, 2004; Lummus et al., 2005). As a result, the risks associated with high levels of uncertainty are shared across the chain (Das & Abdel-Malik, 2003). Ultimately, flexible sourcing has the potential to influence a firm's flexibility in responding to market demands (Narasimhan & Das, 2000).

### *3.3. Flexibility as a determinant for the design of more effective supply networks*

Summarising the vendor and sourcing flexibility concepts introduced above, we suggest in Figure 2 a framework for supply network flexibility (adapted from Gosling et al., 2010). The framework distinguishes between two sources of flexibility: the flexibility of individual nodes within the system (*Vendor Flexibility*) and/or the ability of the focal firm to re-design (re-configure) and manage (coordinate) the supply chain (*Sourcing Flexibility*). As such, the framework acknowledges the fact that internal capabilities of individual nodes within the chain are a necessary but may not always be a sufficient condition for achieving supply chain flexibility and that the external supply network will also have a significant effect (Fisher, 1997). Squire et al. (2009) acknowledge that this perspective clearly resonates with recent theorising within the resource-based view (RBV) of the firm, where both internal and external capabilities are important to performance.

We further aim to explore how the proposed framework for supply network flexibility (Figure 2) could be used to guide the adoption of different supply chain management strategies, based on different combinations of Vendor and Sourcing Flexibility. Of the five external flexibilities suggested previously (new product, mix, volume, delivery and access) this paper will focus on the two that clearly distinguish between leanness and agility, namely mix and volume flexibility (Naylor et al., 1999).

Nevertheless, there is a lack of studies that depict how *Sourcing* and *Vendor Flexibility* practices combine to increase the overall flexibility of a supply system and the lean, agile and leagile conditions that could support the adoption of *Sourcing Flexibility* vis-a-vis *Vendor Flexibility*. As such, this present research aims to narrow this gap. Primary case studies will be presented further in order to explore the adoption of these practices and the ways in which their implementation can facilitate the design of more effective supply networks.

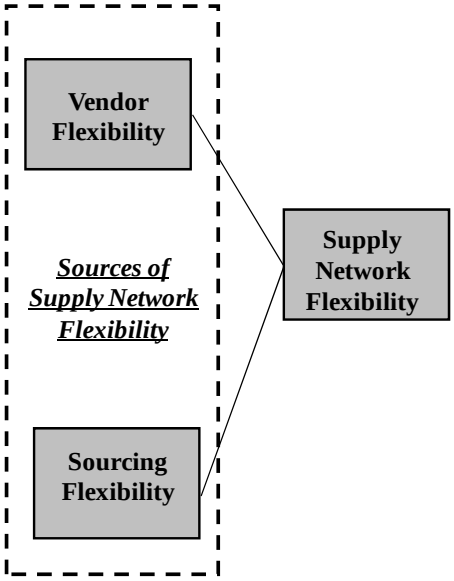


Figure 2. Supply Network Flexibility Framework (adapted from Gosling et al., 2010)

## 4.0. Extending the leagility concept

As discussed in Section 2, the leagility concept originally developed by Naylor et al. (1999) aimed to leverage synergies in both leanness and agility, and hence their inherent flexibilities, through their decoupling via strategic use of stock in the product delivery process, specifically in a manufacturing context. The definitions of lean, agile and leagile paradigms developed by Naylor et al. (1999) have been exploited by many authors and well over 200 citations exist, but for recent examples, see Agarwal et al., 2006, da Silveira et al. (2006), Faisal et al. (2006), Goldsby et al. (2006), Narasimhan et al. (2006), Soni & Kodali (2009), Huang & Li (2010), Rahimnia & Moghadasian (2010), Shukla & Wan (2010), Lu et al. (2011). Other studies, such as those by Herer et al. (2002), Krishnamurthy & Yauch (2007), Towill & Christopher (2002), Vonderembse et al. (2006), Wikner and Rudberg (2005) have extended leagility beyond the material flow decoupling concept by virtue of its exploitation in new contexts.

Furthermore, Towill & Christopher (2002), in a conceptual paper supported by secondary case studies, show how the lean and agility strategies can be combined to create business wide leagility either via parallel processes at the same time or in the same process at different times.

Herer et al. (2002) examined the role of transhipments in achieving leagility. They noted that in situations where it is difficult to achieve cross-functional integration, with production, product design and logistics working together, then leagility via postponement is not viable. They concluded that the use of transhipments is an immediate and low cost way to achieve leagility when compared to supply chain re-engineering programmes that require modifications in process and products.

Wikner and Rudberg (2005) exploit leagility outside of a production context, showing the application of leagility in an engineering environment. Lean and agile processes may be decoupled by distinguishing between engineer-to-order, where a new product is designed and

engineered to a specific order, and engineer-to-stock, wherein a product is designed before an actual order is received.

Vonderembse et al. (2006), through empirical case studies and by relating leagility to the seminal work by Fisher (1997), take due consideration of product type and product life cycle. They show that a standard product may benefit from the adoption of a lean supply chain throughout its life cycle, while an innovative product could benefit from adoption of an agile supply chain during the introduction and infancy stages and a leagile or lean supply chain during maturity and decline. Finally, a hybrid, complex product that has several to many components, which may be a mixture of standard and innovative products (e.g. as automobiles), could be supported by leagile supply chains for all four stages of the lifecycle.

Krishnamurthy and Yauch (2007) take a corporate perspective of leagility to show that the decoupling point is not merely limited to the physical flow of products but may be positioned between a "Sales and Services" department (agile and market focussed) and a "Production" department (lean and production focussed).

Naim and Gosling (2011), in a review 63 papers covering a decade of research on leagility since its inception in 1999, highlight the extension of the leagility concept to include not just the use of the decoupling point, which raises the possibility that there are different leagility 'types'. They postulate various alternative forms of concurrent and / or sequential lean and agile processes.

Having seen the exploitation and extension of the concept of leagility as first demonstrated by Naylor et al. (1999), the findings of the two case studies presented below will highlight that, within the context of supply networks, two other forms of leagility could be considered: *Leagile with Vendor Flexibility* Systems, which combine the use of agile vendors with lean sourcing systems and *Leagile with Sourcing Flexibility* Systems, which combine the use of lean vendors with agile sourcing practices. These strategies will be investigated further in the following sections.

## 5.0. Methodology

Our work aims to propose new theory in the area of operations and supply chain management strategy by further building on and developing existing theory on supply network flexibility. Sections 2, 3 and 4 have summarised some of the relevant literature in order to clearly position our current contribution. To explore the adoption of the practices captured in Figure 2, two case studies of UK based specialist fashion retailers were conducted. The case study is a well-recognised methodology for exploring areas where theory is still developing (Yin, 2003), such as that of flexibility of supply networks. The UK fashion sector was chosen as the focus for this research due to its high levels of demand volatility and short product life cycles, which require the adoption of highly flexible sourcing strategies.

An abductive research process is used, similar to that suggested by Kovács & Spens (2005). The abductive approach stems from the insight that most great advances in science neither followed the pattern of pure deduction nor of pure induction (Taylor et al., 2002). Abductive reasoning emphasizes the search for suitable theories to an empirical observation, which Dubois & Gadde (2002) call 'theory matching', or 'systematic combining'. This search starts in an attempt to find a new matching framework or to extend the theory used prior to this

observation (Andreewsky & Bourcier, 2000). The aim of this process is to understand the new phenomenon (Alvesson & Sköldberg, 2000) and to suggest new theory (Kirkeby, 1990).

