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Research paper

Selecting the right planning approach for a product

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Abstract
Purpose – The purpose of this research paper is to offer a solution to differentiate supply chain planning for products with different demand features and in different life-cycle phases.
Design/methodology/approach – A normative framework for selecting a planning approach was developed based on a literature review of supply chain differentiation and supply chain planning. Explorative mini-cases from three companies – Vaisala, Mattel, Inc. and Zara – were investigated to identify the features of their innovative planning solutions. The selection framework was applied to the case company's new business unit dealing with a product portfolio of highly innovative products as well as commodity items.
Findings – The need for planning differentiation is essential for companies with large product portfolios operating in volatile markets. The complexity of market, channel and supply networks makes supply chain planning more intricate. The case company provides an example of using the framework for rough segmentation to differentiate planning.
Research limitations/implications – The paper widens Fisher's supply chain selection framework to consider the aspects of planning.
Practical implications – Despite substantial resources being used, planning results are often not reliable or consistent enough to ensure cost efficiency and adequate customer service. Therefore there is a need for management to critically consider current planning solutions.
Originality/value – The procedure outlined in this paper is a first illustrative example of the type of processes needed to monitor and select the right planning approach.

Keywords Supply chain management, Product planning, Demand management, Product innovation

Paper type Research paper

Introduction

Matching demand characteristics to supply chain capabilities in order to capture sales opportunities and to satisfy customer needs in terms of speed, location and product variability is the purpose of supply chain planning (Cooke, 1999; Council of Logistics Management, 2004). This takes place over different time horizons, on different levels of aggregation and with varying frequency, depending on whether the planning is strategic, tactical or operational. For original equipment manufacturers (OEMs) that are operating in complex and fast-changing environments, it is challenging to balance demand and supply on the tactical and operational levels. Global OEMs may have to manage a manufacturing network comprising different types of production units and suppliers. Due to long lead times, an OEM may have to plan and commit production quantities months ahead of customer order and delivery.

The purpose of mid-term and short-term supply chain planning is to ensure supply capability across the supply network efficiently (Hoover *et al.*, 2001; Mentzer *et al.*, 2001). In supply chain planning, the company collects relevant information on market demand and downstream inventory, and combines this information with supply capabilities and constraints. The goal is to plan how the supply network is to respond to future demand (Reeder and Rowell, 2001). The time horizon is several months into the future. The plan is then communicated to suppliers, manufacturers, sales and customers. Based on the plan, suppliers can ensure that they have adequate capacity for fulfilling expected future demand. Actual delivery of products is based on consumer demand, customer orders and short-term production plans, weeks and days into the future.

The required planning processes consist of forecasting sales, demand planning, supply planning, and matching demand information and supply capabilities (Cooper *et al.*, 1997a, b; Vollmann *et al.*, 2000). Planning answers the following question: "How much shall we produce of each item for each time period?". This question relates both to volume planning (how much) and to variant planning (how much of each separate variant of the product). This is an important distinction, as companies can use a combination of different techniques for planning total volume and variants. For example, total-demand information is needed to reserve manufacturing capacity, and the demand for each product variant can be planned close to delivery, using end-customer demand. The focus in this paper is on short-term and mid-term planning.

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One factor that increases planning complexity is the product mix, including a growing number of products in different life-cycle stages. Marketing and distribution costs typically make up the largest portions of the total cost (Di Benedetto, 1999). In new product launches or if demand is seasonal, occasional or stochastic, the costs tend to increase. Even if the product's demand is stable, movements by competitors and distortion and volatility of markets ensure that forecasts for the products are not reliable (Fisher *et al.*, 1994). One solution for reducing reliance on forecasts is to adopt response-based logistics strategies: sensing end-customer demand at the point-of-sale and reacting to the changes (Bowersox *et al.*, 1999). However, not all companies have access to end-customer demand and they may not be able to utilise such information in their own processes.

In high-technology industry there is an urgent need for collaborative planning systems that will be able to take into account product life cycles and integrate demand planning and supply chain planning (Langabeer and Stoughton, 2001; Reary, 2002). According to Van Landeghem and Vanmaele (2002), there is a lack of suitable planning methods for complex situations and supply chains. Thus, there is a need for a decision-making framework to help define what the right planning approach is for each situation. In addition to implementing different supply chains for different types of product, the planning processes need to be differentiated to support the chosen supply chain.

The purpose of this paper is to develop a framework for deciding what planning approach should be used for products with different demand features and in different life-cycle phases. The framework offers a way to identify suitable planning approaches on the basis of demand characteristics. The paper is structured as follows. First, different frameworks for selecting the right supply chain for the type of products are reviewed from supply chain management literature. Next, the methodology applied to developing the decision-making framework in the case company is discussed. The results of an explorative mini-case study are presented. A procedure for differentiating supply chain planning is then developed and applied in the case company. Finally, conclusions are drawn and some further research propositions discussed.

Literature review: selecting the right supply chain for the product

Fisher (1997) presented a framework for selecting the appropriate supply chain for a product. This framework has been further developed and refined by Li and O'Brien (2001), Lee (2002), Collin (2003) and De Treville *et al.* (2004).

