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A survey of classifications in supply chain strategies

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Abstract

Supply chain strategies are used to show the companies competitiveness and the position in the market against their competitors. Companies that focus on a specific supply chain strategy are more likely to build shareholder value than those do not. This idea will call for a company in a supply chain to exercise specific strategies. Not all products need the same supply chain strategy. These supply chain strategies for any product or service industries depends on supply and demand uncertainty, product life cycle and manufacturing strategies. Hence, setting the right SC strategy is compulsory for companies competing in the market. In this paper different types of supply chain strategies are identified from existing literatures.

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Keywords: Supply chain strategies;efficient supply chains;agile supply chains;leagile supply chains;push-pull supply chains

1. Introduction

Supply chain management (SCM) has become one of the most popular and fastest growing areas in management. One major issue of SCM is the proper design of supply chains to serve customers effectively and efficiently [1]. This is particularly difficult as companies nowadays face a series of challenges like shrinking product life cycles, the proliferation of product variants (mass customization), and increasing uncertainty on both the demand and the supply side. Dealing efficiently with uncertainty is one of the most crucial points in supply chain (SC) design. These uncertainties are demand, manufacturing, supply uncertainties [2]. According to him these uncertainties poses more threat on the finished goods.

Demand uncertainty focuses on the difficulty of predicting customer demand; supply uncertainty concerns the purchase of materials and manufacturing uncertainty focuses on the use of new manufacturing technology. To support this, [3] stated that company has three safety buffers to handle these uncertainties namely safety inventory, safety capacity and safety time. These buffers are used to reduce variations in the SC. In this particular context, we are concerned with the uncertainties related in fulfilling demand and supply for better customer service at possible lower costs. These uncertainties are supply uncertainty and demand uncertainty. Due to these uncertainties as dictated by [4], different SC strategies emerged.

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Hence, setting the right SC strategy is mandatory for companies competing in the market [4-7]. Companies that focus on a specific SC strategy are more likely to build shareholder value than those who do not [7]. This idea will make a call for a company in a SC to exercise specific SC strategies. [7] dictate that focused companies which experience a unique SC strategy have the following advantages over companies with dispersed SC strategies:

- between three and four times the return on capital employed;
- between two and three times ROA;
- two-thirds less time to increase output by 20%;
- one third less variation in sourcing and production order cycles.

The rest of the paper is organized as follows: Part two discusses criterion for supply chain strategy classifications. Part three discusses details of supply chain strategies. Finally conclusions and managerial insights are presented in part four.

2. Governing criterion for classification of supply chain strategies

Most authors used product types to categorize supply chains. The most widely accepted and validated types are functional and innovative products. These are products clearly set and defined in [5], [8] and [9]. Regarding product characteristics based on functional and innovative we adopted the guiding criterion according to [6] and [9]. The criterions are product life cycle, profit margin, product variety and lead times. Hence long product life cycle, low profit margin, low variety and long lead times are the major characteristics of functional products assumed to be efficient and lean and short product life cycle, high profit margin, high variety and short lead times are the governing characteristics of innovative products linked to responsive and agile supply chains. Since the value of each variable are clearly set in [6] and are clearly justified in [9], we applied these values and attributes as in part of classifying the supply chain strategies.

A company's product type was defined as functional and the supply chain is efficient if the main product offered by the company satisfied basic needs and was readily available, while also satisfying the following conditions simultaneously: a product life cycle longer than two years, fewer than 20 variants in the product line or family, contribution margins under 20%, and lead time longer than six months [9]. A company's product type was classified as innovative and supply chain strategy is responsive if the product had a life cycle of up to a year, more than 30 variants, contributions margins higher than 20%, and lead times measured in weeks. The range in between the values of efficiency vs. responsiveness or lean vs. agile can be used to categorize the supply chain into leagile or hybrid.

Besides, those criterion, there are other measures used to classify supply chain strategies. The first one is inventory turns. The inventory turnover ratio is a common measure of the firm's operational efficiency in the management of its assets. A low turnover rate may point to overstocking, obsolescence, or deficiencies in the product line or marketing effort. However, in some instances a low rate may be appropriate, such as where higher inventory levels occur in anticipation of rapidly rising prices or expected market shortages as the case in risk-hedging and agile supply chains.

