What Is the Right Supply Chain For Your Products?

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In order to have a successful supply chain, in terms of total supply chain costs and service performance to the customer, companies need to match the type of products they are selling with the type of distribution channels delivering their products. To test this hypothesis a product supply characterization (PSC) model was developed and validated on the European operations of a US$15 billion case study company. The application of the PSC model to the case study company reveals significant value in matching specific product clusters with appropriate supply chain designs and that any mismatch represents supply chain under performance.

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In recent years companies operating on a European or global basis have progressively implemented various initiatives in their attempts at integrated supply chain management. Companies have introduced the concept of European business units in an effort to achieve a better focus on their business at a European, as opposed to a country level. This has facilitated supply chain management, in that the new management structures now have some responsibility for the supply chain. Now they should be able to implement coherent supply chain strategies to drive up customer service and drive down their supply chain costs. With these new European management structures in place, management has come to understand the need for integrated supply chain planning software to help join together the various European functions and to facilitate the flow of information.

In many cases, these more integrated companies have shown improvements in customer service and supply chain costs as their new supply chain planning software implementations have taken affect. However, these improvements have not always been as extensive as the companies or the software vendors would have liked. So why do companies still struggle to get the maximum service and minimum cost from their supply chains? Often these companies are multi-product. Often they manufacture and sell thousands of different products, with different characteristics, to several different markets, in many different countries. They also have, in many cases, a dominant supply chain design that is rarely challenged. Could this be a significant part of the problem? Perhaps, no matter how good the supply chain tactics are, if the product fundamentally does not fit with the dominant supply chain design, optimum service and cost cannot be achieved.

The main hypothesis presented in this article is that in order to have a successful supply chain (in terms of total supply chain costs and service performance to the customer) you need to match the type of products you are selling with the type of distribution channels delivering the products. The selection of variables to determine the appropriate distribution channels are largely based around product characteristics with respect to market and customer requirements.

Many companies have adopted a "one-size-fits-all" mentality when it comes to selecting supply chain designs and logistic services [1]. The adoption of this single approach is usually in response to pressure to drive down supply chain costs and maximize efficiencies. Customers and products, come in all shapes and sizes and require quite different outcomes from the supply chain supporting them. Management needs to better understand these differences in customer requirements, and how these differences need to be taken into account in order to align specific supply chain designs with clearly identified customer segments. Supply chain alignment offers benefits that go beyond just cost efficiencies, and if achieved will greatly enhance a company's competitive position.

Management needs to assemble a framework that helps supply chain managers "understand the nature of the demand for their products and devise the supply chain that can best satisfy that demand...the root cause of the problems plaguing many supply chains is a mismatch between the type of product and the type of supply chain" [2]. The resultant framework is a taxonomy based on functional (predictable) and innovative (unpredictable) products.

By segmenting a product range and matching the specific needs of the product segment to a particular supply chain design, logistics performance can be improved [3]. Failure to do this results in a single logistics pipeline that carries a very complex burden, with high costs and customer value deterioration. This effect has been described as averaging; average speeds and averaged costs. The effect is to over serve and over charge customers for commodity style products whilst under serving and under charging (cross subsidize) customers for specialized products. A better balance between customer satisfaction and associated costs can be achieved by differentiating the logistics services [4]. This is analogous to the segmentation approach commonly used in marketing, where differentiated product offerings are targeted on clearly identified market segments based on identified customer needs.

Supply chain design can also be described on the basis of lean or agile [5]. A lean supply chain approach works best in high volume, low variety and predictable environments [6]. An agile supply chain, on the other hand, works best in less predictable environments where the demand for variety is high. This approach is yet another example of segmenting your product portfolio, by some significant criteria, in terms of which type of supply chain design (for example lean versus agile) that you select to supply your customers. More recently Christopher and Towill [7] have extended this approach to a five generic parameter classification; duration of life cycle, time window, volume, variety and variability, known by the acronym DWV3. The classification of demand (supply) chains is further reviewed and summarized by Childerhouse et al. [8]. They reflect that there are few examples in literature on how to achieve the desired level of demand chain focus. Their case study work addresses the design of the manufacturing and distribution processes and proves the general applicability of the DWV3 classification. The classification developed in this paper utilizes the volume, variability and variety taxons in order to extend the approach to the selection of distribution channels.

The first conclusion that can be drawn from the literature is that a segmentation approach of some kind is likely to yield significant benefits if applied to supply chain management. If a workable segmentation and selection model can be derived, then significant reductions in total supply chain costs and increases in customer service are likely to accrue if the right segments are matched with the right supply chain designs. Pushing all your products through the same supply chain design, irrespective of the different behaviors of your products and/or customers is likely to lead to under-performance in terms of cost and service.

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The second conclusion is that the segmentation of a business in readiness for supply chain selection can be achieved on the basis of either products or customers. Case studies exist that describe both approaches. However, closer examination of these case studies and the literature shows that in most cases the segmentation approach actually used is a combination of both product and customer. In order to determine how a supply chain is affected by the behavior of a product and/or a customer it appears necessary to consider product behavior and customer behavior simultaneously.

Selecting the "best" supply chain for a product/customer segment should be based on achieving the right balance between the required levels of customer service and the total costs of supplying that level of service.

Management can then make a rational decision on these two key outcomes in terms of the strategic position of their business in relation to the market and competitors.