Fisher (1997) recommends that the features of product demand define whether the product is functional or innovative. The aspects of demand to be considered are:

- demand predictability;
- life cycle;
- product variety and lead time; and
- service requirements

These factors determine the availability and inventory needs to meet demand. Based on these factors, the products can be categorised as either primarily functional, such as those bought in supermarkets, or primarily innovative, like many products in the fashion or technology sector. For these groups there are two types of supply chains to be selected. For functional products, an efficient supply chain that focuses on delivering products at the lowest possible cost to customers should be developed. Selection of suppliers, capacity usage and product design all aim to gain effective low-cost solutions. The second type is a market-responsive process, where speed and flexibility are required from suppliers, manufacturers, and from product design solutions. For innovative products, the demand for which is difficult to predict, market responsive processes ought to be developed (Figure 1).

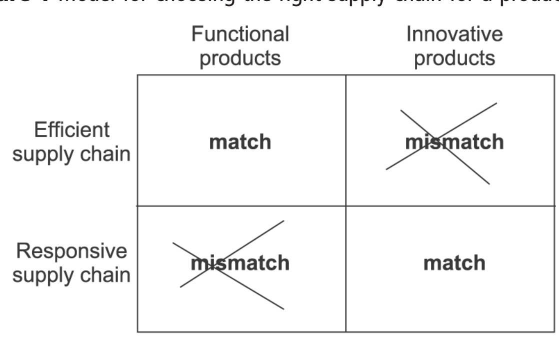
How do companies know they are in the wrong quadrant (see Figure 1)? In the upper right quadrant, moves in the product group are rapid, with frequent new product introductions causing high product variety. In this instance, companies are in a situation where there are many products competing to fulfil the same need. If the market does not require such a wide variety, prices fall and profit margins diminish. Inventory-carrying costs quickly rise if companies try to be responsive to demand, or if capacity is directed towards a wrong product. In this quadrant, the focus of measurement is on efficiency, such as production capacity utilization or inventory turns. These problems cause a high bullwhip effect (Lee *et al.*, 1997) in the channel.

In the lower left quadrant of the framework, operational costs are too high for the product. If a company is located here, it attempts to operate in a highly sophisticated manner not required by the product or market.

To move away from the upper right quadrant there are two options (see Figure 2) – either to treat the products as innovative, or as functional. The first strategy is to move left, which requires changing the product offering and reducing the innovativeness of products. According to Fisher (1997), toothpaste manufacturers ceased treating the product as innovative by reducing the number of product variants, and slowing the pace of new product introductions. This way they stabilized the bullwhip effect in the pipeline and could adopt efficient replenishment systems.

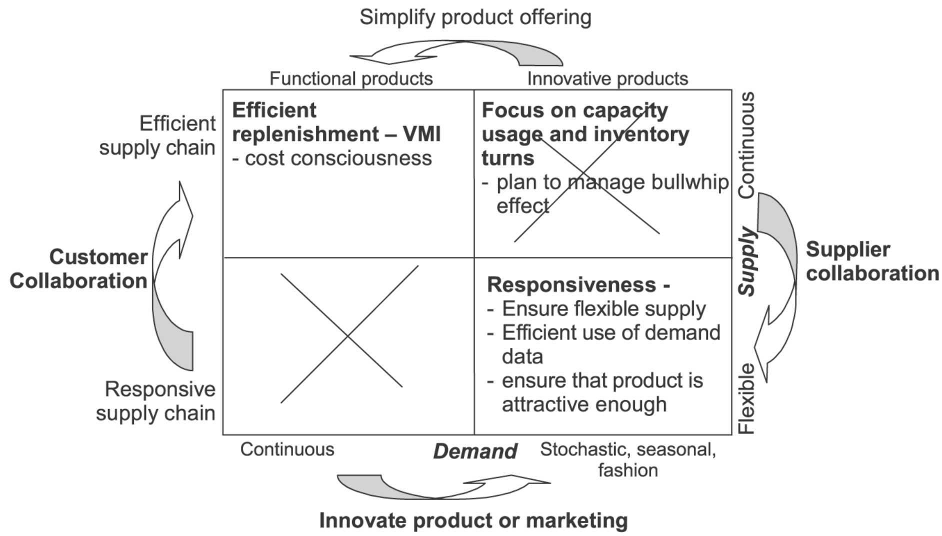
The second direction in which to move is towards the lower right quadrant in order to implement a responsive supply chain (Figure 2). This move requires flexible capacity and the capturing of demand data, and subsequent responsive reactions to fluctuations. For critical components, inventory buffers are essential if lead times cannot be reduced. These actions can be implemented in collaborative supplier relationships. One solution is to base product design on modularity to make the postponement of final assembly possible. There may also be products that have sufficient

Figure 1 Model for choosing the right supply chain for a product



Source: Fisher (1997)

Figure 2 Implementing moves in Fisher's (1997) framework from the supply chain selection point of view



demand and are attractive enough to allow allocations of supply between customers.

The model has been tested and enriched in several studies. Li and O'Brien (2001) have carried out a quantitative analysis to match product types to supply chains; they modelled three alternative supply chain strategies, each of which represented a different level of responsiveness. The results mainly support Fisher's idea that when demand uncertainty is low, the physically responsive process is the correct choice, and when demand uncertainty increases, the other two strategies, having more responsiveness, achieve better performance. However, in the case when demand uncertainty is high and value-adding capacity is low, the make-to-order strategy performed best; that differs from Fisher's results.