Conversely a high turnover rate may indicate inadequate inventory levels, which may lead to a loss in business as the inventory is too low. This often can result in stock shortages. A calculation survey made by the authors in 2012 on top 50 Gartner ranks showed us the range of 8-12 turns for the companies exercising efficient supply chains. Although results vary by industry, typical manufacturing companies may have 6-12 inventory turns per year. The only exception is Dell who performed nearer to 70 turns and a cash conversion cycle of negative 36 days in 2004 through managing inventories, receivables, and payables very closely. This shows information enrichment is widely recognized among supply chains.

High volume/low margin companies (like grocery stores) may have 12 or more inventory turns per year or more. There is also a wide gap in the values of inventory turns reported for retailers. For example, [10] tested inventory turns for 311 US retailers during 1985-2000 and concluded that food stores perform around 11 turns on an average while jewellery stores performs nearer to 2 turns.

Besides [10], the lean benchmarking survey was conducted via the Rogers Industrial Media database using total of 413 Canadian manufacturing companies reported even higher values of turns. The survey indicated that forest products and printing and transportation and defence equipments had as high inventory turns as 20 and 60 respectively. At the same time, chemicals and resources and metals had as low inventory turns as 8 and 9 respectively. These extreme may showed us that those with higher values are practicing lean supply chains. The idea

here is the lower inventory turns favours responsive or agile supply chains while higher values favours efficient or lean supply chains.

The other criteria may be ROA**.** ROA measures how the supply chain is efficient in converting assets to profit. For example, the ROA of the top efficient companies in 2012 under top 25 Gartner ranking revealed the results as shown in Figure 1. Even though it is difficult to make clear range between efficiency and responsive, it can show the trends towards efficiency. So, the companies with lower values of ROA have the affinity towards responsive supply chains.

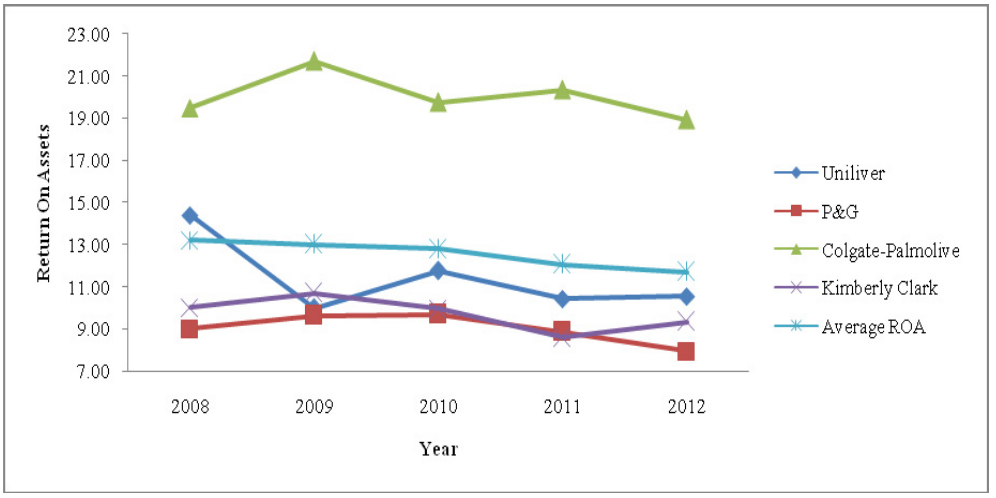

Figure 1. ROA projections for consumer products industries

3. Supply chain strategies

Having mapped the SC strategies it is important to align each strategy for different types of companies. These not only need to be aligned with the SC strategy, but also need to reflect important goals in the scope and within the influence of the part of the organization responsible for the individual process under consideration. Based on extensive and clear reviews, the following are the available supply chain strategies revealed from literature and summarized in Table 1. In the classification, the category under lean and agile also included the leagile or hybrid supply chain.