The abductive reasoning process includes Stages 1 and 2 of the new knowledge generation model suggested by Kovács & Spens (2005), as shown in Figure 3. In the research presented in our paper, Stage 1 begins with some prior theoretical knowledge with regards to the flexibility of supply networks and its two main components: Vendor and Sourcing Flexibility. In Stage 2 real life observations via case studies are then used to explore how the two-sided approach captured in the proposed framework for supply network flexibility could lead to the adoption of different supply chain management strategies through different combinations of Vendor and Sourcing Flexibility. The emerging theory is a taxonomy that dynamically matches Vendor and Sourcing Flexibility for Lean, Agile and Leagile supply network strategies, as will be presented in Section 6. Further research employing a deductive process will be required in order to test the new theory proposed and assess its generalisability, but this is beyond the scope of this paper. While statistical generalisation of research findings is the standard ideal in positivist research, this is not of main concern for the more qualitative case study based approaches (Aastrup & Halldorson, 2008; Barratt et al., 2010).

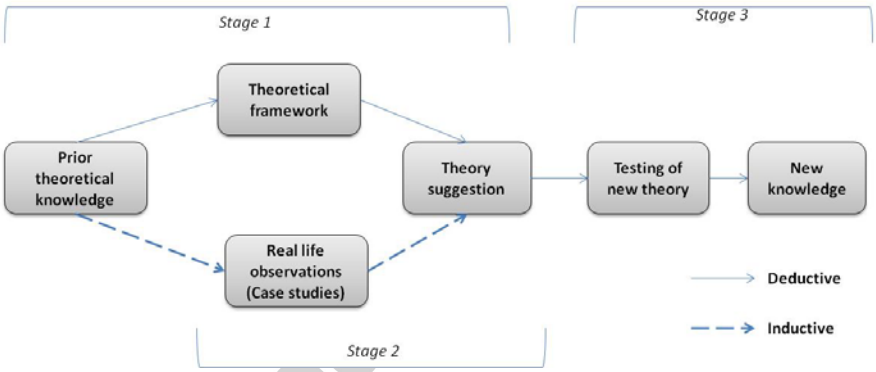


Figure 3. The abductive reasoning process (adapted from Kovács & Spens, 2005)

The authors ensured that the research presented in this article satisfies the three criteria for evaluating case study research quality, acknowledging the contextual data of the phenomenon (Halldorsson & Aastrup, 2003), namely:

1. Truth-value – appreciating there is no single version of reality and that researchers have predefined concepts that they bring into any approach and analysis. The research presented in this paper was undertaken by three academics, each with their own methodological and disciplinary backgrounds from engineering and business management. Eisenhardt (1989) suggested that the use of multiple investigators leads to a better ability to handle the richness of the contextual data and more confidence in research findings. To ensure truth-value, the research findings presented and the resulting taxonomy have been developed jointly and description of the data analysis process is provided (e.i. categorisation, within and between case analysis, etc.).
2. Transferability and contextualism – recognising that the research is context specific and that immediate generalisability is not possible. Authors such as Yin (2003) and Seuring (2008) argue that transferability of case-study findings can be facilitated by documenting the underlying theoretical aim of the study, unit of analysis, justification

of case selection and number of case studies used. Rich context descriptions were also given in our paper, allowing the reader to analyse (dis)similarities to other contexts.

3. Trackability and explicity – relate to the documentation of the research process and the data sources used. Our paper aims to ensure sufficient data and information is made available to the reader, to be able to replicate the research. With due consideration of truth-value and transferability, we provide explanations as to the development of the taxonomy and the evaluation of the case studies conducted with also as much detail as possible with regards to description of the data collection / analysis techniques used. Readers are invited to contact the lead author if further explanation and/or original data, subject to case company confidentiality, is required.

Case selection

Euromonitor (2005) classifies the distribution channels for clothing in the UK into *specialist* (covering independent clothing retailers and clothing multiples) and *non-specialist* (variety stores, department stores, sports shops, hyper- and super-markets, home shopping companies, street markets and other). Based on reports published by Mintel (2007), the structure of clothing retailing in the UK is one of the most concentrated in the world, with specialist clothing retailers accounting for 68% of the market share. However, independent specialist stores have a share of only 14%, which means that the market is dominated by strong clothing multiples. Recent data also suggests that clothing multiples have been remarkably robust through the recent economic downturn and have actually gained share of all non-food retail sales (Mintel / Office for National Statistics, 2010) while registering a sharp drop in average prices (Office for National Statistics, 2011). Their ability to supply versions of the latest catwalk styles at affordable prices and within the shortest possible lead times is seen as an important point of differentiation that they have in the marketplace (Mintel, 2003).

A purposive sampling strategy was used to select the case studies for the purpose of this research and the top 10 leading UK specialist clothing multiples in terms of market share were initially approached thorough email. Three of them replied, but one expressed great concerns in terms of time availability for this research and was used as a pilot case study. The remaining two retailers were used as main case studies, which will be presented in the following section. Their product offering ranged from functional, low fashion content items with long life cycles and predictable demand to high fashion items with a shelf life of up to 6 weeks and a very volatile demand. The retailers managed an extensive global network of garment manufacturers, textile producers, textile finishers and printers, trim manufacturers, carriers and brokers.

The major rationale for selecting the two case studies was to gain insight into the sourcing strategies used and the sources of flexibility employed by fashion retailers at supply network level. Each case consisted of interviews with managers directly involved in supply chain management decisions, supported by documentary evidence. In total, 12 semi-structured interviews were conducted, totalling over 30 hours. Data was further collected through observations and site visits, an industrial workshop and consultation of key documentation and publications related to the two fashion retailers' supply networks.

Initially, the products offered by the two retailers under study were grouped based on their shelf life: long (12-18 months), medium (average of 6 months) and short (3-6 weeks), and the value streams employed for their sourcing were identified and will be presented below as Scenario 1 (for long shelf life, low fashion content items), Scenarios 2 and 3 (for medium shelf life items) and Scenario 4 (for short shelf-life, high fashion items). Scenarios 2 and 3

distinguish between the employment of local UK based sources of supply (a value stream only used by retailer A) and global sources of supply (a scenario used by both retailers interviewed). These four different scenarios cover all products that were offered by the two retailers that participated in this research. Within these four different scenarios, the level of flexibility (both volume and mix) that the retailers required their suppliers to exhibit, as well as the level of sourcing flexibility employed were explored.

The source of qualitative data collected was considerably rich, yielding 200 pages of transcripts from the 30 hours of interviews and further secondary data collection. In supporting the allocation of products to one of the four scenarios, the case study results include example quotes from interviewees.

### *5.1. Rankings*

As depicted in Figure 2, evidence from the two retailers for the adoption of the two sets of supply network flexibility practices was sought. In order to do so, Vendor and Sourcing Flexibility were sought to be classified for different value streams as displaying propensity for either Leanness or Agility (see Table 2).