Lee (2002) expands the framework to consider the supply risk and uncertainty in upstream operations. He emphasises that supply chain uncertainties concern both demand and supply. The demand characteristics of products need to be matched with the right supply chain strategies. For example, in agricultural industries, demand is stable but supply is uncertain, in the sense of both quantity and quality. He proposes demand uncertainty reduction strategies to stabilise the bullwhip effect and supply uncertainty reduction strategies to stabilise the evolving supply process. Efficient information sharing is significant in both types of strategy.

Collin (2003) tested the framework in project-based businesses. He separates different supply chains for innovative products, based on different degrees of postponement and speculation in manufacturing and in logistics. He concludes that, in project-based businesses, the accuracy of the project plan impacts critically on the selection of the supply chain. Another important factor is the level of collaboration in the relationship.

Whether it is better to focus on lead-time reduction instead of using demand-information transfer was investigated by De Treville *et al.* (2004). They divided demand information transfer into three levels and compared these to relative lead time, which describes the degree of production that has to be performed on the basis of forecasts rather than orders. They conclude that improvement in lead times should be prioritized over demand-information transfer. Moreover, they argue that lead-time reduction is a less risky tactic and facilitates the incremental use of demand information.

The need to develop current enterprise resource planning (ERP) systems to better manage the supply chain has been explored in several studies (Davenport and Brooks, 2004; Kehoe and Boughton, 2001). Current dominant planning approaches cannot cope with uncertainty and do not report the level of uncertainty to management (Van Landeghem and Vanmaele, 2002). The approaches used support the responsive supply chain types by aiming at scheduling incoming orders at a very accurate level and at high speed. For functional supply chains, where there is no allowance for capacity buffers and where inventory buffers are needed to cope with uncertainty, there are no adequate planning techniques available. Instead, a robust planning approach for functional supply chains is proposed, where flexibility is limited and capacity utilization is of high importance. The approach recognizes the uncertain factors in supply chains concerning, for example, lead times, yield rates, demand or prices and distribution and the probability of such factors occurring. The model aims at providing a stable and predictable plan with a minimum number of revisions.

The need for planning stabilization was recognised by Holmström (1998). They suggest that planning cycles and changes in plans should be minimized. Choosing the correct frequency of re-planning is of high importance (Reary, 2002). Disney *et al.* (1997) propose that the information coming to a planning system should be smoothed to avoid fast reactions and rapid changes in plans. Smoothing the demand information by, for example, using a running four-week average figure, levels the peaks in the information.

Even though Fisher and other researchers offer solutions as to how to select the supply chain, they do not give advice on how to differentiate planning to support the optimum strategy. The literature seems to concentrate on which physical operations to choose to execute a move to a suitable location. However, there is a much poorer understanding of the kind of planning to choose to implement supply-chain differentiation for the whole product portfolio of a company. Therefore, we conclude that there is need for rules and guidelines to help managers select the right planning approach for each situation to operationalize and execute the supply chain differentiation proposed by Fisher.

Methodology

The objective of the research was to develop a framework to support the selection of the right planning approach for different types of products. The research was carried out in an electronic company in a new business unit that was looking for ways to support supply-chain differentiation by means of planning. The new business unit had a diverse portfolio of products and a complex supply network consisting both of own production units and contract manufacturing.

The research was implemented in three phases. First, a literature review was conducted. Second, a framework was developed to help the case company differentiate its planning for different types of products. Third, the selection framework was applied to the product portfolio of the new business unit in the case company.

The objectives of the literature review were:

- to study Fisher's ideas on supply chain differentiation and later development of the framework; and
- to identify in a benchmark study solution alternatives, or explorative mini-cases, for supply chain planning in a situation where the product portfolio is in continuous change and the supply network is complex.

The available information sources in the benchmark study consisted of research articles from a university library database, reports written by case-company employees after benchmarking visits, case descriptions from the European Case Clearing House (ECCH), conference and summit materials, and information from company web pages.

The process used in the benchmark study was as follows. Potential mini-case examples were identified by searching for reports on the forecasting, supply chain planning and demand-data utilization practices of global companies operating in volatile markets. Reports on planning in companies that offer new innovative products with short life cycles were reviewed. The review identified 12 companies to be investigated in more detail, representing daily products, the apparel industry, electronics, the watch industry, sports equipment and toys. The further analysis focused on the planning solutions. For three of these companies, detailed information could be obtained on innovative planning approaches for dealing with a diverse and changing product portfolio. These companies were Mattel, Inc., Vaisala and Zara. In the latter two companies, further information was obtained by interviews with operational managers and reports from previous benchmark visits by the case company. For Mattel, Inc., the results were based only on written material; the analyses are therefore not homogenous. As the analyses were based on written material in the first phase, we had access only to planning solutions described in the literature and therefore we cannot claim that we have studied the best practices. In addition, the reasons for planning approach selection in the companies were not studied, as external variables were not used.