The Case Study Company

To test the hypothesis and to aid the development of an appropriate supply chain selection model a case study was used. The case study company, for reasons of confidentiality, herein referred to as IndTech, is a US$15 billion plus technology company with leading positions in electronics, telecommunications, industrial, consumer and office, health care, safety and other markets. IndTech has operations in more than 60 countries and serves customers in nearly 200 countries. It is one of the 30 stocks that make up the Dow Jones Industrial Average and also is a component of the Standard & Poor's 500 Index.

IndTech manufactures and sells a vast range of products. These different products behave differently within the different supply chains. But are IndTech's high supply chain costs and lower than required service levels a result of putting products through, fundamentally, the wrong supply chain design? How does a major manufacturing company, such as IndTech, evaluate the design of its current supply chains for a wide range of different products? What key product attributes should be analyzed to help determine the type of supply chain model to be considered? How should products with different attributes be matched to a "best fit" supply chain design in order to optimize cost and service? Or to put it another way - what really is the right supply chain for your products?

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Background

In the last five years the term "supply chain" has appeared in more and more of IndTech's European job titles, as it moves, organizationally and systems wise, towards having a more process orientated approach.

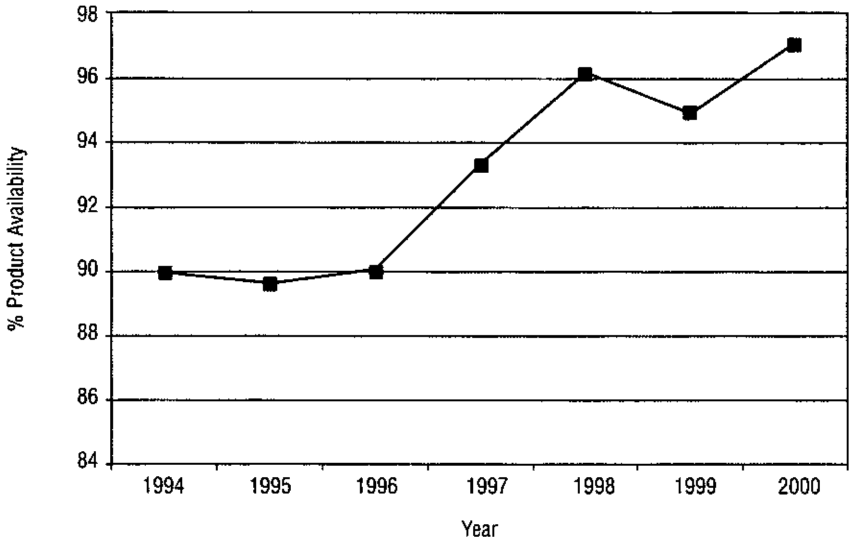
IndTech took the decision to implement a suite of supply chain planning software in 1993, with Manugistics software products being implemented for the whole of the European operation. By 1995, IndTech had implemented a new forecasting system, a new distribution resource planning (DRP) system, and, in key factories, a new master production planning system. The integration of these systems effectively gave the European business units visibility of their internal company supply chain for the first time. The factory planners now had visibility of the inventory in all the warehouses across Europe and could view all the forecasts driving the stock replenishments.

At the same time as implementing the new DRP system a new organizational structure was put into place. Traditionally, the local inventory controllers had been responsible for purchasing products from the factories. This had led to high inventories in some warehouses at the same time as stock-outs existed in others. The responsibility for managing the stock replenishment orders was transferred to a new group of planners, known as central management of inventory (CMI) planners.

These CMI planners were mainly based in the manufacturing plants. It became their responsibility to manage the stock levels in the various European warehouses, based on their production plans and the forecasts developed by the countries. The rationale was one of optimization. With the improved visibility available as a result of the Manugistics implementation, the CMI planners should have been able to get a better balance between inventory investment, production and customer service. They would be able to view and balance the whole of the European supply chain to better support service. With the CMI planners taking on the role of managing warehouse stock replenishments, the local inventory controllers were asked to focus on the quality of their forecasts. The combination of the new systems and the organizational changes resulted in a general improvement in stock availability, and consequently better customer service, see Figure 1.

While companies may have built up traditional strengths (like product development or efficient production technology) that have, in the past, yielded a competitive advantage, with the opening up of global markets, companies are finding these advantages are being significantly eroded. Therefore, to continue to compete successfully, they need to find other sources

Figure 1
Case Study (IndTech) Company's Service Progression



Source: Internal case study company reports, Oct 2000

of competitive advantage. Supply chain management can play an important role in delivering competitive advantage and future competition will be between extended supply chains as opposed to individual companies [9]. Against this background of increasing competitive pressures, IndTech's business directors started to look more closely at what excellence in supply chain management can provide in terms of improved financial performance.

Methodology

The approach was to develop a Product Supply Characterization (PSC) model as a method for supply chain channel selection. The underlying elements of the PSC model are outlined in Figure 2. The rationale behind the PSA model and its development follow [10].

Determining the Costs of the Supply Chain

Selecting the best supply chain for a product/customer segment should be based on achieving the right balance between the required levels of customer service and the total costs of supplying that level of service. Management can then make a rational decision on these two key outcomes in terms of the strategic position of their business in relation to the market and competitors.