Table 1. Brief Summary of literatures for supply chain strategies

Supply Chain Strategies	Authors
Efficient and Responsive	[1], [3], [5], [6], [12], [8], [11]
Lean and Agile	[13],[14], [15], [16], [17], [18], [19], [20], [21], [22], [23], [24], [26]
Efficient, Responsive, Risk-hedging and Agile	[4], [7], [27]
Pull and Push	[15], [28], [29], [30], [31], [32]

3.1. Classification based on efficient and responsive

One could argue that one sensible approach to increase responsiveness could be to raise the inventory levels of finished goods or components, which would allow more flexibility for reactions to changes in customer demand. Increased inventory levels do, however, reduce the efficiency of the SC. A responsive SC, in contrast, requires an information flow and policies from the market place to SC members in order to hedge inventory and available production capacity against uncertain demand [5]. Improving responsiveness in a SC, however, incurs costs for two primary reasons: (1) excess buffer capacity and inventories need to be maintained, (2) investments to reduce lead times need to be made.

Providing the right degree of responsiveness and having an efficient SC at the same time is a goal that is hard to achieve and that typically involves trade-off decisions by management, since increased responsiveness can be perceived to come at the expense of reduced efficiency, and vice versa. Due to these difficulties, many authors

see responsiveness and efficiency as distinct strategies that are strongly linked to different types of products .In our model, we extended this idea that the SC strategies stand by themselves, i.e., taking each SC strategies independently. Contrary to the tradeoffs, [12] tried to accommodate efficient and responsive SCs simultaneously through strategies such as revised planning approaches that restructure SC processes to achieve both goals at the same time and enable a SC to be responsive and efficient simultaneously. [6] also assumed the existence of efficient and responsiveness in the same SC and dictated through a trade-offs to substantiate the values. For example a deliberate increase in safety stock may raise responsiveness through increased product availability when customer needs change unexpectedly. At the same time, however, such an increase in inventory levels raises the cost level both directly, i.e. through increased cost of capital and storage costs, as well as indirectly, since the products on stock might not sell and eventually become obsolete. This increased cost level reduces the degree of efficiency.

Fisher revolutionized SCM by observing that companies were not choosing the SC that matched the nature of their products. He presented a rather stark difference between product and SC types. On one end of the spectrum are functional, commoditized products such as grocery food products. On the other end are innovative, quick life-cycle products such as computers and fashion. Functional products are ones that have long product life cycles and therefore stable demand, while innovative products are products that have short life cycles with high innovation and fashion contents-and which, as a result, have highly unpredictable demand [4, 11]. Therefore, the design strategy of the chain naturally varies depending on the product type, whether it is an innovative product or a functional product. As Fisher has pointed out it is important that the characteristics of demand are recognized in the design of SCs.

Fisher's model is tested by [8] on 128 Swedish manufacturing companies whether product types and supply chain strategies match. They matched product type with supply chain strategies. They conclude that companies with functional products followed physically efficient supply chain strategy. They also found that there is a considerable match in between innovative products and market responsive supply chains. Similarly, [9] analyzed the factors influencing supply chain strategies (efficient and responsive) and the alignment of strategies to the product types and performance of manufacturers in Romania. Conducting on 418 manufacturing companies she concludes that larger companies and companies further upstream are more likely to use a responsive supply chain.

3.2. Classification based on lean and agile

Most of the classifications based on lean vs. agile is credited to [14]. In their research, they compared lean and agile SC based on the ability to cope with uncertainty, including variations, in production volume and the degree of product variety required and hence developed the comparisons among supply chains UK house building that is in turn validated for general businesses as well. The authors comfortably mapped the product positions in terms of variety and variability for leanness and agility and concluded that products with low variety and high variability suits lean strategy where as products with high variety and low variability suits that of agile strategy.

