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Aligning product characteristics and the supply chain process – A normative perspective ☆

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ABSTRACT

The fit between designed product characteristics and the supply chain process has been researched in the operations and supply chain management literature as an important strategic part of operations, but how to secure this fit is still a pending issue. The aim of this study is twofold: (a) to examine the relationship between product characteristics and the supply chain process; and (b) based on the research results, to explore how their alignment should be constructed. This is done by a survey-based experimental analysis using a normative model of supply chain management, which is motivated by consideration of Little's law in a supply chain context. The study provides confirmatory results of past research as well as new results regarding the relationship between product characteristics and the supply chain process. The research introduces the concept of *absolute supply chain orientation strategy* (*ASCOS*), which focuses on perpetual improvements to lead-time, just-in-time control, quality and demand variability to ensure the fit between product characteristics and the supply chain process, as a culture or mind-set that should be encouraged in the firm. The research proposes that ASCOS leads to high competitiveness over time. The results also indicate that the inter-functional product development capability contributes to the development as well as to the implementation of the absolute supply chain strategy.

1. Introduction

The argument as to the desirable fit between product characteristics and the supply chain process was sparked by Fisher (1997) and Lee (2002). They were alert to the uncertainties attached to products that influence supply chain operations. In their studies, specific product attributes were identified, such as *innovative* or *functional*, which place operational requirements on the supply chain process. Following this line, we consider the attribute of the product – innovative or functional – that influences the demand pattern and its relevance to supply chain management.

The requirements placed on the supply chain process advocated in the above-mentioned studies are *agility* for innovative products and *efficiency* for functional products (Fisher, 1997; Lee, 2002). But these requirements have not been clearly proven to be valid by subsequent research, as we summarize in the literature review (Selldin and Olhager, 2007; Lo and Power, 2010). New research indicates that some more mixed or complex relationships appear to exist between product characteristics and the supply chain process. These inconclusive findings are plausible if we consider the requirement of changes to the supply chain process over time triggered by changes in different competitive phases, such as those associated with the product life cycle (Levitt, 1965; Hayes and Wheelwright, 1979; Aitken et al, 2003). Hence, we need to consider such changes when we inquire into the desirable fit between product characteristics and the supply chain process in order to discern significant fit patterns.

A further issue is how to implement the fit if we find significant relationships between product characteristics and the supply chain process. A company cannot instantly change the existing supply chain process in response to new competitive phases, referred to by Skinner as the "millstone effect" (Skinner, 1978). So, a further important research issue is how a company can make

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this adjustment as quickly as possible and in such a way that it can sustain existing competitiveness over time in the way that high performing companies do.

These two issues, desirable product characteristics–supply chain process fit patterns and the implementation of sustaining desirable fits over time, still need more research. Therefore, the aims of this study are, firstly, *to examine the relationship between product characteristics and the supply chain process* and, secondly, *to explore how their alignment* can be constructed and sustained over time. The concept of an *absolute supply chain orientation strategy* (*call ASCOS hereafter*) will be introduced in this study for these research issues. This concept is advocated on the basis of a normative model for supply chain management (SCM) and the validity of this concept will be also tested by using the data set of the High Performance Manufacturing Project, explained later in Section 3.3.

The remainder of the paper is organized as follows. The following section presents a review of the research related to the fit between product characteristics and the supply chain process. The methodology and the theoretical framework used for this research are described in Section 3, along with the hypotheses to be tested in the study. Section 4 analyzes the results and comments on the main findings. Finally, Sections 5 and 6 bring the paper to a close with the article's discussions, limitations, final considerations and conclusions.

2. Literature review

About 15 years ago, a number of authors started to stress the need to manage the Supply Chain as a whole, as a single entity instead of a number of separate nodes pursuing their own goals (e.g., Christopher, 2000; McAdam and McCormack, 2001; Christopher and Towill, 2001). In this context, the alignment of the supply chain (common interest and goal-seeking in order to synchronize and coordinate processes, activities and decisions among SC partners (Piplani and Fu, 2005)) was recognized as necessary, and aligning product characteristics with the supply chain emerged as an important topic in SCM research (Fisher, 1997; Lee, 2002; Huang et al., 2002; Selldin and Olhager, 2007; Lo and Power, 2010). It has also been noted that coordinating the Supply Chain in pursuit of alignment, agility (the SC's ability to quickly respond to sudden and unexpected short-term changes in demand or supply (Van Hoek et al., 2001; Lee, 2004; Swafford et al., 2006)) and adaptability (the ability of a SC to adapt its strategies, products and/or technologies to structural changes in the market (Arana et al., 2011)) leads to the improvement of Supply Chain Performance (Whitten et al., 2012) and paves the way to a sustainable competitive advantage (Lee, 2004). The Spanish company ZARA is a paramount example-in-point of good work in the apparel industry in this regard (Ferdows et al., 2004).

