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The impact of new product introduction on supply chain ability to match supply and demand

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Abstract

Supply chain managers should redesign their supply chains in response to the introduction of a new product. In particular, to reach performance targets, they should align the supply chain to the new product features. The objective of this paper is to highlight the negative effects of mis-alignment between product features and supply chains and to propose a set of mis-alignment indicators, along with an action plan to align supply chains to new products. To this end, an in-depth case study has been performed. In the analyzed company the introduction of a new product line was not followed by a proper redesign of the logistics network, thus reducing supply chain performance. The mis-alignment has been evaluated against a new indicator. Moreover, the main product features that should have been taken into account when redesigning the network, i.e. internal and external variety, and innovativeness, have been highlighted. Finally, a two steps methodology to define a set of coordinated action between product development department and supply chain mangers have been proposed.

Keywords: Variety; Alignment; Supply Chain; New Product Introduction

1. Introduction

Nowadays, firms should be able to launch into the market a growing number of new products. However, there is no reason why a supply chain that is optimal for a given set of product lines stays optimal when the level of variety changes. Therefore, each time a new product is launched in the market, the supply chain should be redesigned so to be able to deliver the new product efficiently and effectively to the market. Product features affect supply chain performance, while being defined during New Product Development (NPD). The magnitude of the effects of product features on supply chain performance is determined by supply chain decisions concerning supply chain structure (Blackhurts *et al.* 2005), supply chain strategy, e.g. agile or lean (Childerhouse *et al.* 2002), or the degree of collaboration among the actors of the supply chain (Doran *et al.* 2007).

Figure 1 depicts these relations, i.e. the main framework which this paper is based on. In particular, it shows that NPD process results in new products characterized by a set of product features. Supply chain managers design the supply chain and define its features. Supply chain performance depends on the matching of supply chain features and product features. Alignment is reached when supply chain performance is maximized. For instance, Swatch can profitably offer a wide variety of products since it has implemented both a modular design of its products and it has adopted flexible manufacturing systems (Montreuil and Poulin 2005). In fact, without flexible manufacturing systems, Swatch could not exploit completely the benefits of modular design, and vice-versa.

Within this context aligning supply chain design decisions with NPD decisions has become crucially important to maintain high supply chain performance and to boost product launch effectiveness (Van Hoek and Chapman 2006, Fine, 1998; Lee and Sasser, 1995). However, despite the complex interdependencies among product design and supply chain design decisions have been recognized as early as Hoekstra and Romme (1992), until Fine (1995) this insight did not enter the realms of competitive strategy nor capture the attention of top management (Forza and Rungtusanatham, 2005). In particular, the drawbacks of a mis-alignment between product design decisions and supply chain design decisions have not been investigated in depth, nor indicators to measure

NPD-Supply Chain Management (SCM) alignment have been developed so far. Therefore, the objective of this paper is to fill these gaps in literature. In particular, the aim of this work is to highlight the need for alignment through the exploration of the negative business effects of misalignment between NPD and SCM. Moreover, the paper proposes a set of mis-alignment indicators, along with some possible actions to mitigate the negative impact on performance of a mis-alignement.

