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Designing Effective Supply Chains in Strategic Alignment with Demand Characteristics and Market Requirements

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Designing Effective Supply Chains in Strategic Alignment with Demand Characteristics and Market Requirements

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ABSTRACT

A key challenge in operations management is how to effectively design a supply chain structure that is in alignment with the company's business model. The supply chain management literature provides a number of techniques and guidelines for developing effective supply chain strategies. Fisher's (1997) famous article profoundly influenced the literature by suggesting a framework which matches product type (*i.e.*, functional or innovative) with supply chain strategy (*i.e.*, efficient or responsive). This taxonomy initiated a large number of studies in product-driven supply chain strategy. While reviewing the studies, we found that the extent to which they empirically support the framework is very different and contradicting in some cases. Also, there is little modeling work that directly contributes to this area. This monograph describes the state of the literature in supply chain strategy and, in particular, how to best match

supply chain strategy with product type. It takes a careful look at Fisher's (1997) canonical framework and describes the studies that have been done to model and/or validate this framework. Moreover, an analytical exploration of the framework is conducted in two steps. First, we examine what two key existing inventory models, namely the newsvendor model and a continuous review system, say with respect to the framework. Second, we develop a basic inventory model to explore the impact of additional factors, *i.e.*, product life cycle, obsolescence, and lead time, on supply chain strategy decisions. This monograph also describes research on general product-driven strategies, *i.e.*, lean, agile, and leagile supply chains, mass customization, and postponement.

1

Introduction

1.1 Supply Chain Strategy

A significant strategic challenge, which has been widely addressed in recent research, is the design of a company's supply chain to effectively align with its business model. Indeed, the thread of this issue dates back to the emergence of the "focused factory", which was Skinner's (1974) advice for US manufacturers who, he claimed, lacked a congruent manufacturing structure integrated with correct competitive objective(s). This thread was followed by many researchers, and resulted in an extensive literature. For instance, Dhalla and Yuspeh (1976) claimed that companies need a set of "marketing-communications models" that enable them to constantly monitor market conditions such as demand changes, and to take a remedial action when appropriate. Further, Hayes and Wheelwright (1979a; 1979b) suggested a "product-process matrix" to help companies link their manufacturing systems with their product and market competence as well as choosing appropriate market entrance-exit and learning curve strategies.

Further contributions to manufacturing strategy significantly influenced the operations management literature. From the emergence of the lean paradigm and mass production, which profoundly changed

manufacturing systems especially in the auto industry (Ohno, 1988), to the introduction of agile manufacturing, which was claimed to be the strategy for enterprises in the 21st century (Nagel and Dove, 1991), the purpose was to maximize companies' expected profits by fitting supply structures with market requirements. Similarly, Hill's (1993) framework for identifying "order qualifiers-order winners" and the concept of "accurate response" (Fisher *et al.*, 1997) are examples of guides for operations managers to achieve increased profit through an appropriate operations strategy. In addition, Fuller *et al.* (1993) introduced "logistically distinct business methods" as a guideline for companies to differentiate the way they serve distinct customers, because they recognized "averaging" was a conventional problem that often causes customers who need specialized products to be underserved, while customers for commodity-type products are overcharged. The issue is that since the two types of products differ in the nature of demand, they should be supplied by different manufacturing processes.

Fisher (1997) looked at this issue from a supply chain perspective and introduced a framework that helps companies to design their supply chain strategies based on their product types. He classified products into two distinct groups, namely, functional and innovative products. The main attributes of the first group are long life-cycles, stable and predictable demand, and low contribution margins. Conversely, the second group have short life-cycles, volatile and unpredictable demand, and high contribution margins. Fisher (1997) believes each group needs its own supply chain strategy. The functional products require an efficient and lean supply chain with a cost reduction approach, while the innovative group call for a responsive and flexible supply chain with high delivery speed.