When a firm implements coordination, its environmental situation, such as supply and demand, becomes contingent on the decision as to which focus to coordinate (Fisher, 1997; Lee, 2002). This is where the fit issue between product characteristics and the supply chain process emerges. A product's characteristics determine demand predictability. *Innovative products*, which add 'newness' as an additional reason for customers to purchase, produce uncertainty of demand in proportion to the degree of newness (Fisher, 1997). On the other hand, the demand for *functional products* (i.e., the staples that people buy in a wide range of retail outlets) is not so variable and is more predictable than the demand for innovative products (Fisher, 1997). *Physically efficient* and *market responsive* supply chains are matched with functional and innovative products, respectively.

Lee (2002) introduced uncertainty factors linked to both demand and supply and proposed two types of supply chain: stable and evolving. He argued that the manufacturing process and the underlying technology are mature and the supply base is well-established in a *stable supply chain*. However, in an *evolving supply chain*, the manufacturing process and the underlying technology are still under early development and are rapidly changing. The supply base is limited in both size and experience. As a result, Lee (2002) advocated *four supply chain strategies*: *efficient* supply chains, *risk-hedged* supply chains, *responsive* supply chains, and *agile* supply chains.

Research on the *alignment between product characteristics* and *the supply chain process* (which we call 'the alignment problem' hereafter) initiated by Fisher (1997) and Lee (2002) can be classified into two types. The first type focuses on *what kind of relationship is desirable* between the two, including testing the propositions made by Fisher (1997) and Lee (2002). The second focuses on *how to align them*. Assuming the importance of alignment, this group of studies focuses on how to coordinate and secure the effective alignment of product value and the supply chain process.

Along with the *first stream of the alignment problem research*, Li and O'Brien (2001) tried to test Fisher's (1997) propositions using mathematical models. Their results suggested that none of the typical supply chain strategies (manufacturing to order, manufacturing from stock and manufacturing to stock) gives the best performance all the time. Operational environments, such as the level of demand uncertainty and process characteristics, make it difficult to see the general validity of Fisher's propositions (1997).

Based on case studies of actual company behavior, Selldin and Olhager (2007) indicated that it is difficult to explain the concept of the supply chain frontier defined by market responsiveness and physical efficiency in the way argued by Fisher (1997). A real company chooses an optimal mix of efficiency and responsiveness to maximize profitability when designing its supply chain's features rather than the argument of preferring responsiveness to efficiency, or vice versa, depending on the nature of the product (Selldin and Olhager, 2007).

This study was followed by Lo and Power (2010), who indicated that the link between the nature of the product and supply chain strategy was not significant. Likewise, this study supported neither a positive link between functional product orientation and efficiency-oriented supply chains, nor a positive association between innovative product orientation and responsiveness-oriented supply chains.

When we inquire into the alignment problem, a dynamic perspective is necessary. The product life cycle especially is an important factor that is influential. Although there are innumerable research studies on the product life cycle, here we restrict ourselves to the studies focusing on its managerial implications. Levitt (1965) proposed exploiting changes in competitive requirements through the various stages of the product life cycle (i.e., market development, growth, maturity and decline). Hoffer (1975) gave the product life cycle as a framework for organizing contingent hypotheses on appropriate business strategy alternatives. Hayes and Wheelwright (1979) focused on the fit between product and manufacturing process by relating changes in product width and volume over the product life cycle to changes in the manufacturing process, such as job-shop, batch and assembly line. The manufacturing process is an important part of the supply chain process. The study by Hayes and Wheelwright (1979) triggered research into the fit between product characteristics and the supply chain process over the product life cycle.

The implication of the product life cycle for supply chain management is that the company needs to deliberate on changes in competitive requirements that the supply chain process has

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