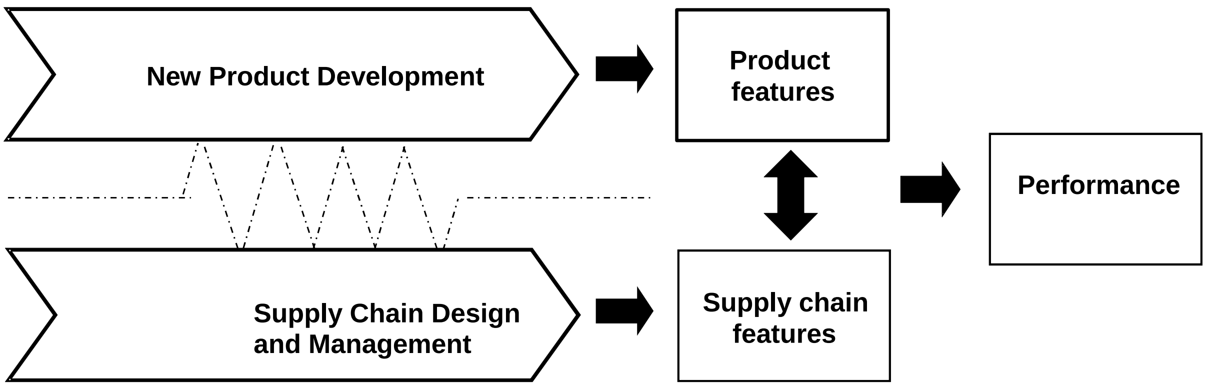

Figure 1. Proposed framework representation

The paper is organized as follows. In sections 2 we set out a theoretical review of studies that deal with the relations among product features, SCM decisions and supply chain performance. In particular we focus on the analysis of the literature about product structure, product variety and innovativeness. In section 3 we present the methodology used, i.e. in depth case study research. In facts, a case study that shows the worsening of performance when NPD and SCM are not aligned and the mis-alignment indicator used to assess such a mis-alignment are presented in section 4. In section 5 we discuss the case study implications while providing some conclusions and the directions for future research.

2. Background

An analysis of the literature shows that the main product characteristics that affect the relations among product features, supply chain features and clients needs are: product variety and product structure, i.e. product architecture and bill of materials, and product innovativeness. Table 1 summarizes the supply chain related variables, along with performance impacted by product features.

2.1 Product variety

Nowadays, customers demand for customized products forces firms to increase product range, i.e. increase the variety they offer in the market. Product variety encompasses both external variety, i.e. the range perceived by the clients, and internal variety, i.e. the diversity of components and semi-finished products (Pil and Holweg 2004). Product variety is defined during NPD process. This decision affects supply chain performance. For instance, when product variety increases, direct manufacturing costs, manufacturing overhead, delivery times and inventory levels increase as well (Ocampo y Vilas and Vandaele 2002, Ramdas and Sawhney 2001, Fisher and Ittner 1999, Fisher *et al.* 1999, MacDuffie *et al.* 1996). Brun *et al.* (2006) introduce and define the concept of behavioural costs as “those costs which arise because of the reaction of people to “excessive” variety”. In particular, these costs are due to human and/or organisational mechanisms which prevent the available variety to be effectively tackled and deployed. They rise in all those cases when people think the decisional task to choose among various options is not that relevant or could take much time to be completed, so that they exploit less variety than the designed one. To deal with higher variety some tools, e.g. information systems, web-based platforms or flexible automated systems (Coronado *et al.* 2004, Jiao *et al.* 2005, Forza and Salvador 2002), should be implemented, thus increasing costs as well (Fisher and Ittner 1999). Prasad proposes a rough index to measure of cost of variety connected to not only manufacturing costs but also plant layout or supplier changes (Prasad 1998).

The magnitude of the impact of variety on the supply chain performance depends on SCM choices. For instance, the impacts of variety on a firm depends on its inherent flexibility (Ramdas 2003, Berry and Cooper 1999) and centralization degree of final assembly (Tynjälä and Eloranta 2007) . De Silveira (1998) develops a framework for the choice of the proper flexibility strategy to deal with high product variety in manufacturing environment. Some empirical and conceptual researches extended this concept to some aspects of SCM (Salvador *et al.* 2002, Randall and Ulrich 2001).

2.2 Product structure and innovativeness

Product design is one of the product-related drivers which impacts the most SCM decisions and supply chain performance (Salvador *et al.* 2002). Indeed, product design information is needed for generating manufacturing plans and schedule, and also for creating a packing plan for shipment (He *et al.* 2006). Two representations of product design are mainly addressed: product architecture and Bill of Materials. Product architecture plays a pivotal role among NPD and SCM (Krishnan and Ulrich 2001). Some relations among product architecture and SCM have been investigated (Fixson 2005), in particular, focusing on sourcing (Novak and Eppinger 2001, Hsuan 2001), postponement strategy and implementation decisions (Hsuan Mikkola and Skjøtt-Larsen 2004, Van Hoeck 2001, Lee and Tang 1998, Feitzinger and Lee 1997) and supply chain structure (Salvador *et al.* 2004, Fine 1995).