Several authors have taken Fisher's work and collected empirical data to support and refine the theory. In particular, much of this work has been focused on examining two fundamental SC strategies: lean, which is roughly equivalent to Fisher's physically efficient and agile, which is roughly equivalent to Fisher's market-responsive. Some functional products may, however, also have quick response requirements of the SC-for example, milk and other dairy products are perishables with relatively stable demand patterns but limited shelf life. Also, companies often carry out promotions that can drastically change the otherwise stable and predictable demand patterns of products such as generic food. These cases forced some authors to extend Fisher's classification of SCs.

Most researchers argued that the adoption of the lean principles are appropriate for commodity products where demand can be predicted and agile principles are relevant for innovative products where demand is unpredictable. "Leagile" takes the view that a combination of lean and agile approaches be combined at a decoupling point for optimal SCM. It can be understood that agility will be used downstream and leanness upstream from the decoupling point in the SC. Minnich [12] called the combination of lean and agile as a hybrid SC. He pinpointed that there will be occasions when either a 'pure' agile or lean strategy might be appropriate for a SC. However there will often be situations where a combination of the two may be appropriate i.e. a hybrid strategy. Hybrid SC strategies recognize that within a mixed portfolio of products and markets there will be some products where demand is stable and predictable and some where the converse is true. As the product variety increases, product life cycles decreases and emergence of virtual firms, authors expanded these classification by either combining or distinctive strategy and calling it leagile or hybrid supply chain.

Some authors classify supply chain types matching to product characteristics. For example, [19] tried to match product characteristics (innovative products, hybrid products and standard products) to respective supply chain types (agile, hybrid and lean). They developed a quantitative score using weighted sum to determine the

desired supply chain strategy. Using interactive software program, they evaluated user's numerical scores (from 1-10) found from questionnaire. This was done by assigning higher scores to higher importance with higher weights. They suggested that for the total score less than 99, a functional and a lean supply chain is suited. Using the same method, if the score is in between 99 and 198, the underline product and the supply chain is hybrid. Finally, if the score is greater than 198, the underline product is innovative and an agile should be adopted. Besides, [20] addressed approaches to SCM that adopt lean, agile and leagile supply paradigms and illustrated their application through cases studies from the textiles and apparel sector. They showed the application of range of these SCs on UK clothing and textile industries and concluded that these companies need to be able to respond quickly to changing markets and be able to provide quick replenishment. However, they are not able to store large quantities as products have a very short life cycle and fashion markets are seasonal. In their study they found that the majority of the clothing and textiles industry in UK practiced the leagile methodology.

The lean and agile paradigms, though distinctly different, can be and have been combined within successfully designed and operated total SCs [13]. Combining agility and leanness in one SC via the strategic use of a de-coupling point has been termed ''le-agility'' [15] and concluded that lean SC and agile SC are complementary, that is, the use of lean pattern is starting point for establishing in agile systems. Therefore leagile is the combination of the lean and agile paradigms within a total SC strategy by positioning the decoupling point so as to best suit the need for responding to a volatile demand downstream yet providing level scheduling upstream from the market place [18].

Three different types of SCs can be recognized in a business organization [23]. A *lean SC*, which employs continuous improvement efforts which focuses on eliminating waste or non-value steps along the chain; an *agile SC*, which responds to rapidly changing, continually fragmenting global markets by being dynamic, context-specific, growth-oriented, and customer focused. The third, a *hybrid SC*, which combines the capabilities of lean and agile SCs to create a supply network that meets the needs of complex products. [22] proposed three types of SCs: lean, agile and leagile SCs. Lean concepts work well where demand is relatively stable and hence predictable and where variety is low. Conversely, in those contexts where demand is volatile and the customer requirement for variety is high, a much higher level of agility is required. Leanness may be an element of agility in certain circumstances, but it will not enable the organization to meet the precise needs of the customers more rapidly.

Some researchers proposed taxonomy of SC strategies based on replenishment lead times, predictability and variability of demand and product characteristics. For example, [21] proposed four types of SC as lean, agile and leagile strategies are shown in Figure 2.The classifications mirrored those of lean, agile and leagile supply chain strategies with split in lean strategy sensitive to supply uncertainties with wide range of lead times.