Traditional costing approaches are based on the concept of absorbing costs using some form of absorption rate. In the area of logistics and distribution costs this absorption rate is often the sales revenue of a particular business unit. The drawback of using this absorption approach is that no understanding of how costs are influenced is derived from the costing method. At the operational level, of say a warehouse, the costs are driven by such factors as the number of orders placed and the number of items picked. These operational costs are not related to the sales revenue or some other high level convenient measure. To really understand true supply chain costs, the activities driving the costs must be incorporated in the cost model. As these activities will be different for different products and customers, then the supply chain costs must be developed from the "bottom up", and eventually summed to give the total supply chain costs for the business unit.

Anderson et al [11] stated that "companies must analyze the profitability of segments, plus the costs and benefits of alternative service packages, to ensure a reasonable return on their investment and the most profitable allocation of resources. To strike and sustain the appropriate balance between service and profitability, most companies will need to set priorities...." They

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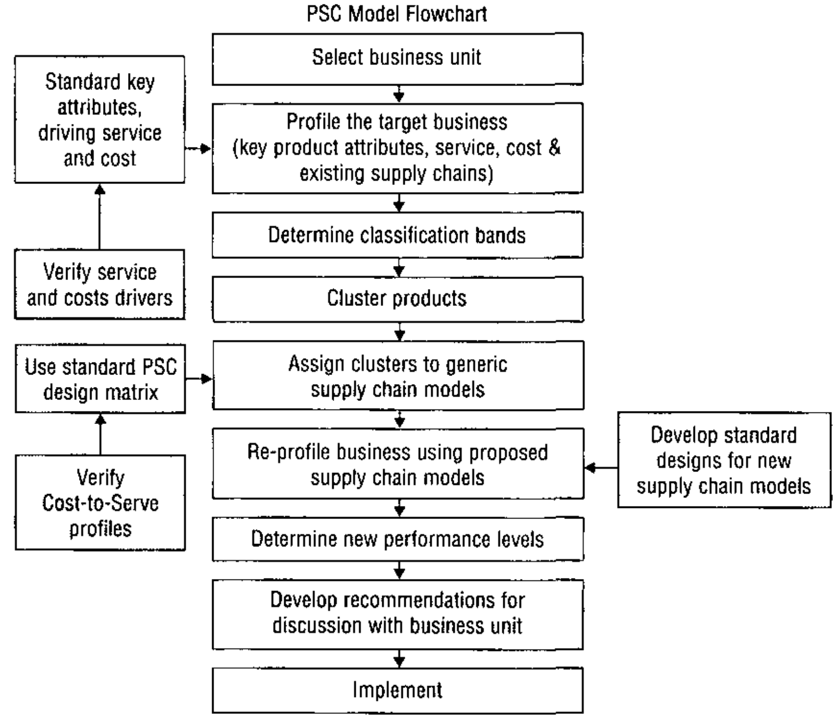
Figure 2
The Product Supply Characterization (PSC) Model



also stated that "only by understanding their costs at the activity level and using that understanding to strengthen fiscal control can companies profitably deliver value to customers".

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Traditional costing approaches (such as absorption costing) do not reflect the true costs of sending a particular order through a particular supply chain. Hence, without proper visibility of true supply chain costs the necessary rebalancing and optimizing cannot be achieved [12].

However, the use of costing approaches that are under pinned by an activity based method can provide supply chain managers with relevant financial information that will enable them to make better informed decisions regarding product, customer and channel profitability [13]. Activity based costing approaches such as cost-to-serve [14]) are able to improve the visibility of supply chain cost information and address the issues relating to product profitability and cost cross subsidy [15], which traditional costing approaches with arbitrary apportionment and absorption rates fail to address [16]. The case study company was fairly advanced in the use of an activity based cost-to-serve methodology for their European operations. This approach was extended to incorporate, the key supply chain cost drivers, as shown in Table 1.

Which Supply Chain Designs to Consider?

The next question to address was that of the generic supply chain models to be considered within the selection model as it was developed. Different generic supply chain designs have different response characteristics and are better suited to some products than others.

Predictable products require a lean supply chain whereas highly unpredictable products require an agile supply chain. A similar separation suggests that functional products be supplied via an efficient supply chain and that innovative products via a responsive supply chain [17]. According to Christopher, "there will be occasions when a pure agile or a pure lean strategy might be appropriate for a supply chain. However, there will often be situations where a combination of the two may be appropriate, i.e. a hybrid strategy [18]." Whereby, a hybrid

Activity	Cost Drivers
Order management and admin	Order or order lines
Primary transport	Cube, routing and frequency
Warehousing	Handling unit and pick details
Inventory financing costs	Stock cover and IRR
Obsolescence	Stock cover and product life cycle
Direct delivery	Cube and frequency
Local delivery	Drop density and order size

Table 1
Typical Cost-to-Serve Cost Drivers by Activity

Source: Alan Braithwaite and Edouard Samakh, "The Cost-to-Serve Method," Logistics Consulting Partners, Chesham. 1997.

supply chain strategy recognizes that, within a mixed portfolio of products and markets, there will be some products where demand is stable and predictable, and some products where the converse is true. It is important that the characteristics of demand are recognized in the design of supply chains [19]. However, it is not necessarily the case that a supply chain should be either lean or agile. Instead, a supply chain may need to be lean for part of the time and agile for the rest.

