AN EVALUATION OF MANAGING DIVERSITY IN THE SUPPLY CHAIN: A CASE STUDY OF AN ELECTRICAL DISTRIBUTOR IN THE UK

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Introduction

Businesses are complex dynamic systems, operating within non-linear environments. They are driven by strategic plans which are conceived and implemented within the tactical and operational levels of the organisation, executed through a myriad of processes including decision-making, involving a combination of technological and human-resource. Businesses operate within markets which are diverse, where the needs and service expectations vary widely. This diversity is also evident in the values that customers have of a company. There is an implicit relationship between the diversity of the market and the diversity within the organisation. This external and internal diversity is a key driver in the formulation of strategies which ultimately determine how a business functions operationally and performs within the market.

The method of understanding and managing the diversity within a business is at the heart of the reasoning behind the concept of 'supply chain segmentation'. The overarching principle is to find economic segments within the diverse product and customer mix and to match differentiated strategies accordingly. Fuller *et al* (1993, p.90) showed that where an averaging of logistics functions exists, a 'diseconomy' is created when uniform standards and polices are applied– 'a one size fits all approach'. The aim of supply chain segmentation is to prioritise resource to both the products and customers which contribute the highest proportion of sales and to reduce operational costs to those that contribute the lowest proportion of sales, whilst matching service level requirements. In essence, this strategy balances supply chain costs for individual products against their value to the business. As a result overall costs are reduced and subsequently profits are increased.

Whether through conscious efforts or through the application of a logical framework, organisations have always responded to market diversity by tailoring their products and approaches to meet the needs of their consumers. The pioneering work of Smith (1956) led to the formalisation of market segmentation. Smith (1956) argued that heterogeneous markets can be segmented into smaller homogenous markets; a differentiated strategic approach can then be applied to meet the individual needs of these segments. Smith (1956, p.3) defines a segmentation approach as "a rational and more precise adjustment of product and marketing effort to consumer or user requirements". Whilst this concept is now widely understood and is a core principle of marketing literature (Kotler and Armstrong, 2010; Lamb *et al*., 2008*)*, supply chain segmentation is less well known and as Lovell *et al* (2005) argue is an underused method.

Supply chain segmentation follows the same basic principle of market segmentation to the management of the supply chain. It is a method which manages the business diversity throughout the supply chain. A.T. Kearney (Feb 2008) propose that "the key to supply success lies in dynamic management – matching the right strategies with the right situation". Companies tend to have a finite amount of assets and available resource so it is imperative that these are used in the most effective and economic way – this is fundamentally what segmentation-based strategies achieve.

This paper sets out to show how a segmentation methodology can be applied to all planning levels: strategic, tactical and operational and the extent to which this can improve service levels and reduce operational costs. A segmentation strategy, which combines different supply chain and research methodologies, is applied to a UK company operating within the electrical industry.

Managing diversity using a segmentation approach

There is much diversity within supply chains because businesses sell a wide range of products to many different customers. It is desirable to serve customers with a mix of products to satisfy varying needs. Increasing global competition, new technologies and changing customer habits have led to greater customisation and product variety; have changed the dynamics of markets (Fisher *et al*., 1994; Ramdas and Spekman, 2000; Ramdas, 2003). This has led to business strategies which increasingly compete on service, putting pressure on the operation and leading to increases in inventory carrying costs, markdowns and write-offs and reductions in profit margins (Fisher *et al*., 1997). It is believed that mass customisation is the new business frontier for manufacturing and service industries (Pine and Davis, 1999). This is different to mass production markets which serve the "average customer". Mass customisation aims to offer "the most suitable product to each one of their customers" (Saisse and Wilding, 1997, p.200). This adds to the diversity in supply chains as product choices are increased and life cycles are shortened. This has been particularly true in markets such as personal computers, consumer electronics, cars and chemicals which have seen increases in new product introductions and product variety (Saisse and Wilding, 1997; Ramdas, 2003).