The second part of the study, the development of a framework to select the right planning solutions, was based on a case company situation. The case company, a consumer durables manufacturer and marketer, was selected because there was a need to differentiate planning to support different supply chains in a new business unit. The new unit had a wide range of diverse products, and many alternative ways of sourcing the product. The diversification of planning approaches became urgent, as the approaches utilized in established units with more stable product portfolios and supply networks could not produce satisfactory planning results (presented in Kaipia *et al.*, 2006) in the new unit with the available personnel.

The goal of the framework development was to institute a more formal way of selecting the supply chain planning approach in the new business unit. The new unit was established to manage innovative and new products; this type of product forms the basis of the unit's product portfolio. However, the business unit also has responsibility for other product types that are somehow connected to the use, sales or distribution of innovative products. Therefore, the selection of the planning approach should consider products with different demand features, although the focus is on innovative products. The basis for developing the framework was Fisher's (1997) framework for selecting the right supply chain for the product, adjusted to deal with supply chain planning instead of supply chain structure. The result of the framework development is a step-by-step procedure for selecting the planning approach for a product. The alternative planning approaches considered in the step-by-step procedure are the procedures that are currently being used in different units of the case company. The mini-case study provided ideas on new approaches that could perhaps be included in the selection of planning approaches.

The third part of the study was to investigate how to use the developed procedure to segment the current product portfolio in the new business unit. To determine how to implement the procedure in practice, the available product data from the current uniform planning system was used to segment the products. The segmentation was demonstrative, and was used by the case company when deciding how to proceed in the development of differentiated supply chain planning capabilities in the new business unit.

Explorative mini-case study on supply chain planning for volatile demand

Companies introducing innovative products into an efficient supply chain environment find themselves in a difficult situation that they can attempt to resolve with supply chain planning. This section analyses the planning solutions for this problem in three mini-cases.

The challenge corresponds to moving by means of supply chain planning from the upper right corner in Fisher's framework (Figure 1) to the top left or bottom right corners. To move left from the upper right quadrant, the key action is to stabilise planning. This can be achieved by changing the product offering, reducing product variants and shortening lead times. Stabilised planning can also be achieved by using available demand information more effectively. However, to avoid a nervous reaction, the change needs to be phased over several planning periods. This requires inventory buffers (Disney *et al.*, 1997). The second alternative is to improve responsiveness by speeding up the planning process. This corresponds to a move to the bottom left quadrant. However, such responsive supply chain planning requires accurate follow-up of end-customer demand information together with fast and frequent updates of plans according to the demand information.

In the study, planning approaches for different types of products and supply chains were investigated. It was found that some companies had been able to both successfully stabilise their operations in very volatile markets and to improve responsiveness by developing innovative supply chain planning approaches. Table I presents a summary of the solutions developed by Vaisala, Zara, and Mattel to operate efficiently in environments with innovative products and unpredictable demand.

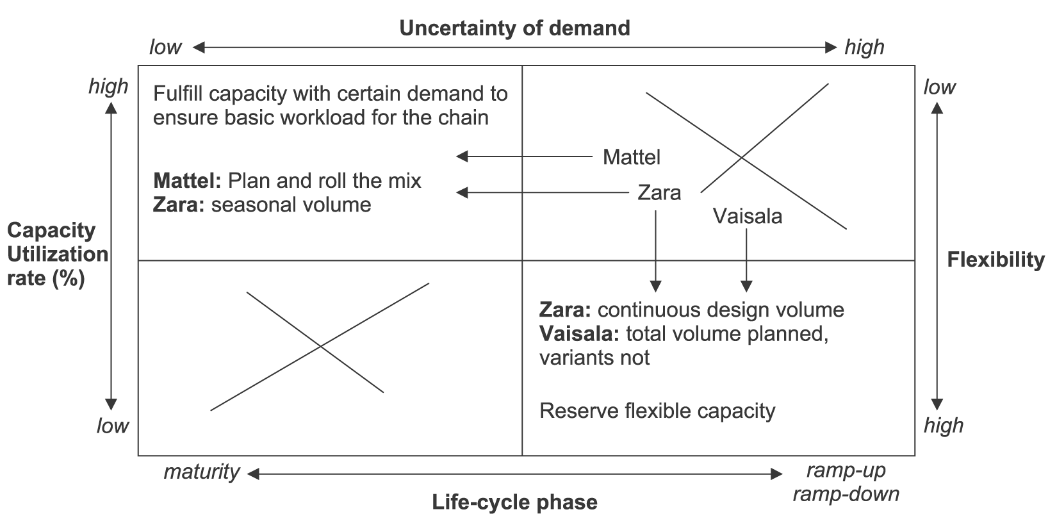
The impact of the planning approaches used by the mini-case companies' planning is analysed next. The three companies are initially located in the upper right hand corner to demonstrate within the analysis framework how the planning approaches adopted by the companies change the efficiency and responsiveness of the supply chain (Figure 3). The dimensions of the framework have been adjusted to describe the effect of the planning approaches used by the companies. Reducing the amount of demand uncertainty by, for example, introducing different planning approaches by product life-cycle phases, makes a horizontal move occur. Vertical moves are the result of planning differentiation that increases or decreases the ability of the supply chain to respond, which also affects the production capacity utilization rate.