The key question here is, if hybrid supply chain designs are appropriate, how to decide which part will be lean and which will be agile. Supply chain design must seek to make the supply chain lean up to the de-coupling point, but agile after that point [20]. The de-coupling point is defined as the point at which real demand penetrates upstream into a supply chain, see Figure 3. This point is also sometimes known as the order penetration point.

Prior to the material de-coupling point the supply chain should be forecast driven or lean. After the material de-coupling point the supply chain will be order driven or agile. As Figure 3 shows that the information de-coupling point should be driven as far upstream in the supply chain as possible. True demand information should be used as far up in the supply chain as possible in order to help synchronize the whole chain [21]. The material de-coupling point is the point in the supply chain where inventory is held prior to the order being supplied to the customer. Choosing where this inventory is held is one of the key decisions in supply chain design and defines how much of the supply chain will be efficient or lean versus responsive or agile.

Another consideration in the area of supply chain design is the degree of postponement that will be incorporated into the overall design. There are three different strategies for implementing postponement strategies within a supply chain [22]. The first is form postponement where customization of the product is delayed until the goods are ordered. The second is time postponement where the product is not produced until the order is received. The third is place postponement where the product is only moved through the supply chain once an order has been received.

IndTech operated several different supply chain designs in Europe, although the stock supply chain was widely believed to be the most prevalent one. The study did not look at new supply chain designs for IndTech, but was intended to help the Company select which of its existing supply chain configurations were a best fit with the different products supplied.

Three generic supply chain designs were identified for consideration in the case study company:

- Dispersed stock model: finished goods stock held in more than one European distribution centre.
- Central stock model: finished goods stock held in only one European distribution centre.
- Finish to order: no finished goods held in stock anywhere.

Each of these generic models has varying levels of postponement inherent in their designs.

Figure 4 shows the dispersed stock model. This model is the typical stock model used by IndTech. The material de-coupling or

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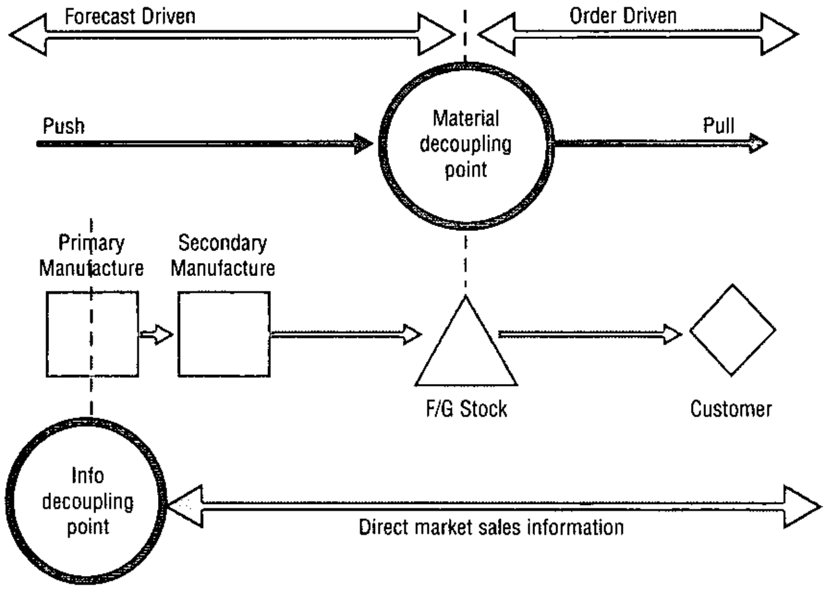
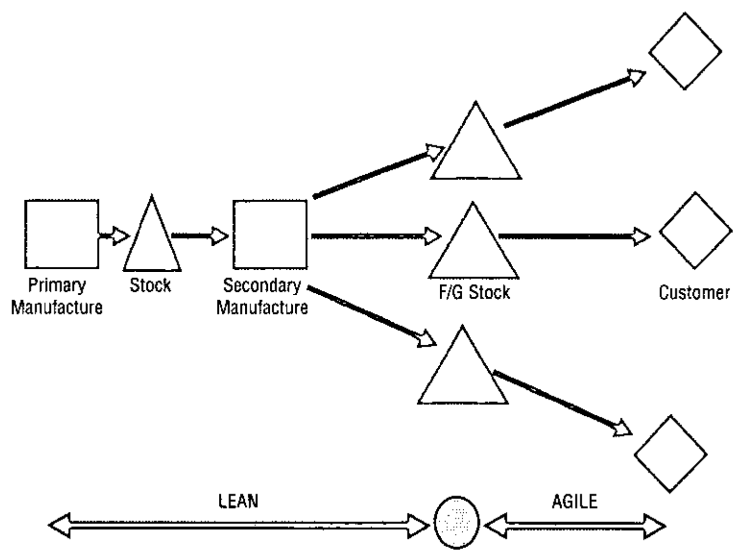
Figure 3
The Design of Hybrid Supply Chains



Adapted from: Mason-Jones, Rachel and Denis R. Towill, "Using the Information Decoupling Point to Improve Supply Chain Performance," *The International Journal of Logistics Management*, Volume 10, Number 2, (1999), pp. 13-26.