Campbell Soup, a producer of canned food, and Sport Obermeyer, a supplier of fashion skiwear, are examples given by Fisher of companies that provide the two distinctive types of products. A highly predictable demand for products that have been in the market for years allows Campbell Soup to satisfy nearly 98% of demand immediately from stocks of finished products. On the other hand, each year, Sport Obermeyer brings to the market a range of products with 95% of them being totally new, while only 5% of Campbell's products are new. Sport Obermeyer

sometimes has a forecast error of 200% and may only have a few months to react to the market because the retail season is very short (Fisher *et al.*, 1994; Fisher, 1997).

Fisher's (1997) framework has been widely considered in the supply chain management literature. It has received many extensions from both conceptual and practical points of view. A number of empirical studies have explored it in different sectors and countries. A few researchers have also analyzed it mathematically. The studies suggest that, despite the fact that Fisher's framework has received significant attention and support from the literature (Zhang *et al.*, 2013), it still has some unanswered questions (Wright, 2013), and perhaps lacks sufficient support (Lo and Power, 2010), especially from an analytical viewpoint.

There are some key issues raised by the literature with regards to Fisher's (1997) proposition. The most common of which are 1) a need for hybrid supply chain strategies that deliver intermediate products with characteristics of both functional and innovative products; 2) insufficient dimensions for characterizing supply chains by product type; 3) some companies with product-supply chain mismatch do not necessarily underperform compared to those with matching conditions; and 4) the framework has not been thoroughly validated mathematically. This monograph will review in detail all the existing evidence regarding the first three issues, and will provide insight into the addressing of the last issue.

In addition to Fisher's work, the supply chain management literature offers some other strategies to structure logistics and manufacturing processes according to product characteristics. For instance, a large group of researchers discuss and develop Naylor *et al.*'s (1999) idea of developing supply chains with lean, agile, or leagile approaches, whichever best match demand/market requirements. Specifically, "leagility" combines leanness and agility in a supply chain by strategically positioning the decoupling point, which is where product differentiation occurs. Moving the decoupling point closer to the customer allows efficiency to dominate the supply chain, resulting in the capability to provide a low cost. This delay in product differentiation is also the essence of a postponement strategy (van Hoek, 2001). On the other hand, positioning the decoupling point further from the end-user (closer to the main supplier), creates more capacity in the supply chain for customization, *i.e.*, a

manufacturer may follow a make-to-order or engineer-to-order strategy (Olhager, 2003). Mass customization is another product-driven strategy that allows for both variety and volume, *i.e.*, customized products at a mass production price, which needs a simultaneous focus on cost and pace. In this review, we will explore the literature of the abovementioned strategies in a separate section.

Overall, the current accelerating competition in the marketplace shows that high speed and low cost are not sufficient for creating competitive supply chains, perhaps because these two factors are becoming more market qualifiers rather than market winners (Hill, 1993). To achieve a sustainable competitive advantage, Lee (2004) suggests the Triple-A supply chain which has “agility”, *i.e.*, quick response to short-term changes in demand or supply, “adaptability”, *i.e.*, design adjustment to accommodate market changes, and “alignment”, *i.e.*, improvement of the entire chain. The successful practices of Wal-Mart, Amazon, Dell, and Seven-Eleven Japan confirm that Lee’s theory is particularly true in this era where “it is supply chains that compete not companies” (Christopher and Towill, 2001), and supply chain decisions are becoming more strategic than transactional (Niezen and Weller, 2006).

This monograph looks at supply chain management from a strategic point of view. It aims to provide a holistic exploration of existing supply chain strategies with most of its emphasis on product-driven strategies, and Fisher’s framework in particular. We explore the literature regarding the framework to present a picture of how it has been considered by researchers, and how it can best develop/improve. Due to the strategic role of inventories in supply chain management, we also analyze the framework from a mathematical view to investigate the extent to which it conforms to two existing inventory models, namely, the newsvendor model and the continuous review model, and to see how different product characteristics (*e.g.*, product life cycle) affect supply chain decisions. Furthermore, other product-driven supply chain strategies, *i.e.*, leanness, agility, leagility, mass customization, and postponement, are reviewed. We start our presentation with a quick review of the fundamentals of operations strategy and the concept of competitive advantage in business model development.