It is naturally advisable for companies to compete for business by delivering requirements demanded upon it by its customer base because; fundamentally, it is the customers who provide the income to keep a company solvent. In an ideal world businesses would best direct their strategies towards total customer satisfaction. If customers are not satisfied with the service they receive it is likely that they will move their business elsewhere. To satisfy all customers across the entire business (100% service level) however would require an unprecedented amount of invested cost (Woo and Fock, 2004). In the context of the supply chain the objective is to "maximise the overall value generated" (Chopra and Meindl, 2007). This is not easily achieved because the measures of cost and customer service trade-off against each another. According to Christopher (1998) as customer service levels approach 100% the elasticity of cost increases exponentially (see figure 1). At this point many products and services become unprofitable as operational costs begin to outweigh market costs. A point is reached where an optimum service level cost is reached. The cost of service starts to outweigh the benefit of revenue returns and profits are maximised.

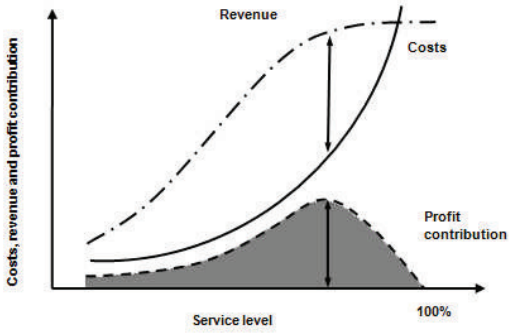

Figure 1: The cost/benefit of service (Christopher, 1998)

The aim of a business is to capitalize on profits by maximising its turnover of sales whilst minimising operational costs. The characteristics of products determine the level of resource that is required to serve the customer. In an instance where resources are uniformly allocated to products a disproportionate level of supply chain costs are incurred. For products which incur excess operational costs their margins are eroded; sometimes to an extent which can result in a negative profit for those items. Furthermore high value products can become neglected if operational resources are not directed effectively. Products which are deemed high priority by customers can fall below service expectations. This means that all products and customers should not have the same level of service (Sabath and Whipple, 2004). The view of A.T Kearney (Sept 2008) is,

> "Providing customers with the right products and services all of the time can be a complex, asset-heavy process, fraught with inefficiencies, waste and duplicate efforts".

A supply chain segmentation method reduces overall supply chain costs and increases service levels by finding solutions to the various supply chain trade-offs. The approach serves customers and products through distinct logistic pipelines, through a predetermined process which uses individual product and customer characteristics. There are few academic papers which embrace this as a subject even though the positive benefits have been emphasised (A.T. Kearney, 2008; Fuller *et al*, 1993; Lovell *et al*., 2005). Supply chain management literature that covers some aspects of segmentation, either intentionally or not, tends to be as part of a larger discipline, such as inventory management, supply chain and network design, warehouse design and management and transport. It is uncommon for segmentation to be a key supply chain strategy which has undertaken a formal planning process and which is then carried out within the different planning levels of the business; strategic, tactical and operational.

An article in the Harvard Business Review in 1993, entitled 'Tailored logistics: The next advantage' showed that companies should have distinct channels of distribution which serve different customer segments, describing them as 'logistically distinct businesses' (Fuller *et al*., 1993, p.87). The article has been described as the first to address this within the context of a supply chain (Lovell *et al*, 2005). The central point of the article was to show that where an 'averaging' across logistics functions exists, where "things flowed through consolidated channels at an average speed and were charged at an average cost" a 'diseconomy of scale' is created by logistics managers who apply uniform standards and polices (Fuller *et al*., 1993, p. 90) – 'a one size fits all approach'. This creates an unbalanced level of customer service and resource priorities are given to the wrong types of products, leading to congestion within the supply chain and an increasing of operational costs. Fuller *et al* (1993, p.90) argued that it is suboptimal to treat each product and customer as equal when in fact there is much diversity, leading to the notion that "customers who needed specialized products quickly but unpredictably tended to be underserved, whilst customers for more commodity-like products were overcharged".