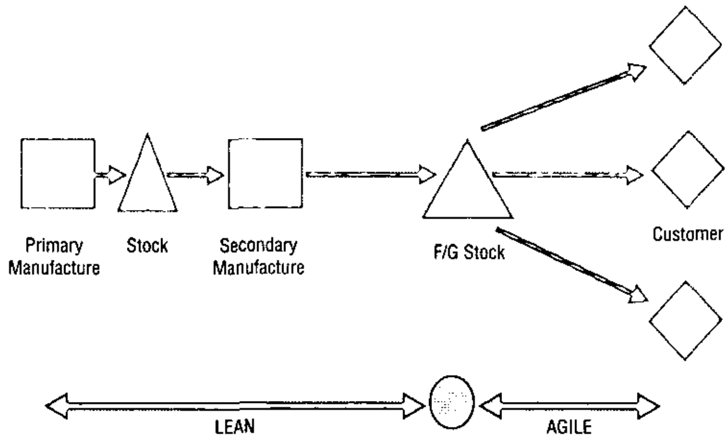
Figure 4
Generic Dispersed Stock Model, Multiple European Distribution Centers



order penetration point is out at IndTech's european distribution centres (EDC's). In this model there is no postponement. The products are manufactured and shipped into the EDCs against a forecast. Therefore, most of the supply chain should be lean with only the final local customer delivery needing to be agile.

Figure 5 shows the central stock model. The material de-coupling or order penetration point is at one central EDC only. In this model there is place postponement. The products are manufactured and shipped into the central EDC against a forecast. However, the products are not moved to the relevant

Figure 5
Generic Central Stock Model, Single European Distribution Center

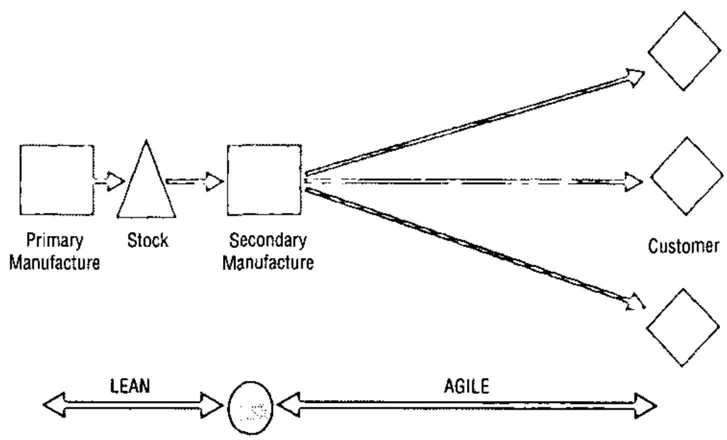


country until a customer order has been received. Therefore, some of the supply chain should be lean, but with the need for the transportation of the product from the central EDC to the customer being agile.

Figure 6 shows the finish to order model. The material de-coupling or order penetration point is back at the secondary manufacturing stage. In this model there is place, time and form postponement. The final product is not finished from work-in-progress inventory until the customer orders it (form postponement). The manufacture of the product is not triggered until the order is received (time postponement) and the product is not moved into the supply chain until the order is received (place postponement). In this model most of the supply chain needs to be agile, that is, responsive to the customer order. The supply chain up to the de-coupling point can remain lean though. Therefore, up to the WIP inventory store the supply chain should be run on a lean or efficient basis.

In summary, the development of a segmentation and selection model, in this case study, used the three generic supply chain models of dispersed stock, central stock and finish to order as the basis for evaluation of how different products will perform within

Figure 6
Generic Finish to Order Model, Direct Distribution from Manufacturing



these three generic models. These three models represent three examples of supply chains with very different levels of postponement inherent in their designs. It was believed that these designs were different enough to allow the selection model to distinguish which groups of products would be best suited to each of the chosen supply chain models.

Data Analysis

The data analysis was carried out on one European division of IndTech and comprised some 700,000 customer order-lines and 20,000 unique products.

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Product Clustering by Key Attribute

The attributes that were believed to be the key determinants in a supply chain design selection model were:

- Volume - in terms of pallets
- Volatility - a measure of overall demand variability
- Orderline value
- Frequency of orderlines
- Orderline weight
- Substitutability of a product - that is, if this product is out of stock could the company supply another product to satisfy the customer or would the customer immediately go to a competitor to re-source the product?
- Number of customers buying each product.

Detailed data analysis also helped to determine appropriate bands by which products could be characterized using the key attributes described above. The following logic was used to set the bands and is summarized in Table 2.

- Pallets per week. "A" products to be those with a European demand greater than one pallet per six weeks. One pallet per six weeks was chosen as a reasonable minimum replenishment cycle in order to ensure full pallets to the warehouse network at near minimum cost.
- Volatility. The volatility of a product was determined by dividing the standard deviation of demand over a 12-month period with the mean demand. It gives a representation of how variable the demand pattern was in relation to the average demand. "A" products to be those with a volatility below 0.5. A volatility of greater than 0.5 shows significant reductions in service, with associated larger levels of inventory to support that lower service level
- Average orderline value. "A" products to be those with an average orderline value of equal to or greater than US$2000. "B" products to be those with an average orderline value of between US$2000 and US$100. "C" products to be those with an average orderline value of less than US$100. The rationale behind the choice of these bands was to try to classify products in terms of how their orderline values would effect true profitability, after the true supply chain costs were taken into account. As supply chain costs are mainly activity driven, and the associated costs are based on this level of activity, then a higher value orderline can stand a higher amount of activity as it passes along the supply chain, and still produce a reasonable return. A low

