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Implementation of a VMI production and distribution control system

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ABSTRACT

This paper is concerned with the implementation of VMI within a grocery supply chain. We use the Time Benefit analysis tool to identify the particular products most suitable for VMI control from within the suppliers product range. Practical issues concerning the production and distribution process are highlighted. A production and inventory control system is selected and refined and realised via a spreadsheet application. Necessary data for enabling VMI is collated and presented to the production planner by the existing supply chain ERP system and entered into the spreadsheet-based VMI DSS. The DSS then advises the production scheduler on production and distribution targets for both VMI and non-VMI customers. Herein we report on the design and installation of the VMI DSS within the real-world supply chain.

INTRODUCTION

In a seminal presentation by Magee (1958, pp298) he discusses "Authority over Inventories" in relation to a conceptual framework for designing a production control system. Quoting directly from the text: "Frequently there is argument as to who should control inventories. For example, should it be the sales organisation or (some) other unit that draws on the stocks and wants to be sure they are there, or the operation that supplies the stock point and wants to feed it economically? There is probably no resolution to this question as stated; the difficulty is that both (players) have a legitimate interest. It is possible to restate the question slightly (differently) and (thereby) reach a solution. (For example), the user has to be sure the material he needs will be there. He has corresponding responsibility to state what his maximum and minimum requirements will be. Once these limits are accepted as reasonable, the supplier has the responsibility of meeting demand within these limits, making whatever use he can of the flexibility that (holding the) inventory provides. Thus both (players) have a share in the responsibility for and control over a stock unit. One specifies what the maximum and minimum demands on the stock unit will be; the other has the responsibility of keeping the stock unit replenished but not overloaded as long as demand stays within the specified limits".

What Magee had described is now embedded within the modern supply chain strategy known as Vendor Managed Inventory (VMI). Other terms in use to describe such centralised inventory control include, Efficient Consumer Response, Quick Response and Collaborative Planning, Forecasting and Replenishment. VMI has become popular in the last 15 years following the success of industrial examples mainly by top retailers in the grocery sector. However, there is often some resistance to implementing VMI, since it is frequently the case that customers expect the supplier to bear the total cost of implementation, but to cream off the benefits for themselves (Clark and Hammond, 1997).

This paper is concerned with the identification and exploitation of the flexibility that the VMI scenario offers in an industrial setting. It is important to identify the most suitable products to

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manage in VMI mode in order to maximise the chance of success of a VMI implementation. Therefore, in the first instance the Time Benefit analysis tool (Kaipia, Holmström and Tanskanen, 2001) will be described and exploited to determine which particular products are best suited to the VMI scenario. We then investigate the impact that the migration to VMI will have upon the production planning process at the supplier. A VMI production planning and inventory control system is then selected, refined and incorporated into a simple Decision Support System (DSS) to cope with the particular issues prevalent in the supply chain.

THE INDUSTRIAL CASE STUDY

This presentation is based on an implementation of a VMI supply chain planning DSS within a Finnish grocery supply chain. Our point of departure is the investigation and selection of non-seasonal products (i.e. the products that have a long life cycle) from the VMI supplier's product range. This was appropriate as some of the product range only had a demand near annual religious/cultural events and in this pilot study it was felt that these products were unsuitable for VMI in the first instance. For this project the industrial partner conducted this filtering exercise.

WHERE SHOULD VMI BE IMPLEMENTED?

The next stage of implementation is to determine where VMI is the most suitable within the everlasting product range. The companies need to know what products should be replenished according to VMI principles. Also whether the implementation should concern the whole product range or only a part of it. A method is therefore needed to identify in which supply chains and on which products the potential benefits of VMI are biggest. This was achieved by application of the Time Benefit Analysis Tool, Kaipia et al (2001). Essentially, this is a technique that quantifies the time that can be gained by moving away from order based material flow control to inventory and sales based material flow control.