Some of the classifications are also tested by the authors. Specifically, [26] investigated supply chain strategies and empirically test the supply chain strategy model that posits lean, agile, and lean/agile approaches using data collected from 604 manufacturing firms in China and found that companies can be distinguished on their supply chain strategy according to an expanded Fisher framework.

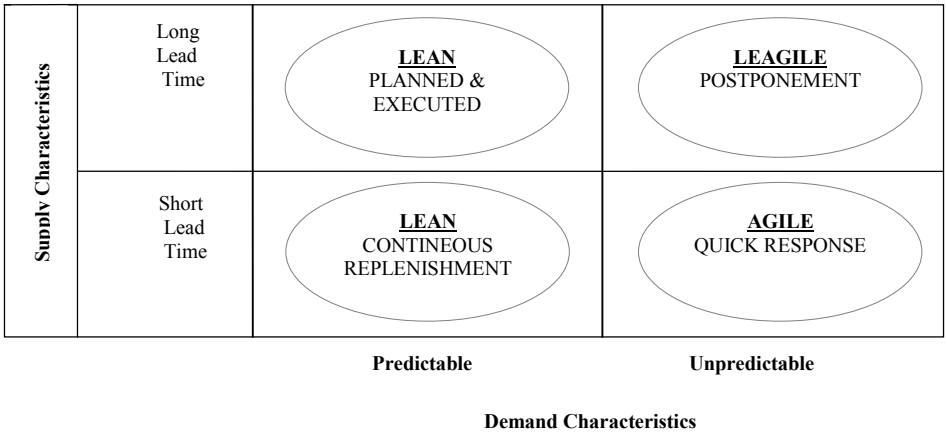

Figure 2. How demand/supply characteristics determine pipeline strategy (adapted from [21])

3.3. Classification based on efficient, risk-hedging, responsive and agile

More interestingly, [4] classified the SC into stable and evolving depending on the product type with uncertainty as the Table 2 and developed SC strategies as in Table 3. He briefly categorize SCs in to efficient, responsive, risk- hedging, and agile SCs based on supply and demand uncertainties and product characteristics (functional and innovative products).

Table 2. Stable and evolving SCs based on uncertainties (adopted from [4])

		Demand Uncertainty	
		Low (Functional products)	*High (Innovative Products*
Supply Uncertainty	*Low (Stable process)*	Grocery, basic apparel, food, oil, & gas	Fashion apparel, computers, pop music
	High (Evolving Process)	Hydro-electric power, some food produce	Telecom, high end computers, semiconductor

Table 3. Uncertainty and SC types (adopted from [4])

		Demand Uncertainty	
		Low (Functional products)	*High (Innovative Products)*
Supply Uncertainty	*Low (Stable process)*	Efficient SCs	Responsive SCs
	High (Evolving Process)	Risk-Hedging SCs	Agile SCs

The annual demand of electricity in a region in Table 3 is stable and can be predictable but the supply of hydroelectric power which depends on the rain fall in the region will be erratic year by year. Some food products may also have a stable demand but the supply may depend on the yearly weather conditions. These two conditions called risk-hedging SCs in action. Similarly, fashion apparel products have short selling seasons and their demand is highly unpredictable with supply stable that operate in responsive SCs. Based on the idea of [4] uncertainties posing threat to the company, we come up with the problem and solution model given in Table 4 and the table is self explanatory and some of the items are discussed in risk-hedging and agile supply chain metrics part.

3.4. Classification based on Pull and Push

The other classification of supply chain revealed by different authors is based on pull and push strategy. [30] identified push and pull supply chain strategies in fulfilling orders. In push based systems, production decisions are based on the long term forecasts, where as in pull-based systems production is driven by demand. [6] also strengthened the significance of the push-pull strategy depending up on the timing of their execution relative to its end-customer demand. With pull processes, execution is initiated in response to a customer order where as with push processes, execution is initiated in anticipation of customer orders. The idea behind pull and push strategies are further strengthened by [31] stating that push-based system is driven by a forecast as production and distribution decisions are based on long-term estimates of demand while the production and distribution processes in a pull-based system are driven by actual downstream demand and not forecasted demand.