Table 2
Product Characterization Variables

	Product Characterization		
Measure	**A (fast moving)**	**B**	**C (slow moving)**
Pallets per week	1 pallet every 6 weeks or more	–	–
Volatility	0.5	–	–
Order line value	>US$2000	US$100-2000	<US$100
Order lines per year	>780	52-780	<52
Average order line wt	>1000Kg	25-1000Kg	<25Kg
Substitutability	Critical	–	Non-Critical
No. of customers per year	5 or more	–	<5

orderline value product will suffer a steeper reduction in profitability if it experiences significant activity through the supply chain. Hence, a different supply chain approach maybe necessary for products with different orderline values.

- Orderlines per year. "A" products to be those with more than 780 orderlines per year (i.e. more than three per selling day). "B" products to have between 780 and 52 orderlines per year (i.e. between three per day and one per week). "C" products to have less than 52 orderlines per year (i.e. one per week). These classification bands were chosen to help differentiate the products in terms of how actively they are ordered by customers. The "A" products will be ordered often and will probably be stocked somewhere in the supply chain in order to optimize cost and service. The "C" products are ordered infrequently and would probably need to be finished to order. For the "C" products a value of less than 52 orderlines per year was chosen as this equates to an average of one orderline per week or less. This level of ordering activity is within the current capability of IndTech's manufacturing equipment, and does not necessitate the need for improvements in the flexibility of these machines in order for them to cope with making these "C" products to order.
- Average orderline weight. "A" products to have an average orderline weight of greater than 1000 kilograms. "B" products to have an average orderline weight between 1000 kilograms and 25 kilograms. "C" products to have an average orderline weight of 25 kilograms or less. The weight of an orderline has a big impact on the transportation costs incurred in moving that orderline along the supply chain. Classifying products by their weight is an important factor in the cost model particularly where parcel carriers may be involved in the final customer delivery as they have optimum (and maximum) weight limitations.
- Substitutability. "A" products to be critical to the customer. "C" products to be non-critical.
- Number of customers per year. "A" products to have five or more different customers per year. "C" products to have less than five different customers per year. This attribute is used to try to assess the risk of obsolescence. If a product has four or less customers in a year then it can be described as highly customized.

Each product was assessed based on its individual value for each of the seven key attributes. The classification and clustering approach was applied to the 20,000 products that made up IndTech's product portfolio in 1999. This resulted in 102 product clusters describing the 20,000 products analyzed, where all the products in each cluster have similar characteristics.

Design Matrix

Next a matrix was developed to aid in the selection of the most appropriate supply chain design for each of the identified product clusters. The logic for the design of the matrix followed these principles and assumptions:

- Products with a demand volatility of 0.5 or less are suitable to be in the dispersed stock model. Above 0.5 volatility the dispersed stock model does not cope with the demand variability and service degrades in tandem with increasing inventory levels. This is primarily a result of the supply chain dynamics and control processes being unable to cope with high level of demand variability in a suitable manner. It is assumed that the central stock models and finish to order models, due to their increased levels of postponement and risk pooling, are more capable of dealing with demand variability. Hence, products with volatilities above 0.5 are assigned to either of these two models.
- Products with volumes of one pallet per six weeks or higher are suitable to be in the dispersed stock model. Products with volumes less than one pallet per six weeks are only suitable to be in the central stock or finish to order supply chain models. This assumption is centered on costs. A dispersed stock supply chain will be efficient where products can be shipped economically into the local warehouses, ready for distribution to customers. Costs decline when the product can be moved around in full pallets. When the product sells in low volumes and full pallets are not feasible or causes excessive inventory

levels then the use of a dispersed stock model is likely to prove uneconomic.

- Products with 52 orderlines or less per year have insufficient activity on them to cause a problem to manufacturing if they were placed in the finish to order supply chain model. With one orderline or less per week, the factories would not suffer any significant loss of efficiency through excessive set-ups. Products with more than 52 orderlines per year are suitable to be placed in either the central stock or dispersed stock models.
- Products with average orderline values of US$ 100 or higher are suitable to be placed in the finish to order models. This assumption is centered on profitability. Secondary (customer) distribution is more expensive than primary distribution. In the finish to order model there is only secondary distribution and no primary distribution. Therefore, in order to try to maintain a suitable margin, only products with average orderline values above a threshold should be put into this model. For the dispersed and central stock models then products with any orderline value can be assigned.
- It is assumed that products with any level of average orderline weight can be assigned to the dispersed stock model. This model would successfully cope with all weight categories. The "Express (24hr)" versions of the central stock and finish to order models can only be assigned products with average orderline weights of 25 kilograms or less in order to gain the maximum economies of using a more expensive parcel carrier (Croners, [23]). The "Standard (five working days)" versions of the central stock and finish to order models can be assigned products where the average orderline weight is above 25 kilograms.
- Products that have four or less customers per year are deemed to be at high risk of obsolescence due to customer turnover. Hence, these products should not be stocked in order to minimize non-working inventory issues. Therefore, products with four or less customers per year can only be assigned to the finish to order supply chain model.