The analysis shows how the planning approaches used by the companies help them deal with volatile market demand and innovative products by means of supply chain planning. Common for Zara and Mattel is the use of planning differentiation to reduce demand uncertainty. Their approach is based on their ability to separate out from the demand of innovative products the aspects that can be treated as *certain* demand. Even though the products of these companies are innovative, it is possible to meet a portion of the demand using efficient supply chain operations, and reduce the need for market responsive operations to meet uncertain demand. Vaisala, again, concentrated on improving the ability of the supply chain to respond reliably, without inventory buffers, to the sales planning.

Table I Summary of the solutions in the mini-case companies

	Number of product variants and change rate	Distribution channel	Demand and supply characteristics	Planning approach	Main benefits
Vaisala (measurement equipment, humidity sensors, etc.)	70,000 variants, 15 percent changes annually, average product life cycle seven years	Direct deliveries from factory to customers	Daily demand for variants unpredictable. Flexible own production, supplier's supply capability ensured by component buffers	Sales planning, ensured availability for sales quotas, continuous demand	Short delivery time, no channel inventories, possibility to respond to surprising orders
Mattel, Inc. (toys, case concerns miniature cars)	Hundreds, 7-8 percent changes per fortnight, whole assortment changes over twice annually	Department stores, toy retailers	Continuous change generates sales, efficiency in production by planned assortment changes	Rolling-mix strategy for a specific assortment pack	Stability despite continuous change, no forecasting for a single SKU, less physical work
Zara (apparel)	10,000 new models a year, short product life, for example four to six weeks	Own store network, 600 stores	Continuous change generates sales, part of production capacity responsive	Accurate gathering of demand data and fast reactions to changes	Catching demand trends, stability through seasonal collections

Figure 3 Treating certain and uncertain demand of innovative products with different planning



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A short summary of the supply chain planning approaches of the companies is given below.

Mattel, Inc. – rolling mix strategy

Mattel, Inc. has developed a strategy to manage demand uncertainty in the toy business. Their solution is called the rolling-mix strategy, which involves increasing product variety by continually introducing slightly different versions of the same product. Mattel launched a special assortment pack, called the master carton, which includes a 72-piece assortment of toy vehicles. The assortment is changed continuously by 7-8 percent every two weeks, which means that the whole assortment is changed twice a year. The strategy creates an atmosphere of continuous change and generates increasing sales. After launching this strategy, Mattel increased sales, while competitors' sales remained flat (Johnson, 2001).

The benefits of the strategy are:

- there is no need for additional retail shelf space in new product introductions;
- the master carton reduces workload in distribution and in ordering; and
- forecasting is eliminated – in production, rapid last-minute changes are reduced and the production plans are more accurate and reliable.

Therefore, the benefit of continuous new product introductions is the stability in the whole supply chain. The typical peaks caused by new products are avoided and therefore the bullwhip effect is reduced. The company has gone beyond the phase of using demand data for replacements. Instead, it anticipates what the consumers want to buy, and develops and offers new models with the best selling features.

By introducing the rolling-mix strategy, Mattel, Inc. made a shift to the effective supply chain. They determine the product life-cycle length in advance. Mattel is one step ahead of the consumer taste changes and can anticipate the demand changes. By making continuous, controlled changes in the assortment, the supply of miniature cars was stabilized.

Vaisala – sales planning rather than forecasting

Vaisala Instruments (see www.vaisala.com) is a marketer and manufacturer of transmitters and instruments for the measurement of relative humidity, dew points, barometric pressure, carbon dioxide and ammonia. It offers approximately 70,000 different product variants for its customers, and 15 percent of the products change each year.

Vaisala's approach to managing unsure demand is that of sales planning. Its responsiveness is based on a reliable distribution chain rather than keeping a finished goods inventory close to the market. The planning process starts with the sales units, who propose a sales plan based on customer collaboration. Vaisala logistics ensures supply capability simulating the chain and checking the suppliers' capability to deliver the required quantities. Confirmed availability is transformed into sales quotas, which defines the maximum quantity the sales units are allowed to sell without any extra confirmations concerning delivery time or availability (Kauremaa and Auramo, 2004; Laurikainen, 2003).

Vaisala manufactures in assemble-to-order mode in its plant in Finland. The delivery time is divided into three classes according to order size. At the fastest, Vaisala delivers within one workday all over the world. The standard delivery time is five working days, and for project deliveries it is 20 working days. Vaisala uses courier services for deliveries, which is the key enabler for fast customer response. The product is low weight, mostly under one kilogramme, and compact in size, and is thus very suitable for courier transportation.

Vaisala highlights the move to the responsive supply chain. Vaisala's way of managing demand uncertainty is to separate volume planning from variant planning. Total volume is planned accurately, but the individual variants are produced to order. Planned utilization rates for production capacity and personnel are low – 50 and 70 percent, respectively. The concept is that the bottleneck should never be in production, but always in the markets. Within the borders of the confirmed plan, delivery time is guaranteed. Speed in manufacturing is realised by setting the minimum lot size to one and eliminating set-up times in production. By the change in its planning approach, Vaisala was able to eliminate sales unit inventories and remarkably increase their responsiveness to customer demand.