A supply chain is almost always a combination of both push and pull, where the interface between the push-based stages and the pull-based stages is sometimes known as the push–pull [28]. In particular, this hybrid strategy is composed of a push element for the component procurement and a pull element for production as well as additional push/pull elements based on network equilibrium and other cooperative mechanisms [29]. However, it is not using both or independent strategies that makes difference to the organizational competences; but, using the combined effect of strategies in order to fetch off the advantages of both strategies in serving customer better at relatively lower cost.

Table 4. Proposed SC problems and solutions for supply chain types

		Demand Uncertainty	
		Certain	*Uncertain*
Supply Uncertainty	*Certain*	**Efficient SCs** **Problem** • Bullwhip Effect **Solutions** • Alignment of incentives and information among SC partners • Collaborative planning, forecasting, and replenishment • Vendor managed inventories	**Responsive SCs** **Problems** • Long and uncertain development and lead times • Highly uncertain demand patterns • Short selling season **Solutions** • Mass Customization • Postponement of final customization • Early orders from customers
	Uncertain	**Risk-Hedging SCs** **Problems** • Highly Uncertain Supply • Disruption risk in supply **Solutions** • Pooled inventory and resources • Extends to reach suppliers and inventory • Contracts that manage risk by locking in factors such as price and delivery	**Agile SCs** **Problems** • All problems in three SC listed **Solutions** Postponement of final customization • Pooling of suppliers to hedge uncertainties • Platforms and modular design that allow postponement of final customization

Despite its benefits and growing popularity, the push-pull strategy is not devoid of risk, particularly when it comes to order fulfilment and robustness against external variability. Inventories at different locations have differing levels of responsiveness to the customer delivery lead time requirements. If the remaining processing time and transportation time from boundary are too long, unstable order-fulfilment performance may occur and result in penalties for failing to meet the customer's negotiated delivery lead time, lost sales costs, and other immeasurable negative impacts on the credibility of the organisation [32].

3.5. Other classifications in supply chain strategies

Those classifications made by different authors other than the lists so far given are classified under other classifications. The classification may be extended from previous lists or are summarized and added entities in to it.

For example, [33] categorized the SCs in to efficient, quick, market responsive, agile, lean and hybrid and their performance measures as quality, delivery, cost and flexibility depending on the product life cycle of the product. According to him an efficient SC deals with functional products that are often sold in high volumes and for which the demand can be forecast and operates in the maturity phase of the product life-cycle; a quick SC deals with innovative products often with a high technical level and a demand that is difficult to forecast and the products are in the introduction (and decline) stage of the product lifecycle; an agile SC is similar to a quick SC in that it deals with innovative products for which the demand is difficult to forecast e.g. fashion goods. Market responsive SCs have similar characteristics to agile SCs; a lean SC deals with functional products whose demand can be accurately forecast and whose market share remains fairly constant and are in the growth and maturity stage of the product life-cycle and a hybrid SC is similar to a leagile SC and deals with both functional and innovative products that are in the introduction, growth and maturity phases of the product life-cycle. Though [33] differentiated lean SC and efficient SC, the supply chains assumed to have the same meaning in the metrics part as their major objective is towards efficiency.

The above classifications are also supported by [24] that four different SC strategies have been adopted by different companies in different times to compete in a given market and these are lean, agile, leagile, and adaptive SCs. Adaptive SC is a method of developing a reconfigurable multi enterprise network model involving multiple SCs to respond to structured changes such as demographic changes, economic fluctuations, product changes, and technology advances [25]. [27] extended the work of [22] and classified the SCs in to five categories; lean, agile, leagile, risk-hedging and responsive SC and compared them based on performance attributes each SCs as in the following Table 5.