In addition to Fuller et al (1993) it has been argued that different product types require different supply chains (Fisher, 1997; Haung *et al*., 2002; Selldin and Olhager, 2007; Payne and Peters, 2004). Fisher (1997) uses an approach not too dissimilar to Fuller *et al* (1993). It is unclear to what extent the article was influenced by Fuller *et al* (1993) but there are parallels to be drawn. Fisher's article, however, has less detail and doesn't ask some of the more precise questions that were posed by Fuller *et al* (1993). It is suggested by Fisher (1997, p.106) that 'before devising a supply chain, consider the nature of the demand for your products'. Fisher (1997) suggests that a supply chain strategy of efficiency or responsiveness can be adopted depending on whether the type of product is either functional or innovative. A functional product is described as a staple product and an innovative product as a fashion product. A particular product is segmented as either a functional or innovative product by the characteristics it exhibits. Harrison and van Hoek (2005) use the characteristics of volume and variability to segment the supply chain into four distinct categories. Christopher and Towill (2002) propose that three variables can be used to define supply chain strategy; products (either standard or special); demand (either stable or volatile); and lead time (either short or long). A survey conducted by Selldin and Olhager (2007) of 128 companies showed that more companies which had used Fisher's model out performed companies which did not.

Recent academic press has tended to cite Fisher's matrix as the foundation for discussion on supply chain segmentation and it has been mostly used as a method in supply chain design (Christopher and Towill, 2002; Lee, 2002; Mason-Jones *et al*., 2000; Naylor *et al*., 1999; Payne and Peters, 2004). Since the 1980s the two paradigms of lean and agile were developing exclusively of each other. In the late 1990s these two paradigms have been drawn together to form a new paradigm called leagile. The methods shown in Fisher's segmentation matrix and leagile methods, which combined lean and agile principles, were aligned (Childerhouse and Towill, 2000, p.340; van Hoek *et al*., 2001, p.131). Leagile methods are superimposed onto Fisher's matrix, where the functional supply chain represents lean practice and the innovative supply chain represents agile practice. It is unclear if Fisher's matrix developed this new approach or it was done as an afterthought. Huang *et al* (2002) build upon this matrix adding a third product type of hybrid. A hybrid product is one that has both functional and innovative characteristics.

For some companies the level of investment required to operate two supply chains which are physically distinct could possibly outweigh the benefits. This would apply to businesses with small revenues, which operate a local supply chain and have a small number of suppliers or products. The process which segments products by their characteristics into either functional or innovative is vague and doesn't focus on the use of business data. The

research concentrates on the different types of products and how they should move within the supply chain. There is no consideration of how this relates to different types of customers and does not attempt to solve supply chain trade-offs and therefore a profitability approach is not used. Sabath and Whipple (2004) have taken an approach which draws together different types of product and customer types into what is described as a customer/product action matrix. Their approach is to segment products and customers using an Activity Based Costing (ABS) method. Products and customers can be one of the four different segments: extremely profitable, highly profitable, marginally profitable and unprofitable.

In reality, grouping products into two distinct categories using a small number of factors isn't always the best solution to adopt, an observation made by Lovell *et al* (2005, p.143). Supply chains for many companies are too complex because of their diverse product range and large supply base to make that simple distinction. A study of segmentation by Lovell *et al* (2003) builds on the work of Fuller *et al* (1993). It is the most in-depth study of this nature and embraces segmentation as a strategy and methodology in its own right. Lovell *et al* (2005) argue that the optimum segmentation strategy lies somewhere between the two distinct supply chains used in Fisher's (1997) model and a supply chain for every individual product. Lovell *et al* (2005) provide a table of possible factors that can influence supply chain segmentation of products and customers. There list is not exhaustive but does allow for an understanding of the different factors that can be considered. There are different types of strategies discussed but there is little detail on an operational methodology. For instance, it is argued without going into any detail that products with a short life cycle would lend themselves best to networks that hold low levels of inventory and use fast transport nodes. An emphasis is put on value density as a measure to determine the choice of supply chain and it is argued that centralised inventory is well suited for higher product value densities.