Table 1. Literature analysis

Product feature(s)	Supply Chain related variable(s)	Performance	Reference(s)
Bill of Material	Supply chain structure	Total cost of supply chain	Huang, Zhang and Liang, 2005; Blackhurts, Wu and O'Grady, 2005; Lee and Sasser, 1995
Architecture	Sourcing, postponement strategy, supply chain structure	Costs, service level	Hsuan Mikkola and Skjøtt-Larsen, 2004; Novak and Eppinger, 2001; Hsuan, 2001; Van Hoeck, 2001;Lee and Tang, 1998; Feitzinger and Lee, 1997; Fine, 1995
Variety and architecture	Sourcing, production scales, supply chain configuration	Operational performances	Salvador, Rungtusanatham and Forza, 2004; Salvador, Forza and Rungtusanatham, 2002;
Variety	Manufacturing	Direct costs, overhead, delivery lead times, inventory	Ocampo y Vilas and Vandaele, 2002; Ramdas and Sawhney, 2001; Fisher, Ramdas and Ulrich, 1999; Fisher and Ittner, 1999; MacDuffie, Sethuraman and Fisher, 1996
	Supplier change	Costs	Prasad, 1998
	Information systems	Costs and demand mismatch	Coronado et al. 2004, Jiao et al. 2005, Forza and Salvador 2002
	Manufacturing flexibility	Costs	De Silveira, 1998
Product innovativeness	Supply chain strategy	Operational performance and service level	Fisher, 1997; Childerhouse et al. 2002

Mathematical models that support designers in choosing the best Bill of Materials, or generic Bill of Materials, that minimizes the total cost of the supply chain have been proposed as well (Huang *et al.* 2005, Blackhurst *et al.* 2005, Lee and Sasses 1995). In these models, supply chain structure is defined concurrently with the product, among a set of possible configurations. There is a strong relation among product structure and product variety. Variety is mainly addressed in NPD literature in the main trade-off "variety – commonality", i.e. the architecture definition phase (Ulrich and Eppinger 2000), or in the platform definition one (Huang *et al.* 2005, Farrell and Simpson 2003, Martin and Ishii 2002, Krishnana and Gupta 2001, Fisher *et al.* 1999, Robertson and Ulrich 1998). Product architecture decision affects the commercial variety that can be proposed in the marketplace at a given cost (Ulrich 1995). As far as innovativeness is concerned, it is the degree of newness of a product. It has been studied mainly in relation to supply chain strategy definition (Fisher, 1997; Childerhouse et al. 2002), although the empirical work by Caridi et al. (2009) shows the impact of product innovativeness on supply chain operative choices too.

3. Methodology

An in-depth case study has been performed. Since NPD is a project based activity, i.e. discontinuous process, we used a approach based on the analysis of the discontinuities introduced by NPD. A discontinuity is the introduction of a change in the product range of a firm, e.g. a new product or a new product line. We called it a "delta" approach, as we analyzed the variables in terms of "differences" or *"deltas"* between the value of each analyzed variable after and before the discontinuity, i.e. the point in time when the new product is introduced. The need to perform such an analysis guided the choice of the case study. In facts, the firm has been selected for the high and growing variety of its product range and for it has recently introduced a new product line and it has deeply changed the structure of its product offer.

The unit of analysis is the supply chain. Interviews have been carried on with Supply Chain Director and Manufacturing Plant Manager on the basis of a questionnaire. Documentary analysis and data analysis have been performed as well. Four main issues have been investigated: (i) the features of the new product introduced in terms of variety, modularity, innovativeness and sales; (ii) the features of the supply chain before and after the introduction of the new product, in terms of both supply base and manufacturing capabilities; (iii) the effects on supply chain performance; and (iv) the actions (when undertaken) to mitigate the negative effects on performance. For confidentiality reasons, company names referred in the case study are imaginary and some figures have been rearranged, being careful in avoiding any alteration in performed analyses, findings and problem defining and solving processes actually happened.

4. The Industrial Example

4.1 Company Profile

Company A is the Electronics Division of ELETECH Group, an European multinational company in the medium-to-low-voltage electrical appliances sector. Company A designs, engineers and manufactures products for communication, e.g. porters, video-porters, and domotics, e.g. touch screen control stations, dimmers, sensors and command/control devices based on open information technology architectures which enable full protection and control in domestic, industrial and commercial applications. Company A offers domotics systems (more than 2,000 products generating a yearly turnover of around 150 million Euros), fully integrated in style and connection with the rest of ELETECH catalogue (more than 60,000 products). Its products are marketed under various group brands, functionally and aesthetically targeted to specific markets and brand policy strategies. Being innovative has always been both one of the company's strengths and the very core of its lifestyle. *"Should it may be something new to study or develop in electrical appliances sector, we must come first in doing it"* was the motto of one of the co-founders. Much of ELETECH historical growth was due to this *credo*, strengthened in the past decade by targeted acquisitions all over the world. Company A experienced in the years between 2002 and 2006 a significant volume increase, at a Compound Annual Growth Rate higher than 15%, with more and more relevance in new targeted markets. Nearly 16% of Company A turnover comes from products in their early lifecycle phase, and almost all of them are strategically kept inside Company A plants: outsourcing policies are generally applied to higher volume, mature items.