Zara – continuous new product introductions

The third case example is Zara, the Spanish apparel manufacturer and retailer company. Zara designs and manufactures clothes for women, men and children, and has over 500 retail outlets in large cities around the world (Inditex, 2003; Virros, 2003). Zara's operations have been widely remarked on because of their speed in reacting to trend changes. Zara succeeds in designing, manufacturing and delivering new garments to stores in only a few weeks. The factors on which Zara's responsiveness is based consist of a combination of its own manufacturing and local flexible capacity, postponing some production phases such as dyeing, reserving unspecified capacity from suppliers to allow changes at the last moment, an efficient logistics system, and an efficient store concept and operations management (Ferdows *et al.*, 2003; Harlé *et al.*, 2002; Carruthers, 2003).

The Zara system is based on fast reactions to retail sales. In addition to gathering POS data automatically, store personnel around the world are in frequent contact by phone with product managers (Ferdows *et al.*, 2002). Such discussions concern orders and sales of specific items in specific stores and the features of the products having increased sales. The designers use such information in designing new garments (Ferdows *et al.*, 2002).

Zara has separated demand into two parts – certain demand and uncertain demand – and realised different operations for each. Zara designs and manufactures approximately half of the seasonal volume before the sales season start. This way, Zara has completed part of the work in advance by designing a seasonal collection, manufacturing it and delivering it to stores. For the advanced part of its volume, Zara can produce larger production batches, and use distant manufacturing and other low-cost solutions. In contrast, during the season, speed, flexibility and responsiveness are required and used. To be able to respond to end-customer demand and taste changes, flexibility is left in each phase of Zara's supply chain. What is remarkable about this approach is the fact that the responsiveness is required for only half of the volume.

Developing the procedure for planning differentiation in the case company

Previous research in the case company in 2001 and 2002 found that the supply chain planning approach of the case company did not effectively support the efficient operation of the supply chain for products with unpredictable demand and in special demand situations, such as product introductions (Holmström *et al.*, 2006). In these situations, the planning approach resulted in greatly varying planning accuracy that led to unnecessary re-planning and over-reactive operations (Kaipia *et al.*, 2006).

These challenges were emphasised in a new business unit with many innovative products, highly volatile demand for some products, and extensive use of contract manufacturing. The life cycles of the products were short, sometimes marketed only for a special occasion. Also, the products might be offered to the markets via new channels that are not familiar to the company. Based on these features, the company recognized that the planning processes used in other business units did not match the needs of the new unit as such. Introducing the same solutions in the new unit would position it in the upper right hand corner of the supply chain planning framework presented in the previous section.

An important aspect of the supply chain planning problem was the different lead times on the supply side. The manufacture of many products was mostly outsourced to East European, Chinese and Far Eastern contract manufacturers. The longest material lead-times were between 84 and 140 days. An additional inflexibility in the upstream operations was the fixed period for supply orders. For example, for four weeks, no changes in the orders were allowed and, for periods of five to nine weeks, changes were not to surpass 20 per cent. Thus, accurate plans for the coming demand were needed months before actual sales to customers started.

In this situation, the need for a procedure to differentiate the supply chain planning approaches for each product type became clear. The goal was to identify the planning requirements for each product type and support the selection of a planning approach that provided the planning accuracy required by the contract manufacturer or production unit, while at the same time keep the planning effort down. Another aspect in selecting planning approaches was the improved visibility to actual demand figures, channel sales and inventories and to downstream plans.

The first step in developing the procedure was to identify the available alternative planning approaches. Suitable planning approaches were collected from the literature and from previous research conducted in the case company's established units (Holmström *et al.*, 2006). A new planning approach, based on the approaches identified in the mini-case study, was also considered. This was sales-based supply chain planning, which was divided into continuous and once-off planning. The new feature for the case company in this planning approach was that supply is assumed fixed, and the focus of correcting actions was on fulfilling the sales plan. The approach was necessary because of the long lead-time constraints faced by the new business unit.

The considered planning approaches are treated in Table II. The main focus is on the relation of each planning approach to supply lead times, requirement and use of visibility, type of demand they support best, and needed planning effort, rather than describing the features of each approach in detail.

The criteria for the selection of planning approaches were their ability to support variable demand and changing product features, ability to utilize customer demand information and their ability to manage long lead times in supply chain upstream operations. The chosen planning approaches were efficient replenishment, which can be implemented as a VMI relationship, streamlined supply chain planning using attach rates (products demand is dependent on other products demand), streamlined supply chain planning using demand visibility, sales-based planning and expert driven supply chain planning. JIT and MRP techniques were abandoned due to their requirement for continuous demand and minor focus on demand planning. For planning and balancing demand and supply for products with volatile demand the chosen techniques were considered to offer best solutions.

The next step was to define the requirements for using the different planning approaches for the OEM. Efficient replenishment requires that sales history can be used as the forecast for future demand, and that there are inventory buffers in the supply chain to which the OEM has visibility. Streamlined planning based on attach rates requires that the sales of an item can be reliably estimated on the basis of the sales forecast of another item. For example, each personal computer needs one power cable, so the demand of power cables can be estimated on the basis of PC sales. Streamlined planning using demand visibility requires that there is point-of-sales information, and that the sales of an item can be modelled using variant mix profiles. The expert-driven supply chain planning requires that there are experts available, and that these persons have the time and interest to plan. Finally, the new sales-driven once-off approach requires that customers accept that they cannot re-order, while the continuous sales-driven planning requires that customers accept the availability constraints within defined lead-time windows.