The segmentation process can provide practical solutions for operational decisions as well as strategic design. For instance solutions can be found to support storage, handling and purchasing decisions (Smith and Slater, 2001). Cachon and Fisher (1997) show that inventory can be reduced if individual rules for average demand and demand variability are used. Smith and Slater (2001) propose that inventory decisions can be formulated by segmenting products into six categories using the characteristics of sales volume and sales variability. Different methods for forecasting and purchasing can be applied depending on the type of product.

Research design

Both the benefits and situations for when a research case strategy is applicable are laid out by Yin (2003). It is appropriate in the context of this research project due in part to the complexity of the problem but also because it is the most feasible way of testing the efficaciousness of the strategy employed. Furthermore, a working supply chain provides the platform to implement new solutions and provides a platform for where observable results can be examined. It is not possible to form a supposition of the benefits of such a strategy without carrying out a project of this kind. A case study research strategy is therefore the appropriate method to achieve these goals.

As a strategy, a case study approach is a common method used in supply chain management studies It is an effective method for conducting research for studies of this type (McCutcheon and Meredith, 1993; Voss, 2002). According to Voss *et al* (2002, p.195) a case study research strategy has "consistently been one of the most powerful research methods in operations management". Typical research methods which use experiments, surveys and history are not applicable for this study because of their limited ability to deal with a large number of variables with a wide-reaching focus. A pilot study approach was used to test and implement various solutions, which when proven to be successful was implemented throughout the rest of the business.

Description of the problem

The case study company is a wholesale distributor of electrical materials and safety equipment, and also parts and spares for maintenance, repair and operations (MRO). The electrical wholesale industry is an intensively competitive market, with pressures from external forces, competing on price, product availability and delivery service. The business has developed a culture, reinforced through strategic policies, where the main aim has been a drive to increase sales. A single supply chain strategy is used to serve all customers with products regardless of their actual value to the business. This atomistic culture has resulted in reducing profits over the long term due to increased logistics costs such as the costs of carrying excess inventory. A profitability analysis

(Smith and Slater, 2001) showed that many products and customers were unprofitable. The results of the product profitability analysis are shown in figure 2. This high level of unprofitability was because logistics costs were exceeding product margins as a result of high volumes of stock obsolescence, low levels of stock turnover and low levels of operational productivity.

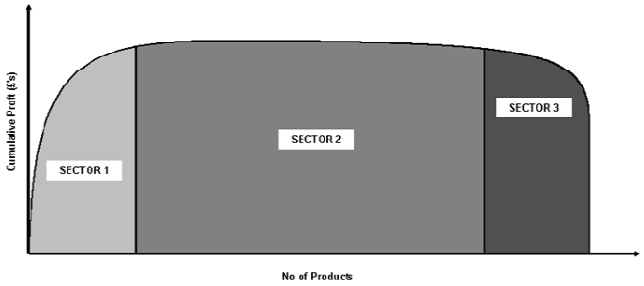

Figure 2: Cumulative product profitability analysis

The case study

Two separate projects were carried out within the case study company from September 2006 to December 2008. A review was undertaken to gain an understanding of the design of the supply chain, operational methods and to uncover the reasons behind the under-performing operation. It was proposed that the supply chain should be redesigned so that the service levels of products and customers reflect their respective value to the business. A segmentation strategy was applied at the different levels of the business in an attempt to reduce the supply chain issues which the business was experiencing. The objectives of the projects were to:

- reduce the amount of products;
- remove obsolete stock;
- increase the rate of stock turnover;
- increase operational productivity;
- improve working conditions;
- improve supplier delivery reliability;
- improve customer service levels (product fulfilment