4.2 Company A supply chain before the introduction of the new product

Company A main plant is located in Italy, as well as product marketing, design, engineering and logistics departments. In the Italian plant, two activities are performed: (i) assembly of boards by inserting components and electronics controls, and (ii) finished product assembly. The first set of activities is performed on automated assembly lines, the latter on semi-automated and manual assembly lines. Company A also acts as coordination unit for other manufacturing facilities in Europe and Far East. Company A policy is to keep internally the production of complex products, therefore Company A subcontracts only the production of simple products or standard high value products. Part of the mature products are manufactured in low-cost countries. Company A plays a focal role in the group electronics purchasing. Company A purchasing categories are four:

- (i) standard electronics components are supplied from East Europe or Far East regions.
- (ii) customized plastic components are partly supplied from Italian (local) suppliers. The parts mostly visible to customers or where aesthetics elements are important are supplied from the other ELETECH associate companies (inter-site flows).
- (iii) packaging are supplied from Italian (local) suppliers. These are the same for all ELETECH associate companies.

Company A clients are the distributors. Domestic market is served through ELETECH channels, other countries are served through Company A's affiliates companies in the other countries. The last group accounts for half of the sales volumes.

4.3 The features of the new product

In the 2nd half of 2005, a new top-level, stylish product family was introduced in Company A offer. In the same period Company A product offer shifted towards more integrated systems. The new product family encompasses domotic solutions for domestic application, e.g. switches, touch screens and command station for control of lighting in the houses. The new product line presents a wide variety of choices in terms of colours, materials and shapes of the external parts of the switches and control panels, along with different internal technologies. The introduction of the new product line was not followed by a redesign of Company A supply chain. As it will be detailed in the following, this led to a decrease in the main operational performance and increased difficulties in following demand mix variation. A detailed analysis of data regarding the features of the new product introduced, in terms of variety, modularity, innovativeness and sales, outlined that the characteristics of the new products that mainly impacted supply chain performance and determined the difficulties were: (i) items sales distribution, (ii) bill of materials complexity and (iii) product and production process technologies novelty.

A Pareto analysis on Company A 2006 cumulative sales evidences that, instead of the expected 50% on products count, the so called "C-class" items represent more than 67% of the catalogue. The items that fall between the 95% and 100% of cumulative sales are called C-class items. Company A clients purchase systems. Therefore all the items, including C-class, must be marketed with high service level standards. Unavailability of a single product may heavily impact perceived non-fulfilment of client needs. The new product line is composed by items characterized by an higher number of both links and levels in the bill of materials than before. This increases managerial complexity in planning and managing parts procurement and products manufacturing.

The new product line is composed by a high percentage of electronics components. The firm does not own internally the competence to produce these components, therefore it had to increase the percentage of purchase from external suppliers. In addition, some of these components, e.g. touch screens, SIM cards holders, are used in other consumer electronics products, e.g. cameras, camcorders, smart phones. The consumer electronics market is dominated by big players. In this market, Company A has relatively low purchasing volumes, thus having relatively low bargaining power for negotiating lots and lead-times. So, Company A is more exposed to supply risks in cases of components shortages on the market. In addition being consumer electronics products' lifecycle extremely short, Company A is forced to follow the pace of components quick obsolescence, increasing the amount of technological modifications to its products and unwittingly coping with obsolescence rates functionally unnatural for domotics competitive arena.

New, i.e. never used before by the firm, production process technologies have been introduced with the new product line. Many of these are involved in manufacturing processes directly managed by Company A main plant. Table 3 shows the effects on technologies saturation of the introduction of the new line in the Company A main plant. In 2003 Company A main plant managed 14 different technologies, with low (LO) to medium (ME) capacity saturation. Capacity saturation is expressed by planned weekly capacity against theoretical maximum one. In 2005 the number of technologies to be managed were 23. Capacity saturation shows decline in mature technologies, i.e. pre-forming and THT components mounting, and increasing in the saturation of recent ones (SMD-based assembly), with high (HI) to very or extremely high (HI+; HI++) rates. Particularly notable is the effect of components miniaturisation, leading to the intense use of SMD micro-components and double-sided Printed Circuit Boards.

Following state-of-the-art design trend, more and more "Top Level" products aesthetics involve painting and chromium-plating technologies, supplied, as well as plastic moulding, by other ELETECH facilities. This leads to an increase in inter-site dependency for Company A main plant.

