

## TECHNOLOGICAL DIFFERENTIATION AND PERFORMANCE MEASUREMENT ON SUPPLIER INTEGRATION IN NEW PRODUCT DEVELOPMENT

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*Această lucrare examinează literatura de specialitate cu privire la integrarea furnizorilor în realizarea de produse noi și contribuie cu o cercetare empirică pentru a demonstra că diferențierea tehnologică, performanțele afacerilor, inovarea și comunicarea dintre companii și furnizorii lor sunt pozitiv asociate cu nivelul de integrare al furnizorilor în realizarea de produse noi. În final, este propus un model conceptual ce indică faptul că nivelul de integrare al furnizorilor în realizarea de produse noi este pozitiv influențat de măsurarea performanțelor furnizorilor din perspectiva inovării și a diferențierii tehnologice.*

*This paper summarizes what the academic literature has to say about the integration of suppliers in new product development and contributes with an empirical research to demonstrate that technological differentiation, business performance, the innovation and the communication between company and its suppliers is positively associated with the level of supplier integration in new product development. Finally, it is proposed a conceptual model that indicates that the level of supplier integration in new product development is positively influenced by innovation-focused measures of supplier performance, and technological differentiation.*

**Key words:** supply chain management, new product development, innovation, technological differentiation, integration

### 1. Introduction

Based both on literature and also on the author's experience through observing firms in Romania, this study observes the impact of two management processes, namely the technological differentiation and the supplier performance measures, on the level of supplier integration in the product development. It is also aimed to help a firm to achieve an improved speed to market, higher product quality and lower costs, and an improved manufacturability.

This paper has three major objectives. First, it provides a comprehensive review of the problems, trends, and business relevance of the supplier integration in new product development. Second, this paper clarifies and facilitates a conceptual model in this area, and then presents findings from an exploratory

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study that analyzes the effect of technological differentiation and supplier performance measured on the level of supplier integration in new product development. Finally, our hypotheses are tested.

Since knowledge is the core of innovation, the investigation of how knowledge is acquired and transferred across organizational boundaries represents an important problem for many companies. The Internet, extranet, intranet and cross-functional teams are recognized as a key means of facilitating the flow of knowledge within and between firms. Additionally, the companies use the performance measures to assess the performance of their suppliers along operation (e.g. cost, quality, reliability), information exchange, and other dimensions.

The remainder of the paper proceeds as follows. In the next sections, we review the literature on supplier integration in new product development, technological differentiation, disruptive innovation and supplier performance measures, and develop hypotheses for the relationships between them. Then we test our hypotheses and describe a conceptual model of supplier integration in new product development. Lastly, we present the discussion and managerial implications of the findings, and conclude with suggestion for future research.

## 2. Literature review and subsequent hypotheses

Companies around the world face today a common challenge: the need to improve their performance in order to capitalize on rapid change, and to establish or regain competitive edge. In Eastern Europe, managers and employees struggle to establish new behaviours and procedures that will allow their companies to compete in the free market.

The formation of any collaborative coalition depends on how its members share some common (or compatible) goals, possess some level of mutual trust, have established common (interoperability) infrastructures, and have agreed on some common (business) practices and values. Achieving these conditions is a pre-requisite for the agility in collaborative networks.

**New product development** (NPD). Given the rapid changes in consumer tastes, technology and competition, companies must develop a steady stream of new products and services. A firm can obtain new products in two ways. One is through *acquisition* – by buying a whole company, a patent, or a license to produce someone else's product. The other is through *new-product development* in the company's own research-and-development department. By new product we mean original products, product improvements, product modifications, and new brands that the firm develops through its own research-and-development efforts.

The business environment is characterised today by escalating R&D costs, increasing product complexity, reduced product life-cycles, difficulties in

managing technological change and a greater amount of resources and knowledge required to innovate.

A company's current products face limited life spans and must be replaced by newer products. But new products can fail – the risks of innovation are as great as the rewards. The key to successful innovation lies in a total company effort, strong planning, and a systematic new-product development process. Distributors and suppliers are close to the market and can pass along information about consumer's problems and new-product possibilities.