#### *5.1.1. Assessing Vendors' Mix and Volume Flexibility*

For Vendor Flexibility, the level of Mix and Volume flexibility that the retailers required their suppliers to be able to accommodate was explored, as these were identified in the literature as the two dominant factors used to distinguish between lean and agile manufacturing (Naylor et al., 1999). *Volume Flexibility* is defined here as the ability to change the level of aggregated output (Slack, 1987). It allows the firm to adjust production upwards or downwards within wide limits (Jack & Raturi, 2002). *Mix Flexibility* is defined as the ability to change the range of products made within a given time period (Slack, 1987), while maintaining the same aggregated output.

The level of Mix Flexibility was explored based on the number of different design/size/colour combinations (also referred in the industry as stock keeping units (SKUs) which were required by the retailer for each product range each season. Typically, fashion retailers offer 5 different SKUs per product range, corresponding to 5 different size offerings (8, 10, 12, 14, and 16). As such, if the retailer interviewed also offered variations in colour, design, etc. as well as variations in size (leading to a product range greater than 5SKUs), the required level of mix flexibility from its suppliers along these pipelines was ranked as *High*. If 5 or less SKUs per product range were reported, mix flexibility was ranked as *Low*.

Volume Flexibility was explored based on the retailer requiring their suppliers to be able to ramp production up or down, with the ability to significantly (>±25%) increase (or decrease) output levels as a result of fluctuations in demand being deemed as *High.* If less than 25% variations were required, volume flexibility was ranked *Low*. These rankings are based on the work of Jack & Raturi (2002).

Based on the work of Naylor et al. (1999), which was introduced in an earlier section of this article, Mix and Volume Flexibility were then used to categorise suppliers as either displaying a propensity for being Lean or Agile. For example if the vendor exhibited high levels of Mix Flexibility but low levels of Volume Flexibility (positioning them in the dark shaded, top left quadrant (2) of Figure 1), the suppliers would be categorised as displaying a propensity for being Lean (summarised as Lean in Table 2).

*5.1.2. Assessing Sourcing Flexibility*

*Sourcing Flexibility*, or the ability of the supply network to rapidly reorganise and find alternative suppliers (Sanchez & Perez, 2005) was rated using the work of Pires et al. (2001) and Christopher et al. (2005), who use sourcing flexibility to distinguish between lean supply chains and agile virtual enterprises. In lean supply chains long term partnership relationships between dyads are established and, as such, the level of reconfiguration and sourcing flexibility exhibited is expected to be low, while in agile supply chains a temporary network of organisations can be reorganised quickly (Christopher et al., 2005) and, as such, high levels of sourcing flexibility should be expected. If the case companies reported redesigning their supply base (sourcing flexibility) along individual pipelines, changing the majority of their strategic suppliers from one season to another as a result of new manufacturing capability requirements, these pipelines would be ranked as having *High* levels of sourcing flexibility and, hence, displaying a propensity for being Agile. If the majority of the strategic supply base would not reconfigure from one season to another, the pipeline would be classed as exhibiting Low levels of sourcing flexibility, hence a propensity for Lean. Again, we acknowledge here that flexibility should be seen as one of a broader series of competences directly (or inversely) correlated with lean and agile systems.

These scores were then used to categorise the supply strategy employed by retailers along parallel pipelines as either Lean, Agile or Leagile.

## 6.0. Case Studies

*Scenario 1: Lean Networks*

Both retailers' offerings included a low fashion, 'functional' range (e.i. white cotton vests, black socks), which had a long life cycle (ranging from 12 to 18 months) and a predictable demand pattern. The design alterations were rare from one season to another and the product range was limited (up to 5 SKUs per range). They were selling in large volumes, with small unit profit margins.

> *"It is more appropriate for basics, these long lead-time things that you can actually place them far out, book fabric cheaply and it's usually a volume margin thing" (Retailer B).*

Demand was relatively easy to forecast based on previous sales data, and volume adjustments would rarely be required and would not exceed increases or decreases higher than 10%. This enabled sourcing to be committed up to one year in advance, and the search for low labour costs meant that global suppliers were always used, mostly located in the Far East, where close proximity among garment manufacturers, fabric suppliers and logistics providers was also an advantage. The high volumes and stable, predictable nature of demand, with long product life cycles, enabled economies of scale and this facilitated the development of stable and ongoing partnerships between the retailer and its suppliers.

> *"It is like we're internal consultants for any issues that might come up. We don't just say, for example, 'we're not working with you anymore' if problems occur" (Retailer A).*

This type of pipeline exhibits the characteristics of Lean Supply Systems (see Table 2). In these systems vendors with a propensity for being lean, which were not required to exhibit

either volume flexibility or mix flexibility, and a stable, lean supply system, where *Sourcing Flexibility* was low, were employed.

*Scenario 2: 'Leagile with Vendor Flexibility' Networks*
The retailers' knitwear ranges had a higher fashion content, with product life cycles averaging 6 months, after which the lines would be discontinued and any left-over stock would be marked down, incurring significant losses. These could be technically complex products which, in an effort to minimise waste and increase the design content, were woven in one piece by a UK based, capital intensive garment manufacturer for Retailer A. Newly developed products were first tested by sourcing small trial quantities from this quick response local supplier, with which the retailer had a long-term partnership in place. If the market trial proved successful, the product would be offered across the retailer's stores chain.

> *"…within 21 days we had garments made and in the stores. And that was for fashion knitwear, which, going back 5 years ago, we couldn't even repeat within a season" (Retailer A).*

Demand for these products was continually monitored and daily analysis of point-of-sale data allowed the retailer to identify quickly changes in the demand pattern. To minimise the risk of obsolescence, frequent orders would be placed and small volume frequent deliveries would be expected. This required a high level of volume flexibility from the garment supplier, who had to accommodate demand variations from the retailer ranging from completely cancelling orders (-100%) to increases of up to 300% for products that proved very popular. The product range for these items would also be much wider, with as much as 30SKUs per range being offered.

In this type of network, the typical buyer-supplier relationship that is too often motivated by opportunism in the fashion industry (Fernie & Azuma, 2004) had transformed into a more collaborative partnership. In this Quick Response partnership, the retailer's objective was to develop the supplier's business. The benefit to the vendor was the fact that they were treated as a preferred supplier. Cost benefits were being achieved through greater sharing of information and integrated logistics systems.

Based on Table 2, this pipeline is categorised as a Leagile with Vendor Flexibility System, in which vendors with a propensity for being agile (which were required to exhibit both high volume flexibility and high mix flexibility) and stable, lean networks, with low *Sourcing Flexibility*, were combined to achieve an adequate response to the market place.

*Scenario 3: Leagile with Sourcing Flexibility Networks*
The remainder of the two retailers' *non-basic range* was mainly made up, for both retailers interviewed, of woven products, the manufacturing of which was a much more labour intensive process. A decision on the raw material (fabric) used for these products was made, on average, six months before each season would be due to start, once information from designers, fashion shows and trend analysts would be gathered. The six month design cycle was dictated by the long lead times imposed by the fabric suppliers. These were the 'mid-fashion' items, designed based on forecasts generated from previous sales data and information received from trend analysts.

With an increasing number of new products introduced each season and reduced volumes per stock-keeping-unit, the pool of skills required for clothing manufacturing was becoming

increasingly complex, calling for a larger network of suppliers every season. And due to the high UK labour costs, combined with reduced local capacity availability, the supply networks used were almost exclusively global in nature. The suppliers used were characterised by high labour intensity, small average plant size and relatively unsophisticated technology used.