Table 2. Complexity increase in technologies portfolio and capacity saturation

Technologies		Capacity Saturation level [planned weekly capacity / theoretical maximum weekly capacity]				
Phase	Kind of technology	2003	2004	2005	2006	2007
Printed circuits boards assembly	Pre-forming	ME	LO	LO	LO	LO
	THT components assembly	ME	ME	ME	ME	LO
	SMD Printed Circuit Boards assembly - Standard	LO	LO	ME	HI	HI+
	SMD Printed Circuit Boards assembly - BGA		LO	LO	ME	HI
	SMD Printed Circuit Boards assembly – Complex Printed Circuit Boards			LO	ME	HI
	Flexible Printed Circuit Boards assembly			LO	LO	LO
	SMD Printed Circuit Boards assembly – micro components					LO
	Printed Circuit Boards tropicalization	LO	ME	ME	HI+	HI+
	Firmware uploading		LO	ME	HI+	HI+
	Printed Circuit Boards tuning		LO	ME	HI+	HI+
	In-circuit testing – No test point			LO	ME	ME
End item final assembly and packaging	Tampoghraphy	LO	LO	HI	HI+	HI++
	Ultra sound soldering	LO	LO	LO	ME	ME
	Keys/Buttons sub-assembly			LO	ME	HI
	Gas detectors final assembly	LO	LO	LO	LO	LO
	Electromechanical manual sub-assembly	LO	ME	ME	ME	ME
	Electromechanical automatic assembly	LO	ME	HI	HI+	HI++
	KIT final assembly	LO	ME	ME	HI	HI
	Accessories and add-ons assembly	LO	ME	ME	HI	HI+
	Displayed equipped items final assembly		LO	LO	ME	HI
	Radio controlled items final assembly			LO	LO	LO
	Instruction sheet printing	LO	LO	LO	LO	LO
	Compact Disk burgning	LO	LO	ME	HI+	HI++
	Label printing	LO	ME	ME	HI+	HI+
	Technologies count	14	18	23	23	24

Legend: LO = Low, ME = Medium, HI = High, HI+ = very high, HI++ = extremely high

4.4 The effect on supply chain performance

After the introduction of the new product line, a reduction in the Company A service performance occurred. This reduction is measured against increased difficulties in reaching service level targets, measured against both Line Item Fill Rate and percentage on average weekly gross requirements, and Master Planning (Master Production Schedule) accuracy, which flickered around an average of 75%, against a Materials Requirements Planning (MRPII) standard target of 95%. Further analyses on these key performance indicators evidenced that, mainly, service level difficulties were originated by in-sourced (or partially subcontracted) items. This reflects Company A policy to concentrate internally most part of manufacturing complexity (Table 2), coming from low-volume and phase-in items. Main explanations on poor Master Production Schedule performance were to be largely found in short-term production schedule variations and purchased materials unavailability, as Figure 2 (related to Master Production Schedule non-performance causes) shows. In particular, materials unavailability grew from 36% of non-performance causes in 2004 to more than 52% in 2006. Information system reports show that material unavailability was mainly due to planning problems at the suppliers and suppliers production capacity exceeding. The incidence of delays in transportation, material defects and delays due to late or wrong communication of information on quantities or means of production, e.g. moulds, have not increased from before the introduction of the new product.

Master Production Schedule non-performances causes	***2006 Work Order***	***% [Work order/total]***
Materials unavailability	3,084	52,4%
Priority variation	1,855	31,5%
Materials poor quality	251	4,3%
Workforce unavailability	63	1,1%
Machine unavailability	59	1,0%
Force majeure	52	0,9%
Quality inspection delay	3	0,1%
Miscellaneous	513	8,7%
Total	*5,880*	*100%*

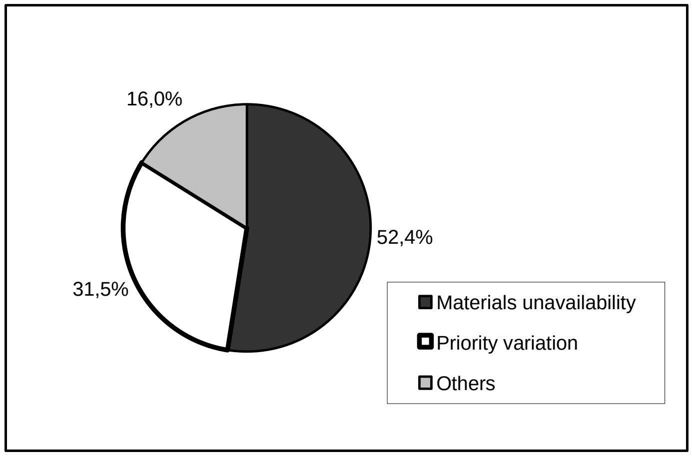

Figure 2. MPS non-performance causes of Company A Master Plan

The worsening of the key performance indicators was not due to increased capacity saturation. As a matter of facts, as Figure 3 highlights, apart from some outlining peaks (generally quickly recovered) Company A manufacturing was able to track volume growth and variability.