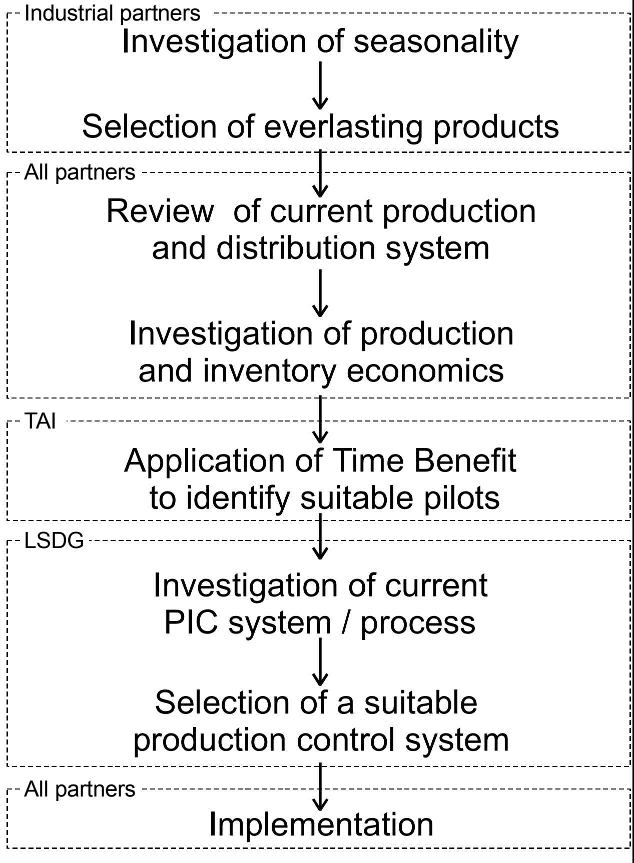

Figure 1. Overview of the VMI methodology

Figure 2, shows the output of the analysis tool as applied across the product range. It can be seen from the results that VMI is best suited to (typically low demand) products that suffer from the Bullwhip Effect (Lee, Padmanabhan and Whang, 1997) as the time benefit is greater here. The time benefit is calculated by working backwards through the re-order point equation for a traditional order based supply chain and comparing it what would happen in a VMI supply chain. Specific details on the logic of this can be found in Kaipia et al (2001) and have been omitted here for brevity. The Time Benefit tool can be used to identify potential VMI supply chains at either the product level or the product group level.

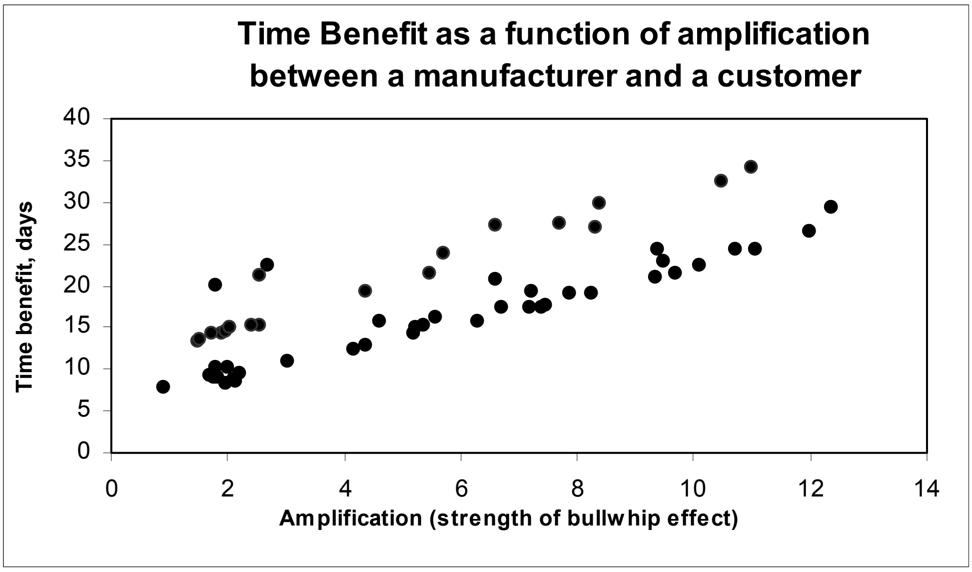

Figure 2. Results from the Time Benefit analysis

REVIEW OF SUPPLY CHAIN STRUCTURE

Big picture process mapping (Berry and Naim, 1992) was used to understand the supply chain in general. Briefly the supplier had 2 Finnish plants, another in Norway and another in Poland. This particular case study is concerned with products that were made in one of the Finnish plants. There were 10's of major customers of this particular plant. The largest customer was interested in adopting VMI. This customer was a third party logistics service provider, filling the role of a traditional distributor for a group of leading grocery chains (app. 10) in Finland, which together consolidated products from 100's of suppliers and delivered them to 1000's of retail outlets. Of particular importance in this industrial setting was the need for low inventory in the supply chain as the products had a shelf life, which coupled with high variety, easily result in a high proportion of discount sales. For example, the products may be discounted in the export market when a production batch is not sold early within the shelf life to domestic customers. The products were easily substitutable by the customer who could choose another brand, thus high availability of product was essential. Additionally, the capital investment in the production facility meant that a high utilisation of equipment was economically desirable.