In order to reduce the complexities associated with global sourcing and the continuous need to restructure the supply network, we found that the common norm for sourcing these 'mid-fashion' items was to make use of third party indirect sourcing import/export agencies, so called intermediaries (Masson et al., 2007) or trading agents (MacCarthy and Jayarathne, 2013). Many of these were agents in the broadest sense, with no manufacturing, logistic resources or assets, but with a wide knowledge of the local supplier base. If and when the retailers' initial market trial seemed to indicate a market existed, the order for the new product in the relatively small quantities would be placed with their sourcing intermediaries. The intermediaries would then organise competitive auctions for garment manufacturing.

> *"We might have 30 auctions in one month, all coming in at different times. Different decisions in different days. Buying is really strong time management, juggling agents and looking at critical paths" (Retailer B).*

However, the final design of the product would not be decided on till much closer to the season, which meant that the retailers had positioned the fabric and pre-booked capacity with the garment manufacturers, but still allowed for a high level of customisation in terms of the number of different product combinations. Up to 30 SKUs would be offered per each product range, which rendered Mix Flexibility requirements to be high.

Due to long delivery times, incurred mainly due to the employment of sea transportation, and in an effort to cut down costs, large volumes of one-off deliveries would be placed, with little volume variations (5%) required, which meant that the level of volume flexibility required from the garment manufacturers was low.

In these networks, establishing long-term partnerships with a small number of more flexible garment suppliers was perceived as likely to reduce the retailers' market-orientation capabilities to flexibly and responsively cater for a diverse, fast moving fashion market. It was, indeed, too risky to trade off the variety with a streamlined (lean) yet less flexible supply chain (Fernie & Azuma, 2004).

These networks are categorised as Leagile with Sourcing Flexibility Systems (see Table 2). In these systems, suppliers with a propensity to be lean, which were required to exhibit high mix flexibility but low volume flexibility, and a highly re-configurable, agile supply network (*High Sourcing Flexibility*) were employed.

*Scenario 4: Agile Networks*

The retailers' seasonal product range offer would also have to allow for quick new product introductions designed as a response to shifts in popular culture expected to occur anytime from anywhere and creating significant demand for a fashion style or trend. For these '*high-fashion'* items with very short shelf lives (averaging 3 to 6 weeks), forecasts were impossible to be made. As a result, the two retailers had to be extremely agile in capturing emerging trends, designing new products once the new season has already started and quickly bringing them to the market. As such, lead-time reduction for high fashion products was key to the

fashion retailers' success. For these items, a Buy-to-Order strategy was employed, using fabrics designed to stock on a speculative basis by partner textile producers.

Even for these items, with a much shorter shelf life, the retailers preferred global sourcing to local producers. Some of the reasons quoted for this were the lack of skilled manufacturers in the UK, the reduced local availability of fabrics and trims, high labour costs and very limited capacity still available. Eastern Europe and North Africa were the preferred sources of supply for these items, mainly due to their proximity to the UK market and hence short delivery lead times.

To minimise the risk of obsolescence, small volume deliveries were required on a frequent basis and this required high levels of both volume and mix flexibility from the manufacturers (see Table 2). The low wage rates enabled the suppliers to afford additional capacity at very short notice. The same sourcing practice of auctioning out production through trade intermediaries was used, allowing for the quick redesign of the supply chain on an ad-hoc basis. The intermediaries' strategy of not owning any production facilities kept the supply chain flexible and adaptable, encouraging the constant search for flexible, quality-conscious and cost-effective producers.

> *"We have contractors that would manage the whole thing for us, from knitting the yarns, assemble, source trims, subcontract embroidery. We get the most flexibility with them" (Retailer A).*

> *"If something new comes along we can say to our agents 'we're looking for this'. They might also need in their turn another supplier. And then the suppliers that are out there manage all of those suppliers" (Retailer B).*

We categorise these pipelines as Agile Supply Systems, in which vendors with a propensity for being agile, which were required to exhibit both high volume and high mix flexibility, and agile supply networks with high *Sourcing Flexibility* were combined to achieve a quick response to the market place.

| Pipeline Type | Vendor Flexibility | | Sourcing Flexibility | Supply System Strategy | Customer Sensitivity (Responsiveness) |
|---|---|---|---|---|---|
| | Mix Flexibility | Volume Flexibility | | | |
| **Scenario 1** | Low (max 5SKUs/range) | Low (+/-10%) | Low | **LEAN** | LOW (12 -18 months) |
| | **LEAN** | | **LEAN** | | |
| **Scenario 2** | High (5-30SKUs/range) | High (-100%;+300%) | Low | **LEAGILE with VENDOR FLEXIBILITY** | MEDIUM (6 months) |
| | **AGILE** | | **LEAN** | | |
| **Scenario 3** | High (5-30SKUs/range) | Low (+/-5%) | High | **LEAGILE with SOURCING FLEXIBILITY** | MEDIUM (6 months) |
| | **LEAN** | | **AGILE** | | |
| **Scenario 4** | High (5-30SKUs/range) | High (-100%;+25%) | High | **AGILE** | HIGH (3-6 weeks) |
| | **AGILE** | | **AGILE** | | |

Table 2. A lean, agile and leagile supply network taxonomy

Based on Table 2, the different applications of agility, leanness and the two types of Leagility with reference to Vendor and Sourcing Flexibility, as highlighted in the two cases presented, is summarised in Figure 4 below.

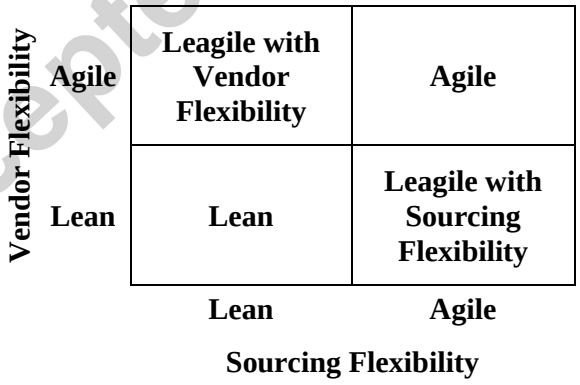


Figure 4. Dynamic matching of *Vendor Flexibility* with *Sourcing Flexibility* for Lean, Agile and Leagile supply network strategies

A summary of the four different SCM strategies employed is presented below:

- *Lean Supply Systems*: Functional items, with long shelf lives (12 to 18 months) required lean sourcing practices and vendors with a propensity for being lean. This has led to the design of lean supply chain strategies focused on efficiency.

- *Leagile with Vendor Flexibility Systems* employed for the sourcing of knitted items in the UK by Retailer A required the adoption of lean sourcing practices and vendors with a propensity for agility in order to achieve a medium term (6 months) level of responsiveness.
- *Leagile with Sourcing Flexibility Systems* employed for the sourcing of mid-fashion, woven items, required agile sourcing practices and vendors with a propensity for leanness. A medium response (6 months), in terms of the time horizon affected, was achieved through the implementation of this strategy.
- *Agile Supply Systems*: Due to the unstable nature of market demand and non-standard nature of the high-fashion items, an agile strategy was employed for items that required short term responsiveness (3 to 6 weeks). In this situation, both agile sourcing practices and vendors with a propensity for agility were necessary in order to achieve a high level of speed to market.