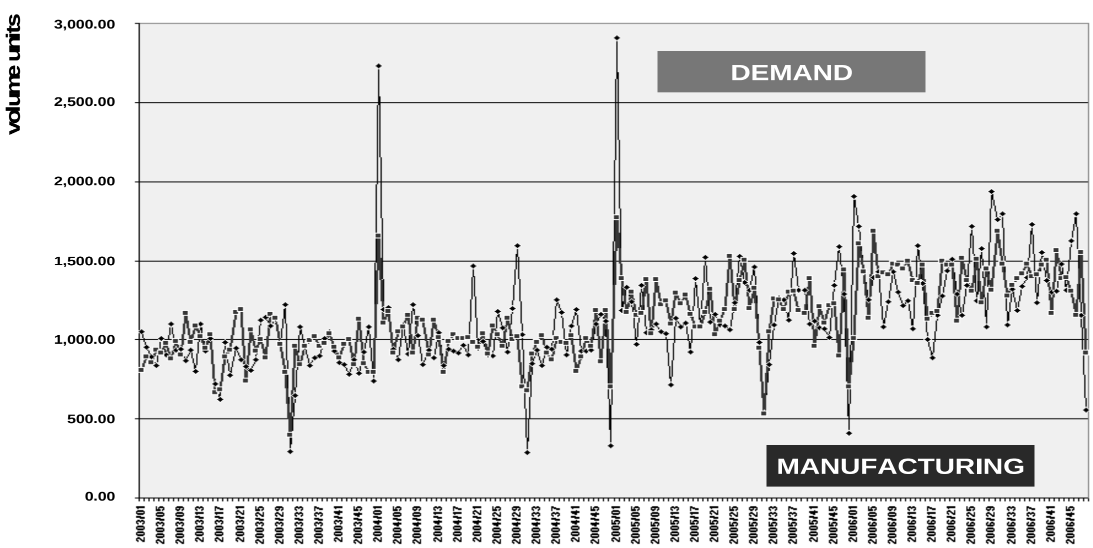

Figure 3. Demanded vs. Manufactured volumes at Company A

Created and transported varieties dynamics and their alignment with customer orders were therefore investigated. Data analyses show that almost the entire product range is actually requested by clients. Therefore, created variety and customers orders are “equal”, i.e. all the variety offered on the market was actually ordered by the clients. A measure of transported variety that could be comparable to customer orders was needed. A measure was applied to Company A 2003-2006 weekly operations key figures: demand and manufacturing (in its widest meaning of purchasing and/or internal production) of finished goods. This measure is known in Company A as Tracking Ratio (TKR) and is calculated as follows (1):

$$TKR_i = MC_i / DC_i \tag{1}$$

where:

i = i^{th} working week

MC_i = count of different manufactures items in week i^{th}

DC_i = count of different demanded items in week i^{th}

TKR measures the rate between the variety manufactured and customer orders.

Operational steps implemented for computing Tracking Ratio were the following. First we got historical demand and manufacturing weekly data (triplet: Item/date/quantity), then we counted different demanded and manufactured items per period. Finally we divided manufactured by demanded item count.

The analysis performed at Company A identified a progressive decline in Tracking Ratio starting from mid 2005, and that phenomenon becomes even more evident by plotting DC_i, i.e. the count of different demanded items in week i^{th}, and MC_i, i.e. the count of different manufactures items in week i^{th}, as in Figure. 4.