Table 5.Comparison of lean, agile, leagile, risk-hedging and responsive SCs (adopted from [27])

Attributes	Lean SC	Agile SC	Le-agile SC	Risk-Hedging SC	Responsive SC
Market Demand	Predictable	Volatile	Volatile & unpredictable	Volatile	Predictable
Customer Drivers	Cost	Lead time and availability	Service Level	Lead Time and Cost	Quality & availability
Purchasing Policy	Buy Goods	Assign Capacity	VMI	VMI	Assign Capacity
Quality	MQ	MQ	MQ	MQ	MQ
Cost	MW	MQ	MW	MW	MQ
Lead time	MQ	MQ	MQ	MQ	MQ
Service Level	MQ	MW	MW	MW	MW

Label: MW=Market Winner; MQ= Market Qualifier; VMI=vendor managed inventory

4. Conclusions and managerial insights

The classifications based on the available articles as lean vs. agile, efficient vs. responsiveness, efficient-risk hedging-responsive-agile, push vs. pull and others are clearly reviewed from the available literatures. From this survey, we found no agreed classifications available that are tested empirically. It has been mentioned that developing a distinct supply chain strategy helps companies in developing competitiveness. The boundary between lean and agile classification is called leagile supply chain by most authors and hybrid supply chain by some others. This strategy has given different meaning and application by different authors including the position of decoupling point. The position of the decoupling point is also dictated in pull-push supply chain strategy where the upstream chain uses push and the downstream chain favors pull strategy. The question regarding what are the appropriate supply chain strategies for different supply chains seems has not got convincing answer yet. It is also indicated that efficiency vs. responsiveness strategies can be mapped independently for different supply chains and the lean vs. agile classification has not got consensus among authors. The same is true for the pull vs. push strategy. However, most authors agreed on the combined use of the two strategies unlike lean vs. agile classification. But, still there is no distinct point where to place the decoupling point. Regarding lean vs. agile, some authors argued both are complementary while some authors pursue them in standing independent for supply chains.

Even though there is no universally agreed supply chain strategies exist, one cannot simply ignore the attention given to lean vs. agile, efficient vs. responsive and push vs. pull supply chains applied in actual case studies. So far, the advantages and applications have been discussed in each classification. Let us give some managerial insights to the classifications regarding the difficulties to agree on them.

The lean vs. agile has got the most number of authors who applied it in a case study research. But the classifications are still not complete to cover all supply chains. For example, in the lean vs. agile classification given by [14] based on product variety and product volume, those supply chains with high product volume and low product variety are matched to lean and those supply chains with low product volume and high product variety are suited to agile supply chain. The questions what about those supply chains with high product variety and high product volume and those supply chains with low volume and low variety have not got any answer in the their research. Using mass customization, a supply chain can operate at high volume with relatively high variety. An interesting example for this is Dell's supply chain. Besides today's flexible manufacturing factories attempt to produce both high volume and high variety products at the same time in opposite direction to those focused factories. The other example which exist in reality but not matched to those classifications by [14] are the supply chains for high value products (example, gold, diamond, platinum) and other heavy equipments in projects with small volumes.

Another example in which the mismatch occurs seems to be Toyota's supply chain. Its supply chain is assumed by many authors as lean supply chain in a strategy. In practice, Toyota operates with high product variety and high volume using Just-in-Time (JIT) inventory systems, small lot production, quick die changes, the switch from a 'push' to a 'pull' systems. In the same manner, Mazda known for operating in a lean supply chain, have also developed flexible body lines that allows for a very diverse product mix.

In classifying supply chains into efficient vs. responsiveness, the most widely applied approach is matching functional products to efficient and innovative products to responsive supply chains. For example, [8] have done a

breakthrough research on supply chain strategies on testing Fisher's model on 128 manufacturing companies in Sweden. In this category, significant numbers of companies with functional products are matched with innovative and this is termed as mismatch in their study. Similarly, a considerable number of innovative products are operating in efficient supply chains are observed. In efficient vs. responsiveness classification, more flexibility for reactions to changes in a customer demand is one of the criterion for the responsive supply chain where as more cost reduction is said to be the main criterion for efficient supply chains. In reality, supply chains nowadays are trying to combine both supply chains-delivering products and services fast at relatively lower costs. Again, the best example is Dell's efficiency driven by responsiveness through mass customization and Toyota's responsiveness through technology capability and JIT philosophy.

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