## 7.0. Conclusions

Though both leanness and agility are broader encompassing concepts than flexibility alone (see, for example, Lamming, 1993; Reichhart & Holweg, 2007), our paper argues, based on the work of Naylor et al. (1999), that flexibility, when seen as a performance capability, can be used to distinguish between lean, agile and leagile supply systems. The supply network flexibility framework introduced in Figure 2 rationalises the flexibility of a supply network by considering two sources: *Vendor Flexibility* and *Sourcing Flexibility*. Using this framework, we have shown that parallel value streams with different requirements for service levels may have different requirements for different types and levels of flexibility and, as a result, different supply network strategies will need to be employed, with different levels of customer sensitivity achieved. A new taxonomy that dynamically links Vendor and Sourcing Flexibility with Lean, Agile and Leagile supply network strategies is proposed as a result (Figure 4).

More specifically, for companies to be successful in their current markets, which increasingly require a high level of customised response to the different needs of different customers, our research further confirms that developing 'one size fits all' supply chain solutions is no longer viable. As a result, we suggest that the model proposed in Figure 4 can be used as a guideline for designing and managing parallel supply pipelines which match different operating environments, as suggested by Fisher (1997), Towill & Christopher (2002) and Vonderembse et al (2006). By 'pipelines' we refer to smooth, well defined passages through the supply network enabling undisrupted movement, therefore requiring some form of design by the supply chain members (Mason-Jones & Towill, 1997).

In addition, two new types of leagility have been illustrated and defined: Leagile with Vendor Flexibility Systems, which combines the use of agile vendors with lean sourcing practices and Leagile with Sourcing Flexibility Systems, which combine the use of lean vendors with agile sourcing practices.

The case study findings presented in this paper also revealed a series of trade-offs involved in the practices adopted by UK fashion retailers in order to increase the level of supply network flexibility exhibited. These trade-offs are worthy of further investigation. For example, though the supply chain management literature argues extensively that greater benefits are achieved by those companies that attain closer relationships with their suppliers or customers (Dwyer et al., 1987; Lambert & Knemeyer, 2004; Fynes et al., 2005), our case study findings

reveal that retailers in fashion supply chains strive to limit interdependence and retain the ability to easily switch partners at short notice in order to allow for greater sourcing flexibility. In the long term, however, this may lead to poor levels of integration, higher transaction costs and reduced efficiency along these pipelines.

The two case studies presented in the paper also revealed that, in order to increase the retailers' sourcing flexibility in a global and complex context, new supply chain structures and actors, such as trade agents / intermediaries, needed to be involved (MacCarthy and Jayarathne, 2013). The typical services offered by an intermediary included sourcing, supplier quality control, shipping management and distribution. The ability of the intermediaries to consolidate orders from different customers before placing them with a specialised manufacturer, as well as consolidating orders placed with different manufacturers before shipping finalised products to the UK, led to retailers reporting significant cost savings. From a transaction cost economics perspective, our results show that intermediaries were more knowledgeable about the foreign markets (lowering retailers' search costs), had superior negotiating capabilities (lowering their negotiating costs) and were used by the retailers for supplier quality control and to take title of the goods produced (lowering the retailers' monitoring and enforcement costs).

However, for items with lower levels of demand variability which were produced in large volumes, as well as those items produced in the UK, direct sourcing and long term partnerships were employed without making use of trading agents. This confirms findings from previous studies (Shin, 1989, Klein et al, 1990) which highlighted that the value-added contribution of the intermediary will be correlated with the uncertainty or risk inherent in the particular exchange setting. In essence, fashion retailers recognized that overseas intermediaries are better equipped to manage all aspects of the sourcing, production and delivery process when high levels of responsiveness and an ability to build flexible alliances at short notice are required, while only engaging in direct sourcing for products with more stable demand profiles. This, however, can also restrict the retailers' competitive edge, which is now focused towards the management of activities further downstream the supply chain, such as retailing, UK distribution and branding, and increases their dependence on the use of global intermediaries. In the long term, this could encourage opportunistic behaviour.

*7.1. Contributions*

This paper has made a number of contributions. Firstly, a framework for supply network flexibility is proposed that is then used to develop a lean, agile and leagile supply network taxonomy. Two key sources of supply network flexibility are considered: Vendor Flexibility and Sourcing Flexibility. Secondly, we extended the Leagility concept by proposing two new types of Leagility: Leagile with Vendor Flexibility Systems, where there are agile vendors but switching between vendors is low, and Leagile with Sourcing Flexibility Systems, where there are lean vendors but switching between vendors is high. The taxonomy put forward links the Leagility concept with an existing framework for supply chain flexibility, showing that lean, agile, and leagile supply chains have different flexibility requirements. Finally, the literature on supply chain flexibility is still in its infancy, and most of the previous studies of flexibility in the wider context of inter-company collaboration have aimed to build conceptual frameworks and have lacked empirical validation. Our paper provides practical evidence with regards to the sourcing strategies used and the sources of flexibility employed by UK fashion retailers at supply network level.

*7.2. Relevance to practitioners*

As customers are increasingly demanding tailored products and shorter lead-times, practitioners are starting to acknowledge flexibility as a strategic capability. This paper adds to the understanding of the ways in which the two sources of supply network flexibility put forward (vendor and sourcing) interact and provides evidence of the ways in which companies can strike various balances between these sources and the effects that can be achieved. The taxonomy put forward also highlights the importance of organisations taking a network perspective when aiming to increase the level of flexibility exhibited, as well as some of the trade-offs involved.

The two case studies we report on were conducted in the clothing sector, which is characterised by a series of industry specific factors, but the four sourcing strategies identified cover products with varying shelf lives (from 3-4 weeks to 12 months) and demand patterns varying from very stable to very volatile. As such, we believe that the findings of our case studies could be applied and extended in some other sectors, though other mechanisms and practices may be involved, particularly in service supply chains. However, we note that further research is required to support our findings.

*7.3. Limitations and suggestions for further work*

Further studies are necessary to investigate the sources of supply flexibility conceptualised in the framework we have put forward, as well as the complex interactions that can arise between them. We specifically considered only two external flexibility types (mix and volume) in our research out of the five identified in the literature. Further studies would benefit from addressing the three flexibility types that were not explored in this paper (new product, delivery and access), as well as the trade-offs involved when trying to improve a supply system's flexibility along different combinations of these.

Another limitation that needs to be acknowledged is related to the extrapolation of the 'flexibility' construct to leanness and agility. In this present study we use flexibility as an indicator for 'propensity for lean' and 'propensity for agility'. This is based on previous work (Naylor et al., 1999; Narasimhan et al., 2006; Gunasekaran et al., 2008) which highlighted that one of the principal distinctions between agility and leanness appears to be in the flexibility performance dimension. However, we fully acknowledge that both leanness and agility are broader concepts, encompassing practices other than flexibility alone. For example, Shah and Ward (2003) postulate four bundles of inter-related and internally consistent lean practices: just-in-time (JIT), total quality management (TQM), total preventive maintenance (TPM) and human resource management (HRM). They suggest that it is the concurrent rather than sequential application of bundles of lean practices that makes a substantial contribution to operational performance. In relation to agility, Braunscheidel and Suresh (2009) found that, alongside external flexibility (considered as volume and mix flexibility), internal firm integration and external integration with key suppliers and customers have a significant positive impact on the firm's supply chain agility, alongside organisational characteristics such as market and learning orientation.