1.2 A Motivating Example

The issue of developing an effective supply chain strategy has always been a significant concern, and is becoming more challenging due to the accelerating rate of competition in the current business environment. A very large scale example is New Zealand's strategic plan for Business Growth, especially in the export sector. In the international marketplace, New Zealand is well-known for its dairy products, meat, and logs/timber. For many years, these three groups of products have been New Zealand's top exports (in value)¹. These are all primary products where having very low value-adding capacity is their main feature, which leads to low contribution margins. However, they are attractive to producers and traders because they usually guarantee a minimum of average demand, which in the long term is relatively high. Overall, 70 percent of all goods exported from New Zealand are primary products and 25 percent are manufactured products².

From an economic point of view, we might criticize this reliance on exporting low value-added products while higher value-added items could be produced making the international trade more profitable. The case of Fonterra, New Zealand's largest company and the world's largest dairy exporter, raises concerns. Fonterra exports significantly more low-profit milk powder than high-profit infant formula. Moreover, according to The International Farm Comparison Network (IFCN) 2014 report, although Fonterra is the world's second largest milk processor in terms of milk intake (million tons/year), it holds 16th place in terms of average turnover (\$/kg milk)³. Addressing this issue, the New Zealand government has targeted the ratio of exports to GDP to be 40% by 2025, and one of the key areas to focus on is "strengthening high-value manufacturing and service exports."⁴

¹<https://www.nzte.govt.nz/en/invest/statistics>

²http://www.stats.govt.nz/browse_for_stats/snapshots-of-nz/nz-in-profile-2013/exports.aspx

³http://www.ifcndairy.org/en/news/2014/top_20_list.php

⁴<http://www.mbie.govt.nz/what-we-do/business-growth-agenda/export-markets>

The government's agenda of investing in high-value manufacturing exports may be in conflict with Fisher's framework. New Zealand is far from all its potential markets and, due to its geographical remoteness, it has low physical connectivity, making a responsive supply chain difficult to build. Furthermore, according to StatisticsNZ⁵ only 0.45% of the country's enterprises have more than 100 employees and only 0.5% have between 50 and 100 employees. Based on the European Commission's definition⁶, 93% of New Zealand businesses are micro, and usually, interested in leanness and cost efficiency. These issues make exporting innovative (high value) products a significant challenge. Thus, the question is to which direction (primary products or innovative products) investments in the country should be encouraged.

1.3 Objectives and Organization

The example in the previous section reflects one of the challenges that managers face when making decisions on building their supply chain strategies. Obviously, for product-driven strategies, Fisher's framework is one of the most well-known tools, and over the last decade, it has been widely employed in various industries/countries. However, despite the huge attention that it has received from both researchers and practitioners, the extent to which it is capable of identifying the best supply chain strategy has been reported differently. Therefore, one of the objectives of this monograph is to undertake a comprehensive review of the literature of both the framework and other product-driven supply chain strategies. The review helps with understanding the potential developments/improvements that lead to an effective update of the framework, from both empirical and analytical perspectives. Another objective is to mathematically explore what two inventory models, newsvendor and continuous review, suggest about the framework, and how we can further analyze the framework by including additional factors, *e.g.*, product life cycle.

⁵http://www.stats.govt.nz/browse_for_stats/businesses/business_characteristics.aspx

⁶http://ec.europa.eu/growth/smes/index_en.htm

The organization of this monograph is as follows. Section 2 discusses business strategy, competitive priorities, and the importance of strategic alignment. It is a brief introduction to operations strategy and its key role in successfully establishing and managing businesses. Section 3 goes through Fisher's framework, reviews its pertinent literature, and reports the results of existing studies with three major approaches, namely, conceptual, empirical, and mathematical methodologies. Section 4 analyzes the framework from a mathematical view. It analytically explores the impact of different demand/product characteristics on supply chain decisions. Section 5 reviews some additional product-driven supply chain strategies and compares and contrasts them with Fisher's framework. Section 6 concludes by summarizing the findings and results of this monograph.

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