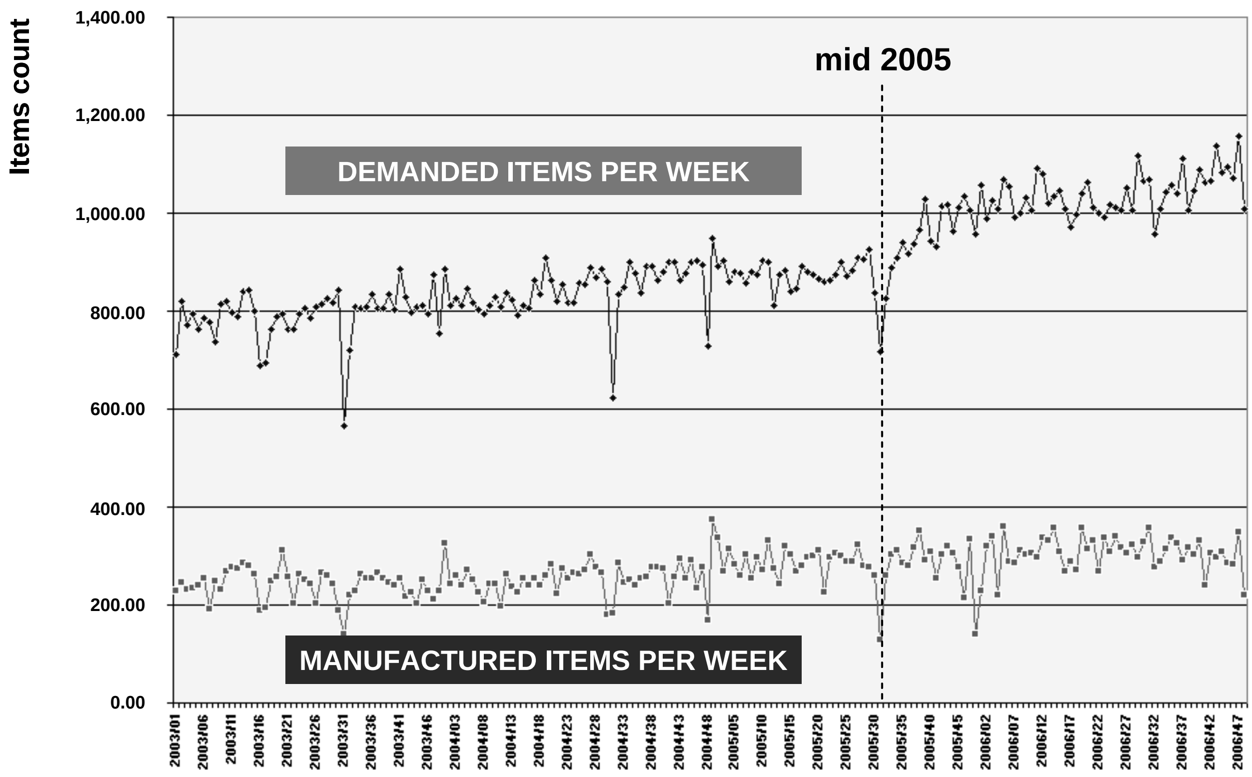

Figure 4. The increasing gap between demanded and manufactured variety

By this analysis, along with the performances analysis of section 4.4, mis-alignments in terms of efficiency and effectiveness have been therefore measured. In facts, the number of different products ordered were not delivered in the time and at the costs requested. The graph in Figure 4 represents by MC_i, i.e. the count of different manufactures items in week i^{th}, the the sub-array [Number of different product, time] that Company A supply chain is able to deliver, whereas DC_i, i.e. the count of different demanded items in week i^{th}, represents the variety requested by clients in time, i.e. the customer orders. By comparing the rate of different products that the supply chain delivers to the rate requested, effectiveness mis-alignment has been measured. Operational performance targets in terms of capacity saturation or material stock levels were not reached neither. In fact, at the aggregate level the total amount of items produced equals the total amount of items sold (as it has been shown in Figure 3), but since the requested

mix of product variants is different from the mix of product variants actually delivered (as it has been shown in Figure 4), stock level of those products that were not requested, but produced, has increased.
Figure 4 shows also that Company A supply chain is not able to deliver more variety than the actual one, as average MCi, i.e. the count of different manufactures items in week i^{th}, is horizontal.

4.5 The applied counter-measures to reach alignment

In order to reach alignment, Company A has made some analysis and undertaken some long term and short term actions. Meetings between marketing managers, product developers and supply chain managers have been held to discuss the actions and define a roadmap. A two steps methodology has been defined: (i) Requested variety definition and (ii) Matching product features and supply chain features. In the first step, i.e. requested variety definition, marketing managers analyze jointly with product developers the expected requested variety, i.e. identification of unexpected demand growth scenarios, main risk areas in terms of volumes, demand peaks and variety. In this way a list of products that can present managerial problems for the supply chain is defined, e.g. products with strong expected demand variation and/or high uncertainty on the demand mix. The products in this list are called "risky products".