Furthermore, like many case-based studies, limitations such as the small sample size, contextual bias and subjective criteria used for some of the variables considered have to be noted. We acknowledge also that other definitions and interpretations of the concepts investigated in this study may be justified. Future research may include the development and deployment of a survey. A study employing a larger set of variables and investigating the

interactions between them may reveal additional insights with regards to the role of flexibility in developing lean, agile and leagile supply network taxonomies. The impact of flexibility on firm performance and total supply chain cost, as well as the long term sustainability of the sourcing systems employed in this study would also benefit from further investigations.

**References**

Aastrup, J. and Halldorsson, A., 2008. Epistemological role of case studies in logistics: a critical realist perspective. International Journal of Physical Distribution & Logistics Management, 38(10), 746-63.

Abrahamsson, M., Aldin, N. and Stahre, F., 2003. Logistics platforms for improved strategic flexibility. International Journal of Logistics: Research and Applications, 6(3), 85-163.

Agarwal, A., Shankar, R. and Tiwari, M.K., 2006. Modelling the metrics of lean, agile and leagile supply chain: An ANP-based approach. European Journal of Operational Research, 173(1), 211-225.

Alvesson, M. and Sköldberg, K., 2000. Reflexive methodology: new vistas for qualitative research. London. Sage.

Andreewsky, E. and Bourcier, D., 2000. Abduction in language interpretation and law making. Kybernetes, 29(7/8), 836-45.

Baker, P., 2006. Designing distribution centres for agile supply chains. International Journal of Logistics: Research and Applications, 9(3), 207-221.

Barratt, M., Choi, T.Y. and Li, M., 2010. Qualitative case studies in operations management – trends, research outcomes, and future research implications. Journal of Operations Management, 29 (4), 329-342.

Braunscheidel, M. and Suresh, N., 2009. The organizational antecedents of a firm's supply chain agility for risk mitigation and response. Journal of Operations Management, 27, 119-140.

Bernardes, E.S. and Hanna, M.D., 2009. A theoretical review of flexibility, agility and responsiveness in the operations management literature: toward a conceptual definition of customer responsiveness. International Journal of Operations & Production Management, 29(1), 30–53.

Bower, J. and Hout, T., 1988. Fast-cycle capability for competitive power. Harvard Business Review, 66(6), 110-118.

Chase, R.B., Jacobs, F.R., Aquilano, N.J., 2004. Operations management for competitive advantage. McGraw-Hill/Irwin, Boston.

Chiang, C., Kocabasoglu-Hillmer, C. and Suresh, N., 2012. An empirical investigation of the impact of strategic sourcing and flexibility on firm's supply chain agility. International Journal of Operations & Production Management, 32(1), 49-78.

Childerhouse, P. and Towill, D., 2000. Engineering supply chains to match customer requirements. Logistics Information Management, 13(6), 337-345.

Christopher, M., 2000. The agile supply chain: competing in volatile markets. Industrial Marketing Management, 29(1), 37-44.

Christopher, M. and Towill, D.R., 2000. Supply chain migration from lean and functional to agile and customised. Supply Chain Management: An International Journal, 5(4), 206-213.

Christopher, M., Lowson, R. and Peck, H., 2005. Creating agile supply chains in the fashion industry. International Journal of Retail & Distribution Management, 32(8), 367-376.

Chung, W., Yam, A. and Chan, M., 2004. Networked enterprise: A new business model for global sourcing. International Journal of Production Economics, 87(3), 267-280.

Collins, R.S. and Schmenner R.W., 1993. Achieving rigid flexibility: Factory focus for the 1990s. European Management Journal, 11(4), 443–447.

Crowe, T. J., 1992. Integration is not synonymous with flexibility. International Journal of Operations & Production Management, 12(10), 27-35.

da Silveira, J.C. Giovani, and Cagliano, R., 2006. The relationship between interorganizational information systems and operations performance. International Journal of Operations & Production Management, 26(3), 232-253.

Das, S. K. and Abdel-Malek, L., 2003. Modelling the flexibility of order quantities and lead-times in supply chains. International Journal of Production Economics, 85(2), 171-181.

De Toni, A. and Tonchia, S., 1998. Manufacturing flexibility: a literature review. International Journal of Production Research, 36(6), 1587–1617.

Dubois, A. and Gadde, L., 2002. Systematic combining: an abductive approach to case research. Journal of Business Research, 55, 553-60.

Duclos, L. K. Vokurka, R. J. and Lummus, R. R., 2003. A conceptual model of supply chain flexibility. Industrial Management & Data Systems, 103(6), 446-456.

Dwyer, F.R., Schurr, P. and Sejo, O., 1987. Developing buyer-seller relationships. Journal of Marketing, 51(2), 11-27.

D'Souza, D. and Williams, F., 2000. Towards a taxonomy of manufacturing flexibility dimensions. Journal of Operations Management, 18(5), 577-93.

Easton, G. and Rothschild, R., 1987. The influence of product and production flexibility on marketing strategy. In Pettigrew, A., The Management of Strategic Change. Basil Blackwell Limited, Oxford.

Eisenhardt, K.M., 1989. Building theories from case study research. Academy of Management Review, 14(4), 532–550.

Euromonitor International, 2005. Clothing and footwear – United Kingdom, available at: www.portal.euromonitor.com. Last accessed 17th January, 2013

Faisal, M.N., Banwet, D.K., and Shankar, R., 2006. Supply chain risk mitigation: Modelling the enablers. Business Process Management Journal 12 (4), 535-552.

Ferdows, K., 1997. Making the most of foreign factories. Harvard Business Review, 75(2), 73-88.

Fernie, J. and Azuma, N., 2004. The changing nature of Japanese fashion: Can quick response improve supply chain efficiency?. European Journal of Marketing, 38(7), 790-808.

Fisher, M.L., 1997. What is the right supply chain for your product? Harvard Business Review, 75(2), 105-16.

Fynes, B., Voss, C. and de Búrca, S., 2005. The impact of supply chain relationship quality on quality performance. International Journal of Production Economics, 96(3), 339-354.

Gereffi, G., 1994. The organisation of buyer-driven global commodity chains: How US retailers shape global production networks. In Gereffi, G. and Korzeniewicz, M. (Ed), Commodity Chains and Global Capitalism. Greenwood Press, Westport.

Gerwin, D., 1993. Manufacturing flexibility: a strategic perspective. Management Science, 39(4), 395-410.

Goldman, S. L, and Nagel, R. N., 1993. Management, technology and agility: the emergence of a new era in manufacturing. International Journal of Technology Management, 8(1/2), 18-38.

Goldman, S. L., Nagel, R. N and Priess, K., 1995. Agile competitors and virtual organizations: strategies for enriching the customer. Van Nostrand Reinhold, United States.

Goldsby, T.J., Griffis, S.E., and Roath, A.S., 2006. Modelling lean, agile and leagile supply chain strategies. Journal of Business Logistics, 27(1), 57-79.

Gosain, S., Malhotra, A. and El Sawy, O.A., 2005. Coordinating for flexibility in e-business supply chains. Journal of Management Information Systems, 21(3), 7-45.