ISSUES IN THE PRODUCTION PLANNING PROCESS

Each week the production planner conducts a scheduling activity. This involves cross checking and modification the ERP systems' suggested production plans, as the planner was not convinced the output was always appropriate. A similar activity has been documented and studied in Olsmats, Edghill and Towill, (1988). The planner would spend a complete day each week doing this activity and there were several important factors that be considered. These included; capacity limits, multiple value streams competing for the same resources, unpredictable yield rates, integration of VMI and non VMI value streams, transportation planning. What was needed was a simple DSS that would assist the production planner in this task by coping with these issues. We will now give a brief overview of the selection of a control strategy and how it was "fine-tuned" to cope with these issues.

Firstly because, only everlasting products (i.e. those with a reasonably constant average demand) were selected, a constant target inventory position was appropriate for the supply chain and a constant re-order point could be used at the VMI distributor. This reduces the complexity of the

VMI control system design as changes in the re-order point create additional variation in the demand signal that have to counter-acted by suitable adjustment of design parameters. Given these two facts, a suitable starting point was considered be the Automatic Pipeline, Inventory and Order Based Production Control System (APIOPBCS) due to John, Naim and Towill (1994).

The next issue to be tackled is how to incorporate the VMI and non-VMI demand and inventory signals into one demand rate. The solution to this problem is also helped by the fact that mean demand is reasonably stable. Under such condition demand from the customers' customer in the VMI case can be simply added to the non-VMI customers demand. Additionally, it must be remembered that VMI also treats inventory positions differently. Therefore, the available stock at the VMI customer was integrated with the finished goods level at the supplier.

Next, we had to design a system that could cope with the above issues in the production process. The so-called Deziel-Eilon (Deziel and Eilon, 1967) solutions to APIOPBCS have been shown (Disney (2001) and Disney and Towill (2001a & b)) to be robust to variable lead-times, yield rates and capacity constraints and are guaranteed to be stable. Multiple values streams competing for the same resources can be easily shown to mimic variable capacity constraints. Genuine changes in production lead-times, that have been shown to create inventory drift in APIOPBCS supply chains, were addressed by incorporating in integral controller in the inventory feedback loop as outlined in Evans, Naim and Towill (1996). It is also important to account for inventory shrinkage (due to the short product life cycle). Simulation showed that this is best tackled by treating shrinkage as external demand. A DSS that incorporated all of these solutions was developed on a Microsoft Excel spreadsheet for six products going down the same production line. A screen shot of the data input and output of this DSS is shown in Figure 3. Our DSS automatically generates the production target by product and the press-of-a-button and incorporates a number of error-checking routines. The latest version can be obtained from the corresponding author upon request.

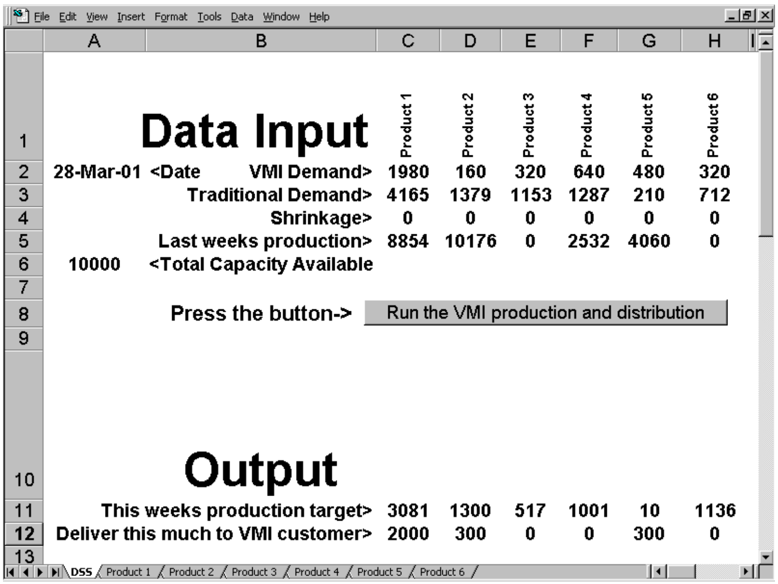

Figure 3. Example screen shot of the VMI Decision Support System

IMPLEMENTATION

The logistics development manager of the case plant has tested the DSS. The logistics development manager performs the tasks of the production scheduler when developing the weekly production and distribution plan. Figure 4 shows how the production scheduler's activities are influenced by the DSS. The role of the DSS is to link VMI replenishment to production planning. This is an improvement over conventional VMI implementations reported in the literature (see e.g. Holmström, 1998), as in the case implementation the customer's information is used in production planning and not only to generate replenishments in the ERP system.