The first project was carried out within the Southwest region of the business, where changes were made to the design of the supply chain and to the design and layout of a regional distribution centre (RDC). The major problem was with the large amount of stock congestion at the branches and RDC. Products were categorised by sales volume into A, B and C classifications and customers into key, core, occasional and competitor's classifications. A warehouse was opened to hold all of the slow moving products. A customer service level matrix was designed using the customer and product classifications and to establish new delivery times. These changes to delivery times meant that overall transport costs could be reduced and service levels for key customers increased. The layout of the RDC was redesigned after the slow moving products were removed. A storage media type and location for each product was allocated using the products volume, type and weight and the maximum quantity to be held.

The implementation of the project created some immediate benefits. The benefits from the changes to the operation are readily observable. The redesign of the warehouse, the movement of stock to the slow moving warehouse and removal of obsolete products freed up space and increased the efficiency of the operation. It became much easier to walk around the warehouse and reduced put-away and picking times because the congestion had been reduced. The improvement of the layout in the warehouse, by placing priority products in the most favourable positions, means that productivity levels were increased. Manning levels were reduced by 15% as a result. As part of the location process the products are amalgamated into one easily identifiable location. The products are counted and any differences in the balance of stock changed. The ease of which the right products could be easily located improved the accuracy of stock levels from 82% to 98%.

The second project was based upon a study which was undertaken of the company's purchasing and inventory system. Analysis undertaken of a number of products had showed that the behaviour and level of stock was erratic and in excess of what was deemed acceptable by the company. An example of an analysis of single product for a year is shown in figure 3. This was because of inadequate forecasting techniques and inventory methods which were being used. The same methods were also being used to calculate reorder levels and purchasing quantities for all products.

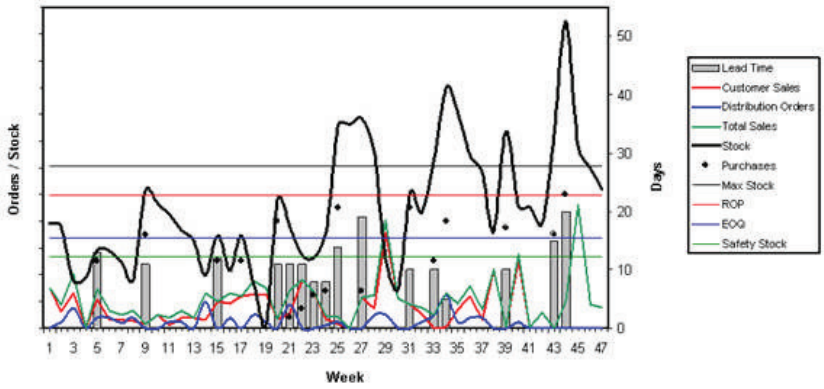

Figure 3: Product analysis

A discrete event simulation (DES) model was designed to fully replicate the system and to act as a vehicle to test a number of scenarios using a segmentation approach. The factors of product classification (A, B and C), product variability and lead time variability were used to split the products into twelve different segments. The products were classified using a combination of sales volume and sales revenue. These two factors were used to take into account the value which was generated for the business and the value to the customer. The inventory methods which were used to calculate the level of the reorder point and the purchasing quantity were set depending on the classification of the product. The variability of volume was calculated using a correlation coefficient equation. The results from this equation were used to determine the type of forecasting method and the parameters for the base and the trend. A four month and six month sales period were used to calculate the base and trend respectively. Products which exhibited large values were given a larger parameter value. A coefficient of variance was used to calculate the variance of lead times. If a product exhibited a high lead time coefficient then an extra quantity of safety stock was added.