Figure 4 illustrates the segmentation procedure for defining how to plan demand and supply for each product. The planning approach for a product is determined by sequentially considering how the product fulfils the requirements for each planning approach. The criteria affecting the selection of planning approaches are: availability of historical sales information, the customer's reorder requirements, the product's being used together with other products (called attach rates), the availability of channel and point-of-sales visibility, and the availability of an expert organization for planning. Efficient replenishment is considered first, as it requires the least planning effort. Expert-driven demand-supply planning is considered last, as it requires the most planning.

The developed procedure was used to segment the current product portfolio in the new business unit. Table III presents the results of the first segmentation of products. Commodity items inherited from established units, such as power cables and batteries can be handled without detailed demand and supply planning. Responsibility for replenishment according to agreed rules can be given to production units and selected suppliers. No suitable product groups were found for continuous sales planning, as long material lead-times for expensive components require that supply constraints are taken into account. However, several candidates for once-off sales planning were found. These products were typically

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Table II The considered planning approaches, their basic features and requirements

Approach	Features	Requirements or type of operations the approach supports best
CRP, continuous replenishment (Vergin and Barr, 1999; Raghunathan and Yeh, 2001)	Vendor replenishes based on actual data or forecasts, goal to reduce stick-out and improve availability at retailers	Sales history for forecasting, sharing of inventory or forecast data. Supports best continuous and relatively stable demand. Required planning effort low
Vendor managed inventory (VMI; Waller *et al.*, 1999; Disney and Towill, 2002)	Vendor is responsible for replenishments. Vendor can schedule own operations according to customer needs and benefit in production planning. Other benefits are lower inventories and reduced bullwhip	Visibility to inventories or to production plans. Supports continuous sales. Required planning effort low
Sell the plan, continuous demand (Vaisala)	A collaborative sales plan is matched with supply capabilities, guaranteed availability for the quantities in the confirmed plan	Organisation to create the sales plan. Access to POS data and weak signals for product design purposes. Supports variable demand. Requires medium or high planning effort
Streamlined planning with attach rates	Using existing plans for planning another product's demand	Product's demand is connected to other products' demand. Low planning effort
Streamlined planning with visibility (Holmström *et al.*, 2006)	Instead of forward planning (in product introduction phase), purchases and assembly are based on sell-through downstream the supply chain in maturity phase	Channel visibility required. Supports stable sales and continuous demand. Inventory buffers needed to balance minor changes in demand and supply. Requires medium planning effort
Expert-driven planning with accurate response to early sales (Fisher *et al.*, 1994; Fisher, 1997)	An expert group forms a volume estimate, accurate response to early sales to update forecasts, stable total supply chain combined with responsiveness	Access to demand data. Supports variable or unpredictable demand. Requires high planning effort, for example an expert organisation to create a consensus forecast
Just-in-time (JIT; Vokurka and Davis, 1996; Vollman *et al.*, 1992)	A production philosophy or technique. Elimination of waste in the forms of time, energy, material and error, quality improvement, reduction of work-in-process inventories, small batches, short production lead time and stabilized production	Change in production philosophy. After adoption requires low or medium planning effort. Supports best continuous demand and focuses on internal operations
Manufacturing resource planning (MRP; Vollman *et al.*, 1992; Kumar and Meade, 2002; Enns, 1999)	A time-based approach provides a detailed purchasing, manufacture and assembly plan	Accurate bill of materials, knowledge on supply lead times. Supports batch production and focuses on internal operations and procurement. Supports best supply planning for products with permanent features

high-margin fashion or seasonal items that could be procured from low-cost producers and distributed and marketed by the new business unit.

These results were demonstrative. The case company used the results for deciding how to proceed in the development of differentiated supply chain planning capabilities in the new business unit. Streamlined demand-supply planning using attach rates was already in use for a number of product types. In terms of differentiating planning, the most interesting area for development was that of streamlined planning using demand visibility, i.e. using channel inventory data from distributors and points-of-sale (POS) data from retail outlets. Here, the typical product for which planning could be streamlined is offered to the consumer in a large number of different variants, such as colour and cover design. If a variant mix can quickly be established after product introduction by monitoring actual sales, this can be used to reduce the need for expert-driven planning. This way, the efforts of expert-driven demand-supply planning can be focused on the product-introduction stage of innovative new products.

One challenge encountered with the introduction of differentiating planning approaches is that, in addition to the selection procedure, it would be necessary to monitor and manage the planning of individual items. This monitoring introduces the need for implementing expert-driven and automated approaches in parallel. This is needed for identifying when another planning approach would be more appropriate. For example, when using an expert-based approach, it is necessary to check the planning results of the experts against historical and visibility-based forecasts. When the results of the experts are no better than the automated result, the planning approach used for the item needs to be reviewed. Similarly, in exceptional situations that can be identified beforehand, resources for expert-driven planning need to be available.