Gosling, J., Purvis, L and Naim, M.M., 2010. Supply chain flexibility as a determinant of supplier selection. International Journal of Production Economics, 128(1), 11-21.

Griffiths, J. and Margetts, D., 2000. Variation in production schedules–implications for both the company and its suppliers. Journal of Materials Processing Technology, 103(1), 155-159.

Gunasekaran, A., 1999. Agile manufacturing: a framework for research and development. International Journal of Production Economics, 62(1-2), 87-105.

Gunasekaran, A., Lai,K.-H. and Cheng,T.C.E., 2008. Responsive supply chain: a competitive strategy in a networked economy. Omega: The International Journal of Management Science, 36 (4), 549–564.

Halldórsson, Á. and Aastrup, J., 2003. Quality criteria for qualitative inquiries in logistics, European Journal of Operational Research, 144(2), 321–332.

Handfield, R. and Bechtel, C., 2002. The role of trust and relationship structure in improving supply chain responsiveness. Industrial Marketing Management, 31(4), 367-382.

Harrison, A., 1997. From leanness to agility. Manufacturing Engineer, 76(6), 257–260.

Herer, Y.T., Tzur, M., and Yucesan, E., 2002. Transshipments: An emerging inventory recourse to achieve supply chain leagility. International Journal of Production Economics, 80(3), 201-212.

Hines, P., 1998. Benchmarking Toyota's supply chain: Japan vs UK. Long Range Planning, 31(6), 911-918.

Hines, P., Holweg, M. and Rich, N., 2004. Learning to evolve: A review of contemporary lean thinking. International Journal of Operations & Production Management, 24(10), 994-1011.

Hoekstra, S. and Romme, J., 1992. Integral logistic structures – Developing customer-oriented goods flow. McGraw-Hill, London.

Hormozi, A.M., 2001. Agile manufacturing: the next logical step. Benchmarking: An International Journal, 8(2), 132–143.

Huang, Y. Y. and Li, S. J., 2010. How to achieve leagility: A case study of a personal computer original equipment manufacturer in Taiwan. Journal of Manufacturing Systems, 29(2-3), 63–70.

Iacocca Institute, 1991. 21st Century manufacturing enterprise strategy. Lehigh University, Bethlehem, PA.

Ikeda, M., 2000. The new product development system of the Japanese automobile industry. In Jurgens, U. (Ed.), New Product Development and Production Networks, Springer-Verlag, Berlin.

Jack, E. and Rathuri, A., 2002. Sources of volume flexibility and their impact on performance. Journal of Operations Management, 20(5), 519-548.

Jin-Hai, L., Anderson, A.R. and Harrison, R.T., 2003. The evolution of agile manufacturing. Business Process Management, 2(9), 170–189.

Kanter, R.M., 1994. Collaborative advantage: the art of alliances. Harvard Business Review,

72(4), 96-108.

Kirkeby, O., 1990. Abduktion, in Andersen, H. (Ed.), Vetenskapsteori och metodlara. Introduktion, (translated by Liungman, C.G.), Studentlitteratur, Lund.

Klein, S., Frazier, G. and Roth, V., 1990. A transaction cost analysis model of channel integration in international markets. Journal of Marketing Research, 26 (May), 196–208.

Koste, L. and Malhotra, M., 1999. A theoretical framework for analyzing the dimensions of manufacturing flexibility. Journal of Operations Management, 18(1), 75-93.

Koste, L., Malhotra, M. and Sharma, S., 2004. Measuring dimensions of manufacturing flexibility. Journal of Operations Management, 22(2), 171-196.

Kovács, G. and Spens, K., 2005. Abductive reasoning in logistics research. International Journal of Physical Distribution & Logistics Management, 35(2), 132-144.

Krishnamurthy, R. and Yauch, C.A., 2007. Leagile manufacturing: A proposed corporate infrastructure. International Journal of Operations & Production Management, 27(6), 588–604.

Lambert, D. and Knemeyer, M., 2004. We're in this together (supply chain partnerships). Harvard Business Review, 82(12), 114-121.

Lamming, R.C., 1993. Beyond partnership: strategies for innovation and lean supply. Prentice-

Hall, Hemel Hempstead.

Lee, H. L., 2002. Aligning supply chain strategies with product uncertainties. California Management Review, 44(3), 105-119.

Lee, H. L., 2004. The triple-A supply chain. Harvard Business Review 82 (10), 102-112.

Lu, W., Olofsson, T. and Stehn, L., 2011. A lean-agile model of homebuilders' production systems, Construction Management and Economics, 29(1), 25-35.

Lummus, R., Duclos, L. and Vokurka, R., 2003. Supply chain flexibility: building a new model. Global Journal of Flexible Systems Management, 4(4), 1-13.

Lummus, R., Vokurka, L. K., and Duclos L.K., 2005. Delphi study on supply chain flexibility. International Journal of Production Research, 43(13), 2687- 2708.

MacCarthy, B. and Jayarathne, P., 2013. Supply network structures in the international clothing industry: differences across retailer types. International Journal of Operations & Production Management, 33(7), 858-886.

Malhotra, M. and Mackelprang, A., 2012. Are internal manufacturing and external supply chain flexibilities complementary capabilities?. Journal of Operations Management, 30(3), 180-200.

Mason-Jones, R. and Towill, D., 1997. Information enrichment: designing the supply chain for competitive advantage. Supply Chain Management: An International Journal, 2(4), 137-148.

Masson, R., Iosif, L., MacKerron, G. and Fernie, J., 2007. Managing complexity in agile global fashion industry supply chains. International Journal of Logistics Management, 18(2), 238-254.

McCullen, P. and Towill, D., 2001. Achieving lean supply through agile manufacturing. Integrated Manufacturing Systems, 12(7), 524–533.

Mello, A., 2001. Bulletproof your supply chain. available at http://www.zdnet.com/news/bulletproof-your-supply-chain/297103 Last accessed 17th January, 2013.

Mintel 2003, 2007, 2010. Market research report – Clothing retailers, available at http://academic.mintel.com Last accessed 17th January, 2013.

Morlok, E. and Chang, D., 2004. Measuring capacity flexibility of a transportation system. Transportation Research Part A: Policy and Practice, 38(6), 405-20.

Naim, M. M., Potter, A. T., Mason, R. J. and Bateman, N., 2006. The role of transport flexibility in logistics provision. The International Journal of Logistics Management, 17(3), 297-311.

Naim, M.M. and Gosling, J., 2011. On leanness, agility and leagile supply chains. International Journal of Production Economics, 131(1), 342-354.

Narasimhan, R. and Das, A., 2000. An empirical examination of sourcing's role in developing manufacturing flexibilities. International Journal of Production Research, 38(4), 875–893.

Narasimhan, R., Swink, M., and Kim, S.W., 2006. Disentangling leanness and agility: An empirical investigation. Journal of Operations Management, 24(5), 440-457.

Naylor, J. B. Naim, M. M and Berry, D., 1999. Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain. International Journal of Production Economics, 62(1/2), 107-118.

Oke, A., 2005. A framework for analysing manufacturing flexibility. International Journal of Operations & Production Management, 25(10), 973-996.

Parnaby, J., 1987. Education and training in manufacturing systems engineering. IEE Proceedings, 134, Part A (10), 816-824.