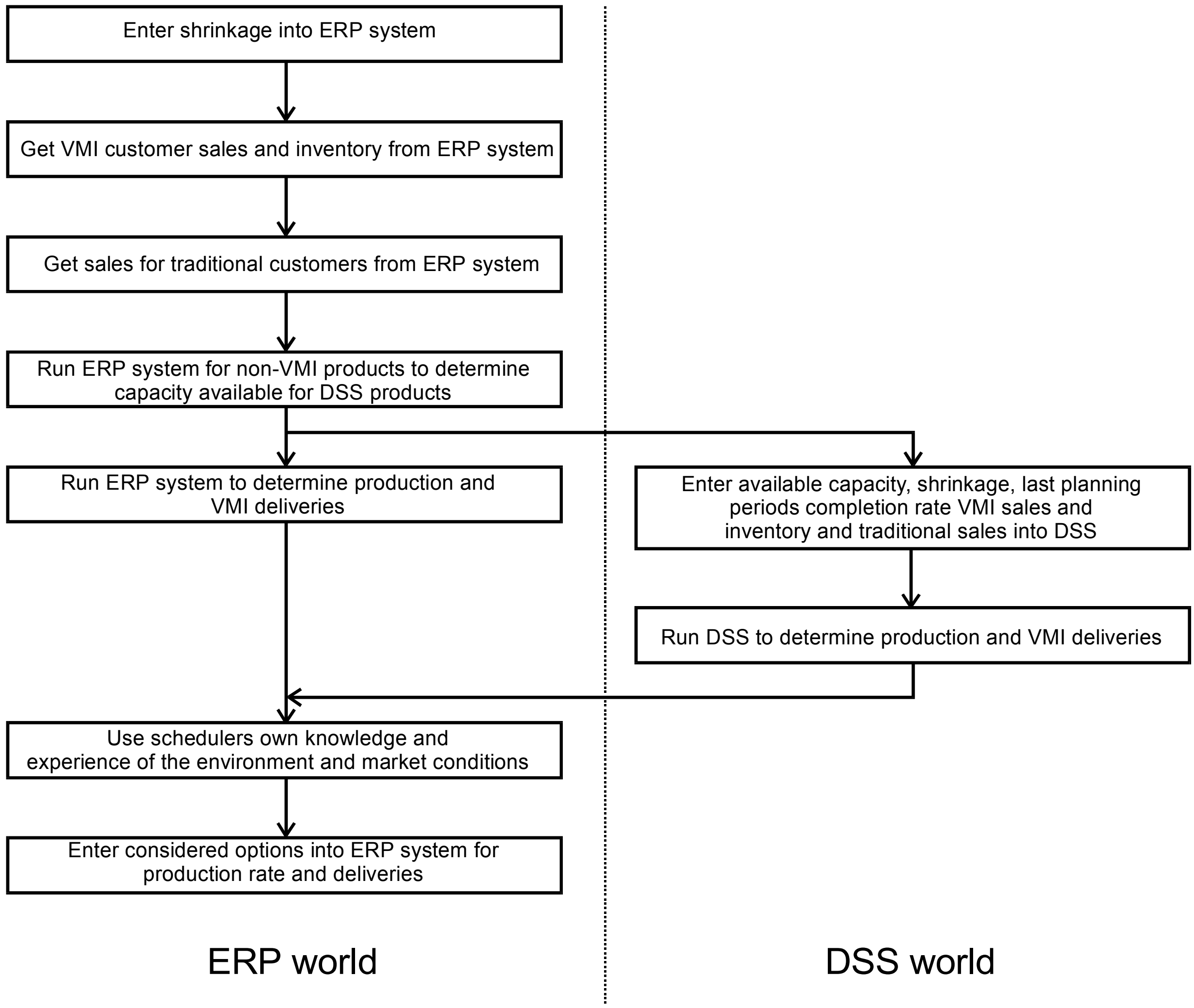

Figure 4. How the DSS is actually used in the industrial setting

CONCLUSIONS

VMI is not a new idea, rather it is an old idea that has now become technically feasible due to recent advances in Information and Communications Technology. All the data requirements for VMI are easily available from modern ERP systems. It is also possible to design production planning and distribution control systems that are robust to many real-life uncertainties. Although this is on-going research, initial feedback from the industrial partners and analysis of the DSS output by the research team each week (they are emailed each week to the academic team) suggests that the implementation is successful. Future publications will report on this in detail. The Time Benefit analysis tool quickly highlights the most profitable products in a company's portfolio for VMI implementation, requiring only data that is readily available. Findings from the analysis of production and inventory control strategies can be easily incorporated into simple Decision Support Systems that are understandable, reliable and useful to production schedulers in VMI supply chains.

FURTHER WORK

This work raises many subsidiary questions such as; How much effort should a supplier put into attempting to change the ratio of VMI to non VMI customers?, What about VMI customers helping out with set-up costs or sharing the benefits?, Does VMI success vary according to market sector? What are the real barriers to VMI diffusion?

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