Correlation coefficient

$$r = \sqrt{\frac{[n\sum_{i=1}^{n} t_i Y_i - (\sum_{i=1}^{n} t_i)(\sum_{i=1}^{n} Y_i)]^2}{[n\sum_{i=1}^{n} t_i^2 - (\sum_{i=1}^{n} t_i)^2][n\sum_{i=1}^{n} Y^2{}_i - (\sum_{i=1}^{n} Y_i)^2]}}$$

Y = Month sales
t = Month
n = Number of months

Coefficient of variance

$$CV = \frac{\sigma}{\mu}$$

CV = Coefficient of variance
σ = Standard deviation of sales
μ = Mean of sales

The results from the simulation model showed that the segmentation approach outperformed the current 'one-size' fits all approach. The results indicated that customer service levels for the fastest moving products (A classification) could be increased from 95% to 98%. This was because forecasting errors were reduced and the reorder levels could be set to better match the pattern of sales. The total number of products stock-outs was also shown to be reduced. The overall level and cost of stock held could be significantly reduced by increasing the turnover of stock for slow moving products (B and C classifications). The results generated were used to validate the final recommendations to the business.

Conclusions

The existing literature on supply chain segmentation is limited. There are few academic papers which embrace this as a subject even though the positive benefits have been emphasised (A.T. Kearney, 2008; Fuller et al, 1993; Lovell et al., 2005). The methods and reasoning of this strategy have been applied to isolated areas of management and not interpreted as a theory of segmentation. These approaches are embedded as theories within smaller subject areas and have not been amalgamated into a holistic strategy and set out as theoretical framework. The concept in recent years has been applied mainly to the design of supply chains (Christopher and Towill, 2002; Lee, 2002; Mason-Jones et al., 2000; Naylor et al., 1999; Payne and Peters, 2004). Lovell et al (2005) argues that a segmentation strategy should involve characterising products and customers by using many more factors.

A segmentation strategy, which combines different supply chain and research methodologies, is applied to a UK company operating within the electrical industry. It was found that uniform policies had created high volumes of stock obsolescence and logistics costs that exceeded product margins which had left many products and customers unprofitable. It was shown in the case study that a segmentation methodology can be applied to all planning levels, strategic, tactical and operational and the extent to which this can improve service levels and reduce operational costs. The case study project was undertaken using a structured approach which followed a clear research strategy and process. The segmentation approach which was used by Smith and Slater (2001) was built upon to add the dimension of lead time variability. From a practical point of view the evidence showed that the application of a segmentation strategy in this context had created significant benefits for the business. The improvements to customer service levels and a reduction in the cost of the operation will continue to manifest in increased profits in the long term.

References

- A.T. Kearney. (2008) '*How many supply chains do you need'*, http://www.atkearney.com/main.taf?p=5,3,1,72 Date Accessed 14/06/08.
- Cachon, G & Fisher, M (1997) '*Campbell Soups continuous replenishment program*': Evaluation and enhanced inventory decision rules, Vol. 6, No.3, Production and Operations Management
- Chopra, S. & Meindl, P. (2007) '*Supply chain management*: Strategy, planning & operations', 3rd ed, Prentice Hall.
- Childerhouse, P. & Towill, D. R. (2000) '*Engineering supply chains to match customer requirements*', Vol.13, Issue 6, pp.337-345, Logistics Information Management.
- Christopher, M. (1998) '*Logistics and supply chain management*: Strategies for reducing cost and improving service', 2nd ed, London: Financial Times.
- Christopher, M. & Towill, D. R. (2002) '*Developing market specific supply chain strategies*', Vol.13, Issue 1, pp.1-14, The International Journal of Logistics Management.
- Fisher et al (1994) '*Making supply meet demand in an uncertain* world', Vol.72, Issue 3, pp. 83-93, Harvard Business Review.
- Fisher, M. L. (1997) '*What is the right supply chain for your product*?', Vol.75, Issue 2, pp.105-116, Harvard Business Review.
- Fisher *et al* (1997) *'Configuring a supply chain to reduce the cost of demand uncertainty'*, Vol. 6, No.3, pp.211-225, Production and Operations Management.
- Fuller, J. B *et al*. (1993) '*Tailored logistics: The next advantage*', Vol.71, Issue 3, pp.87-98, Harvard Business Review.