In the second step, i.e. matching product features and supply chain features, product developers and supply chain managers define an action plan to concurrently change the product structure and/or the supply chain so to guarantee transported variety to equal requested one, for the defined list of risky products. For instance, reverse engineering techniques can be adopted to define product architecture and bill of materials so to make feasible the application of late differentiation by increasing commonality and standardization, e.g. in the packaging and instruction booklets, and to reduce the supply market risk. Other examples of actions are: demand forecast techniques support the identification of products with high demand uncertainty for which higher safety stocks might be needed; to support faster re-planning of the supply chain, new planning systems can be introduced.

Table 3 summarizes the actions taken in the specific case. It should be noted that the basic structure of the supply chain has not been changed and supplier involvement in the product development is low. This is due to the firm policy to keep development inside the company and to manage complexity internally. The same firm policy applies to the risky products, which will be in any case kept inside Company A manufacturing facilities. The results in terms of performance improvements are definitely positive: notwithstanding the persistence of strong growth rates and even increased demanded variety, Company A late orders reached their historical minimum in last two years.

Table 3. Actions taken in Company A

Step		*Area*	*Analysis*	*Action*
1	Requested variety definition		Market analysis and forecast of future trends	Definition of "risky" products list (where risky products are those that may generate managerial problems for the supply chain, e.g. products with strong expected demand variation and/or high uncertainty on the demand mix)
2	Matching product features and supply chain features	Product feature	Reverse engineering and analysis of the product structure of the above identified "risky" products	Definition of possible architecture and bill of materials modification to the apply to "risky products"
		Plan	Analysis of demand variance expected for risky products	Setting of specific "Strategic Stocks" (apart from usually computed Safety Stocks) on critical components more likely involved in unexpected variety and volume growth
			Analysis of present and emerging planning needs	Renewal of the Planning System: introduction of an Advanced Planning and Scheduling (APS) application
		Make	Analysis of manufacturing flows	Manufacturing flows simplifications
			Analysis of machine loadings	Internal capacity increase on most critical (saturation and/or short-term outsourcing difficulties) technologies
		Source	Part commonality and product components analysis	Alternative sources opening
			Analysis of demand variance expected for risky products	Pre-identification of product clusters for tactical outsourcing, in case of sudden demand increase on risky items

5. Conclusions

Nowadays, to remain competitive firms should be able to sustain innovation by coordinating the two processes of NPD and SCM. NPD-SCM alignment is fundamental for reaching NPD-SCM coordination. Literature analysis shows that interrelated product features are of interest when addressing NPD-SCM alignment are product structure, product variety and product innovativeness. Variety, both internal and external, is created during NPD process while SCM decisions can affect the ability of a supply chain to deliver efficiently and effectively such variety to the marketplace. A difference among created variety, transported variety and customer orders results in lower supply chain performances, i.e. a mis-alignment is measured. When this occurs the determinants should be sought in the mis-alignment between new product features, SCM practices and customer needs. A framework that outlines these relations have been proposed. The case study supports the framework. Indeed Company A experienced an enlargement in the product offer and some radical innovations to its traditional products, i.e. an increase in the bill of materials complexity, and in the variety and number of product and process technologies that should be managed by the firm's supply chain. The consequences of these phenomena on supply chain were not at first fully evaluated thus resulting in lower operational and service level performances. The weekly analysis of unavailable items evidenced that the long-term cause of perceived difficulties in keeping required service level was to be sought in overall rigidity in following demanded mix. Finally, the case study highlights the negative effects in terms of fulfilment of client needs and operational performances of a lack of alignment between new product features and SCM. The root cause of this lack of alignment was a the introduction of a new product line whose implications on SCM were not simultaneously planned in full.

Company A case study suggests that the product features that should be taken into account in SCM choices are the internal and external variety of the new product line, i.e. bill of materials complexity and number of different products, and the innovation content of the new product line. As a matter of fact, the innovativeness, i.e. novelty for the firm, of the technologies to be managed at product and production process level represents a major problem for the supply chain, e.g. the purchasing department. In addition, a two step approach to define counter-measures to overcome mis-alignment has been proposed. In the first step the requested variety is defined, whereas in the second one, the supply chain features matching the new product features are draw out. It must be noted, that the actions should be defined by a team composed by supply chain, marketing and product development managers. We acknowledge that more empirical research should be done on the framework. In particular, relevant measures and indicators that case-by-case are needed to evaluate alignment should be identified. This can be the theoretical basis for developing a methodology to support NPD-SCM alignment and can pave the way to the definition of new managerial approaches, new models and solutions to reach alignment.

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