For each key attribute, a decision was taken as to which class of that attribute fitted best with each generic supply design. The matrix was designed in an attempt to determine the best-fit supply chain from the perspective of both service and total supply chain costs. Table 3 shows the design matrix that was used to assign the product clusters to

Table 3
Supply Chain Design Matrix

	Pallets	Order lines	Volatility	Average Order line Value	Degree of Criticality	Average Order line Weight	Number of Customers pa.
Dispersed Stock Model	A	A B	A	A B C	A B	A B C	A
Central Stock Model (Express)	A C	B A	C A	B C A	A B	C	A
Central Stock Model (Standard)	A C	B A	C A	B C A	A B	A B	A
Finish to Order (Express)	A C	C	C A	A B	A B	C	C
Finish to Order (Standard)	A C	C	C A	A B	A B	A B	C A

Express – 24 hour parcel carrier service < 25 Kilograms
Standard – 5 working days > 25 Kilograms

the different generic supply chain designs.

Each product was assigned a value for each key characteristic. This resulted in each product having a 7-character code assigned to it (e.g. AACBAAA). Then based on the matrix in Table 3 one of the generic supply chain designs was assigned to the product. For example, a typical high volume product had the characteristic code AAABBAA, that is, it was a high volume, stable product that sold to many different customers. Using Table 3 the characteristic code AAABBAA fits into the dispersed stock model (follow the characteristic codes from right to left and the final supply chain design is narrowed down). Another product had the characteristic code CCABBAC, it was a slow moving product that only sold to a handful of customers each year. Again applying Table 3 shows that the most appropriate supply chain is the finish to order design.

This process was repeated for each product in the case study. The result was that 87% of the product range was directly assigned to one of the three generic supply chain designs. The remaining 13% of the range had characteristic codes that did not exactly fit within the design matrix. However, these 13% of products only accounted for 1% of sales revenue and 1% of the total orderliness. These products were fitted into the nearest fit supply chain design taking their volatility rating as the most important factor.

Results

Did the application of the PSC to the product portfolio of IndTech yield any significant potential benefits? The "as was" case could be ascertained directly from the historical data. The future scenario was re-costed and various other service and inventory impacts evaluated.

Figure 7 illustrates IndTech's reliance on the traditional dispersed stock model. The "as was" analysis indicated an overall supply chain cost of 14.5% of sales.

Figure 8 illustrates what IndTech's business could look like after the application of the PSC supply chain selection model. The model is recommending less reliance on the traditional dispersed stock model, and much more use of the central stock model. Re-running the cost analysis for this case illustrates that the supply chain cost could reduce to 9.9% of sales from 14.5% of sales. Comparison of supply chain costs between the before and after shows that application of the segmentation and selection approach has resulted in the costs reducing by US$ 7.34 million, or 32%. This is a large reduction in total supply chain costs, increasing bottom line profit, from the same sales, by 4.6%. Also, the realignment of supply chains improves service as demonstrated in Table 4.

More use of the central stock model also improves inventory turns. The case study results are shown in Table 5. This table shows that (through application of the

The model is recommending less reliance on the traditional dispersed stock model, and much more use of the central stock model. Re-running the cost analysis for this case illustrates that the supply chain cost could reduce to 9.9% of sales from 14.5% of sales.

Figure 7
"As Was" Situation for Case Study Company

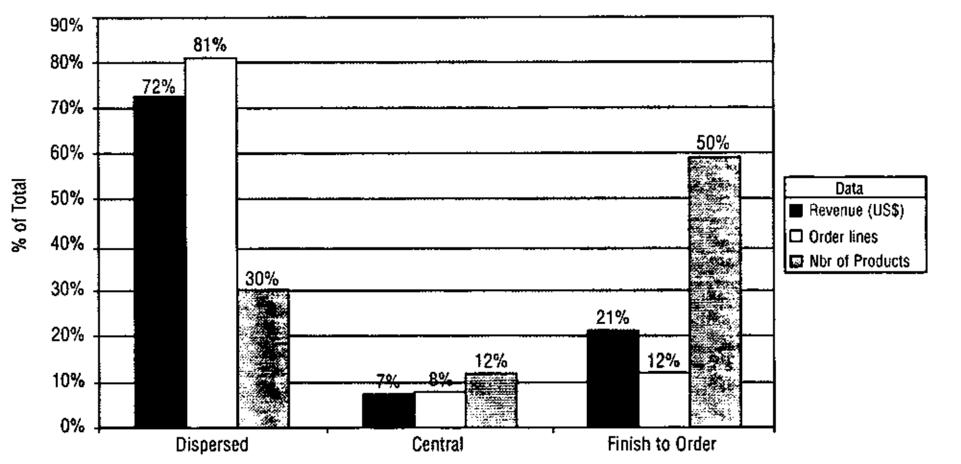
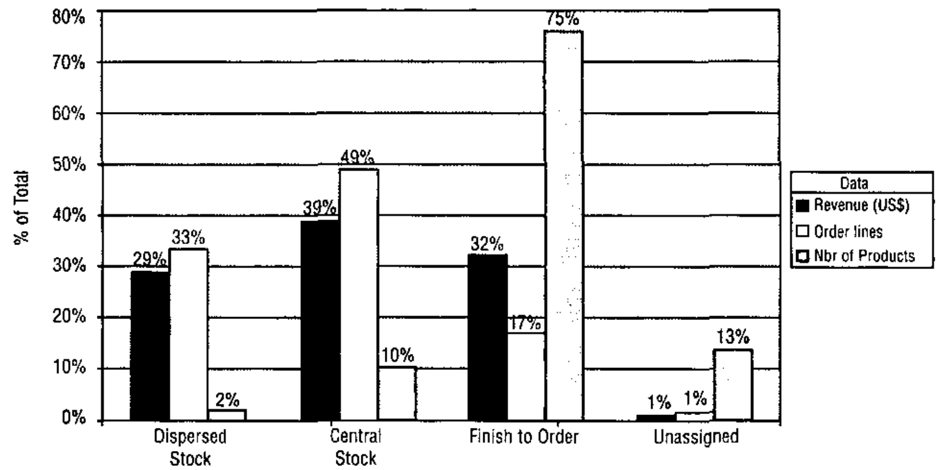