Figure 4 Choosing the right planning approach for the case company

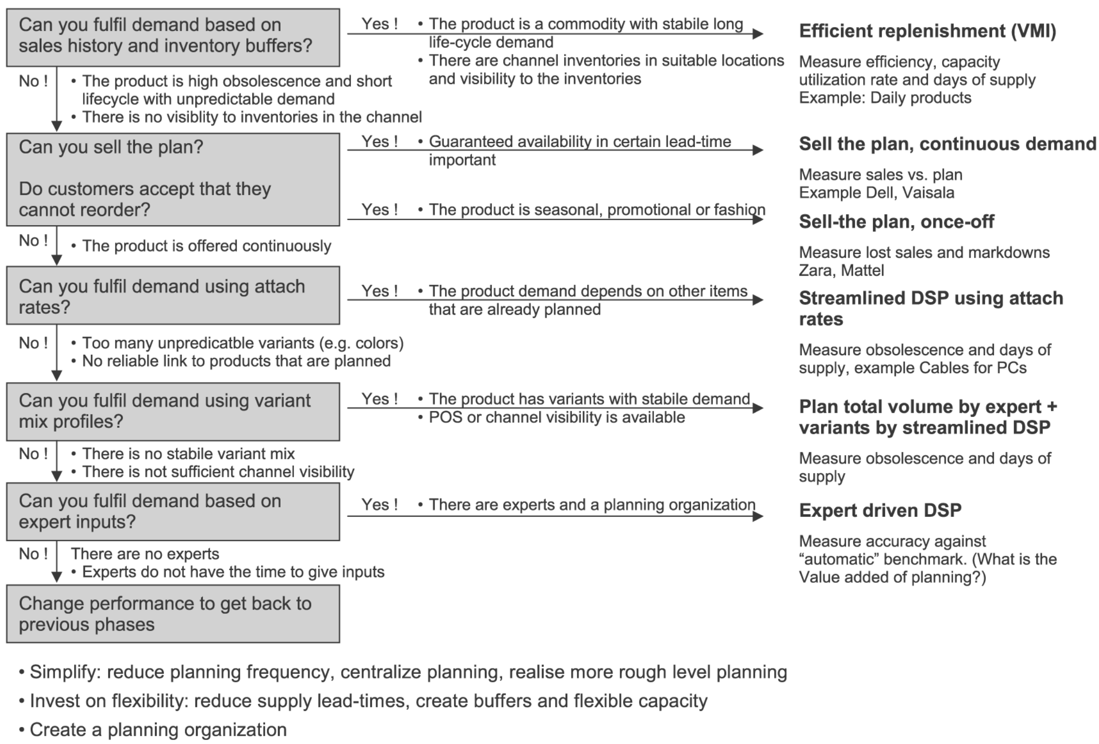

Table III Rough segmentation of OEM products according to demand characteristics and selected planning approaches

OEM product type	Characteristics of demand and supply	Chosen planning approach
Commodity items: power cables, batteries	Stable demand, streamlined distribution from production units or suppliers	Efficient replenishment
Seasonal items, fashion items	Life-cycle one season, unpredictable demand	Once-off sales planning
Most consumer durables. Potential new use for identifying demand division between variants	Total demand predictable, but sales of variants not. Supply may be short and balancing demand and supply needed to capture sales opportunities	Streamlined planning for demand and supply
Innovative new products, product introductions	Demand uncertain and difficult to predict as products may be totally new. Long material lead times, production ramp-up – time long	Expert-driven planning of demand and supply

Conclusions and further research

The need for planning differentiation is clear in the case of OEM with wide product portfolios in volatile markets. One reason for the need was that the current planning approach provided unsatisfactory results. In this study alternative planning approaches were identified, and a procedure for their selection is presented. The benefit of differentiating supply chain planning by product type or product item is that streamlined, or automated, planning approaches can be introduced. Scarce expert and management attention can then be focused on the situations that benefit most from their involvement. One goal of differentiated planning is to support the needed supply chain features, required by product.

For introducing planning differentiation, new monitoring and management procedures also need to be developed. In this article we present one solution as to how to choose the planning approaches for products. The procedure developed in the case study outlines what kind of management is needed to select planning solutions. The results from the case also suggest that it is necessary to monitor parallel supply chain planning approaches. However, the high cost of implementing parallel approaches may be a sufficient reason to opt for a uniform expert-driven supply chain planning approach.

The proposed approach was, however, not evaluated in this paper. To find out whether introducing differentiated planning approaches makes it possible for manufacturers to improve both efficiency and responsiveness in their supply chains by means of supply chain planning needs more case studies. One example of such cases has been studied, for example, by Holmström *et al.* (2006).

The procedure outlined in this paper is a first illustrative example of the type of process needed to monitor and select the right planning approach. The selection process is to be further developed in future research. There are several aspects that need to be addressed. The first task in future research is a description of planning approaches according to supply chain characteristics. First, significant determinants for matching planning approaches with supply chain characteristics need to be chosen. Then, the constraints and requirements of each planning approach need to be considered in the light of these determinants, which can be for example objective functions, type of demand, state of supply chain visibility or required planning effort. Last, cases in which different planning approaches were used will be examined to evaluate the procedure.

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