- Harrison, A. & van Hoek, R. (2005) '*Logistics management and strategy*', 2nd ed, Harlow: Pearson Education.
- Haung, S. H. *et al* (2002) '*A product driven approach to manufacturing supply chain selection*', Vol.7, No 4, pp.189-199, Supply Chain Management: An International Journal.
- Kotler, P. & Armstrong, G. (2010) *'Principles of marketing'*, 13th ed, Pearson.
- Lamb *et al* (2008) 'Essentials of marketing', 6th ed, Mason: South-Western Cengage Learning.
- Lee, H. L. (2002) '*Aligning supply chain strategies with product uncertainties*', Vol.44, Issue 3, pp.105-119, California Management Review.
- McCutcheon, D. M., & Meredith, J. R. (1993). '*Conducting case study research in operations management,* pp. 239-356, Vol 11, Issue 3, Journal of Operations Management.
- Mason-Jones, R *et al*. (2000) '*Lean, agile or leagile?* Matching your supply chain to the marketplace', Vol.38, Issue 17, pp.4061-4070, The International Journal of Production Research.
- Naylor, B. J *et al*. (1999) '*Leagility, Integrating the lean and agile manufacturing paradigms in the total supply chain*', Vol.62, Issue 1-2, pp. 107-118, The International Journal of Production Economics.
- Payne, T. & Peters, M. J. (2004) '*What is the right supply chain for your products?*', Vol.15, Issue 2, pp.77-92, The International Journal of Logistics Management.
- Pine, J. B. & Davis, S. B. (1999) '*Mass customization'*: the new frontier in business competition, Harvard Business School Press.
- Ramdas, K. & Spekman, R. E. (2000) *'Chain or shackles'*: Understanding what drives supply chain performance', Vol. 30, Issue 4, pp.3-21, Interfaces.
- Ramdas, K. (2003) '*Managing product variety*: An integrative review and research directions', Vol.12, Issue 1, pp.79-101, Production & Operations Management.
- Reddy & Vrat (2007) *'Vendor managed inventory model*': A case study, Vol. 4, Issue 1, pp.83-88, Journal of Advances in Management Research.
- Sabath, R. & Whipple, J. M. (2004) '*Using the customer/product action matrix to enhance internal collaboration*', Vol. 25, Issue 2, pp.1-19, Journal of Business Logistics.
- Saisse, M.C.P & Wilding, R.D. (1997) '*Short-term strategic management in mass customized markets*', Vol. 10, Issue 5, pp.199-207, International Journal of Logistics Information Management.
- Selldin, E. & Olhager, J. (2007) '*Linking products with supply chains*: testing Fisher's model', Vol.12, Issue 1, pp.42-51, An International Journal.
- Slater, A. (2008) '*Conceptual warehouse design'*, section in Logistics policy guidelines – warehouse design, Altrincham: Added Value Logistics Publications.
- Smith, W. R. (1956) '*Product differentiation and market segmentation as alternative marketing strategies*', Journal of Marketing, vol. 21, p. 3.
- Smith, D & Slater, A. (2001) 'Decision support tools for supply chain analysis & planning', Altrincham: Added Value Logistics Publications Limited.
- van Hoek, R. I *et al*. (2001) '*Measuring agile capabilities in the supply chain*', Vol.21, Issue 1/2, pp.126-147, International Journal of Operations & Production Management.
- Voss, C. (2002) '*Case research in operations management*', Vol. 22, Issue 2, p195, International Journal of Operations & Production Management.
- Woo, K & Fock, H.K.Y. (2004) '*Retaining and divesting customers: an exploratory study of right customers, at-risk" right customers, and wrong customers'*, Vol.18, Issue 3, pp.187 – 197, Journal of Services Marketing.
- Yin, R.K. (2003) '*Case study research: Design and Methods'*, Vol.5. 3rd ed, London; Thousand Oaks, CA: Sage Publications.