Figure 8
After Application of the PSC Model in Case Study Company



segmentation and selection model) IndTech's inventory investment can be reduced by 22% (US$ 4.7 million). This is worth an ongoing US$ 0.5 million per year in terms of the cost of capital.

This inventory reduction is due to the more optimum matching of products to supply chain channels. For example, in the dispersed stock supply chain, the months of stock has reduced from 2.5 to 2.01. This is purely due to reallocation of products with characteristics not suited to dispersed stock model (and which had exceptionally high inventory cover when they were in the dispersed stock model) to the central stock or finish to order models.

Additional inventory savings would be achieved after optimization of the safety stocks for the two stock models. The products now allocated to the dispersed stock model would have lower demand volatilities and would therefore need lower safety stock levels to achieve higher service levels. This reduction is not included in Table 5. The products now allocated to the central stock model would require lower safety stocks than the total of their safety stocks in a dispersed model, due to the risk pooling effect of having all the demand fed into one inventory location in Europe. Again, this potential reduction is not included in the numbers in Table 5.

Implementation Considerations

Following on from the product characterization IndTech implemented the supply chain design changes as indicated by the analysis. Initially, the products designated for the dispersed stock supply chain design were moved under this channel. This was IndTech's traditional channel and was relatively easy to set-up. Next the products

Table 4
Simulated Service Results After Supply Chain Realignment

	1999 "As Was"	Proposal	% Improvement
At Order-line Level:			
<=80% of orderlines	6 days lead-time	5 days lead-time	17%
<=95% of orderlines	11 days lead-time	6 days lead-time	45%
Average	10.2 days lead-time	6.6 days lead-time	35%
Standard Deviation of lead-times	10.7 days	3.6 days	67%
At Product Level:			
<=80% of products	13 days lead-time	7 days lead-time	46%
<=95% of products	>19 days lead-time	12 days lead-time	>36%

Table 5 Simulated Inventory Position After Supply Chain Realignment			
	Inventory (units)	3 Month Demand (units)	Months of Stock
1999 As Was Supply Chain:			
Dispersed Stock	372,591,533	446,846,407	2.50
Central Stock	33,275,706	39,069,620	2.56
Finished to Order	0	8,825,234	0.00
Total	405,867,239	494,741,261	2.46
Inventory (US$)	**20,509,066**		
Proposed Supply Chain:			
Dispersed Stock	153,236,611	229,122,896	2.01
Central Stock	159,677,588	174,141,088	2.75
Finished to Order	0	82,483,391	0.00
Unassigned	6,610,333	8,281,688	2.39
Total	312,914,199	485,702,375	1.93
Inventory (US$)	**15,812,012**		
Inventory Saving (US$)	**4,697,053**		
Cost of Capital of Inv. Saving at 10%	**469,705**		

destined for the central stock model were identified. This supply chain design required the secondary distribution to the customer to be rapid enough to met the lead-time from one central warehouse in Europe. Pilots were set-up to ensure the lead-time targets could be meet in all cases. Once this was successfully established the designated products were progressively rolled into the central stock model. Finally, the finish to order products were implemented after changes to the factories to allow the establishment of "make to order" production modules within the factories. These "make to order" modules allowed the factory to focus on small batch production with many change-overs, distinct from the high volume lean production lines. Once the products were assigned into their designated supply chains the identified benefits began to flow.

Conclusions

In this article, we addressed the following questions:

- How does a major manufacturing company, such as IndTech, evaluate the design of its current supply chains for a wide range of different products? The application of the PSC model is a good way of assessing this.
- What key product attributes should be analyzed to help determine the type of supply chain model to be considered? The case study has shown that key attributes can be identified for analysis purposes. Products within a company's portfolio can then be clustered using these key attributes to help with the assignment of a more ideal supply chain design.
- How should products with different attributes be matched to a "best fit" supply chain design in order to optimize cost and service? Again, the case study has shown that the application of an appropriate segmentation and selection model (such as the PSC model) can help drive the decision making process as to which generic supply chain model should be used for which product segment in order to improve supply chain costs and service significantly.

The development of the PSC model and its application in IndTech has shown the value of matching specific product clusters with appropriate supply chain designs as well as the high cost of having a mismatch between products and the supply chain design.

The development of the PSC model and its application in IndTech has shown the value of matching specific product clusters with appropriate supply chain designs as well as the high cost of having a mismatch between products and the supply chain design.

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