Petkova, B.N. and van Wezel, W., 2006. Disentangling manufacturing flexibility. Proceedings of the 14th International Working Seminar on Production Economics, Innsbruck, 287-95.

Pires, S. R., Bremer, C. F, De Santa Eulalia, L. A and Goulart ,C. P., 2001. Supply chain and virtual enterprises: comparisons, migration and a case study. International Journal of Logistics, 4(3), 297-311.

Prince, J. and Kay, J.M., 2003. Combining lean and agile characteristics: creation of virtual groups by enhanced production flow analysis. International Journal of Production Economics, 85(3), 305–318.

Pujawan, I., 2004. Assessing supply chain flexibility: a conceptual framework and case study. International Journal of Integrated Supply Management, 1(1), 79-97.

Rahimnia, F. and Moghadasian, M., 2010. Supply chain leagility in professional services: How to apply decoupling point concept in healthcare delivery system. Supply Chain Management: An International Journal, 15(1), 80–91.

Reichhart, A. and Holweg, M., 2007. Creating the customer-responsive supply chain: a reconciliation of concepts. International Journal of Operations & Production Management, 27 (11), 1144-1172.

Rich, N. and Hines, P., 1997. Supply-chain management and time-based competition: the role of the supplier association. International Journal of Physical Distribution & Logistics Management, 27 (3), 210-25.

Sako, M., Lamming, R. C. and Helper, S. M., 1995. Supplier relations in the UK car industry: good news – bad news. European Journal of Purchasing and Supply Management, 1(4), 237-248.

Sanchez, L. M. and Nagi, R., 2001. A review of agile manufacturing systems. International Journal of Production Research, 39(16), 2561-3600.

Sanchez, A. M. and Perez, M.P., 2005. Supply chain flexibility and firm performance: A conceptual model and empirical study in the automotive industry. International Journal of Operations & Production Management, 25(7), 681-700.

Seuring, S. A., 2008. Assessing the rigor of case study research in supply chain management. Supply Chain Management: An International Journal, 13(2), 128-137.

Shah, R. and Ward, P. T., 2003. Lean manufacturing: context, practice bundles, and performance. Journal of Operations Management, 21(2), 129–150.

Sharifi, H. and Zhang, Z., 2001. Agile manufacturing in practice: application of a methodology, International Journal of Operations & Production Management, 21(5/6), 772–794.

Shin, K., 1989. Information, transaction costs and the organization of distribution: the case of Japan's general trading companies. Journal of the Japanese and International Economies, 3, 292–307.

Shukla, S.K. and Wan, H. D., 2010. A leagile inventory-location model: Formulation and its optimisation. International Journal of Operational Research, 8(2), 150-173.

Slack, N., 1983. Flexibility as a manufacturing objective. International Journal of Operations & Production Management, 3(3), 4-13.

Slack, N., 1987. The flexibility of manufacturing systems. International Journal of Operations & Production Management, 7(4), 35-45.

Slack, N., 2005. The changing nature of operations flexibility. International Journal of Operations & Production Management, 25(12), 1201-1210.

Soni, G. and Kodali, R., 2009. Performance value analysis for the justification of the leagile supply chain. International Journal of Business Performance Management, 11(1-2), 96 - 133.

Squire, B., Cousins, P., Lawson, B. and Brown, S., 2009. The effect of supplier manufacturing capabilities on buyer responsiveness. International Journal of Operations & Production Management, 29(8), 766-788.

Stalk, G., 1988. Time – The next source of competitive advantage. Harvard Business Review, 66 (4), 41–51.

Stevenson, M. and Spring, M., 2007. Flexibility from a SC perspective: definition and review. International Journal of Operations & Production Management, 27(7), 685-713.

Stevenson, M. and Spring, M., 2009. Supply chain flexibility: an inter-firm empirical study. International Journal of Operations & Production Management, 29(9), 946-971.

Swafford, P. M. Ghosh, S and Nagash, N. M., 2006. A framework for assessing value chain agility. International Journal of Operations & Production Management, 26(2), 118-140.

Swafford, P.M., Ghosh, S. and Murthy, N., 2008. Achieving supply chain agility through IT integration and flexibility. International Journal of Production Economics, 116(2), 288-297.

Swaminathan, J.M., 2001. Enabling customization using standardization operations. California Management Review, 43 (3), 125–135.

Tachizawa, E. M. and Thomsen, C. G., 2007. Drivers and sources of supply flexibility: an exploratory study. International Journal of Operations & Production Management, 27(10), 1115-1136.

Taylor, S., Fisher, D. and Dufresne, R., 2002. The aesthetics of management storytelling: a key to organizational learning. Management Learning, 33(3), 313-30.

Towill, D. R. and Christopher, M., 2002. The supply chain strategy conundrum: to be lean or agile or to be lean and agile? International Journal of Logistics: Research and Applications, 5(3), 299-309.

Upton, D., 1994. The management of manufacturing flexibility. California Management Review, 36 (2), 72-89.

van Hoek, R. I., Harrison, A. and Christopher, M., 2001. Measuring agile capabilities in the supply chain. International Journal of Operations & Production Management, 21(1/2), 126–147.

Vickery, S., Calantone, R. and Droge, C., 1999. Supply chain flexibility: an empirical study. Journal of Supply Chain Management, 35(3), 16-23.

Wikner, J., and Rudberg, M., 2005. Integrating production and engineering perspectives on the customer order decoupling point. International Journal of Operations & Production Management, 25(7), 623-641.

Vokurka, R. and O'Leary-Kelly, S., 2000. A review of empirical research on manufacturing flexibility. Journal of Operations Management, 18(4), 485-501.

Womack, J. and Jones, D., 1996. Lean thinking: banish waste and create wealth in your corporation. Simon & Schuster, New York.

Vonderembse, M. A. Uppal, M. Huang, S. H and Dismukes, J. P., 2006. Designing supply chains: towards theory development. International Journal of Production Economics, 100(2), 223-238.

Yin, R. K., 2003. Case study research: design and methods. Applied Social Research Methods Series, Thousand Oaks. Sage Publications, California.

Yusuf, Y. Y., Sarhadi, M. and Gunasekaran, A., 1999. Agile manufacturing: the drivers, concepts and attributes. International Journal of Production Economics, 62(1/2), 33-43.

Yusuf, Y. Y., Adeleye, E. O. and Sivayoganathan, K., 2003. Volume flexibility: the agile manufacturing conundrum. Management Decision, 41(7), 613-624.

Yusuf, M., Gunasekaran, A., Adeleye, E. and Sivayoganathan, K., 2004. Agile supply chain capabilities - determinants of competitive objectives. European Journal of Operational Research, 159(2), 379–392.

Zhang, Q., Vonderembse, M.A. and Lim, J.S., 2003. Manufacturing flexibility: defining and analyzing relationships among competence, capability and customer satisfaction. Journal of Operations Management, 21(2), 173-91.

Zhang, Q. Vonderembse, M. A and Lim, J, 2005. Logistics flexibility and its impact on customer satisfaction. International Journal of Logistics Management, 16(1), 71-95.

Highlights

- We explore the meaning of flexibility in the context of lean, agile and leagile SCs
- A supply network flexibility framework is put forward
- An extension of the 'leagility' concept is proposed
- Two primary case studies are presented.