In practice, innovation can be very risky. For example, RCA lost \$580 million on its Selecta Vision videodisc player; Texas Instruments lost a staggering \$660 million before withdrawing from the home computer business; and WebTV lost \$725 million before it was shut down [1].

It is difficult, however, for a single firm to possess all the resources, knowledge and capabilities required to innovate effectively, and thus organizations are increasingly involving suppliers in the product development process as one means of coping with these problems. Integrating suppliers into the design and development process has been found to facilitate learning, speed capability development and minimize exposure to technological uncertainties [2]. It also helps a firm to achieve improved speed to market, higher product quality and lower costs, and improved product manufacturability [3].

Figure 1 shows the new product development process in a manufacturing company. This process must be support by cross-functional information system that cross the boundaries of several business functions. We can see the role of suppliers in the new product development process. They are involved in R&D/Engineering activities and in manufacturing process.

The manufacturing companies focus on developing the most efficient and effective sourcing and procurement processes with suppliers for the products and services needed by a business. In addition, knowledge management applications focus on providing a firm's employees with tools that support group collaboration with suppliers and decision support.

A successful strategy implementation is usually characterized by an integrated and coordinated set of actions and commitments designed to gain a competitive advantage. An efficient company has higher productivity, and therefore lower costs, than is rivals.

We argue that the use of technological differentiation and supplier performance measures by the buyer firm will result in higher levels of supplier integration. Although the importance of early supplier integration in product development is well established, the role of technological differentiation and of supplier performance measures remains to be studied.

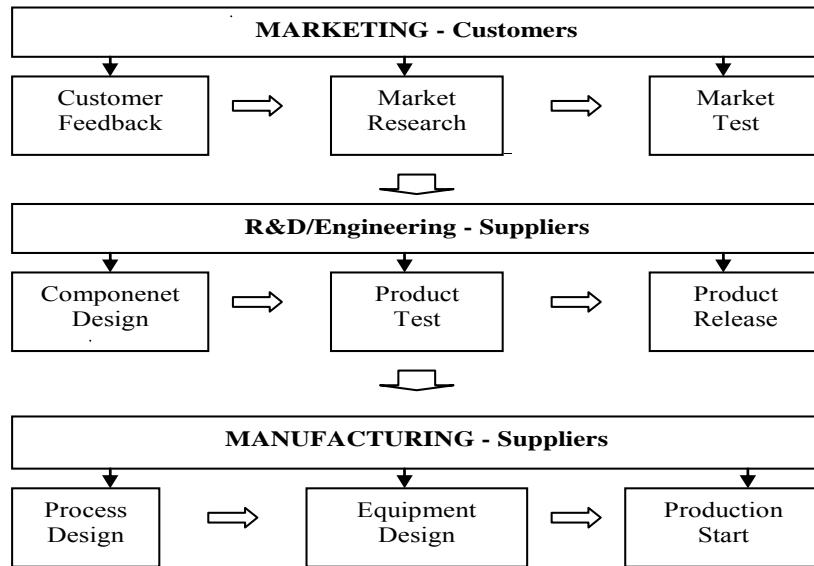


Figure 1. The new product development process in a manufacturing company

**Supply chain management** (SCM) is the integration of the activities that procure materials and services, transform them into intermediate goods and final products, and deliver them to customers. These activities include purchasing and outsourcing activities, plus many other functions that are important to the relationship with suppliers and distributors. The objective is to build a chain of suppliers that focuses on maximizing value to the ultimate customer. Competition no longer manifests between companies; still it manifests between the supply chains.

As firms strive to increase their competitiveness via product customization, high quality, cost reductions, and speed to market, they place added emphasis on the supply chain. The key to an effective supply chain management is to transform the suppliers into “partners” in the firm’s strategy to satisfy an ever-changing marketplace. A competitive advantage may depend on a close long-term strategic relationship with a few suppliers.

Cooperation among supply chain partners for mutual success is another hallmark of modern supply chain management systems. For example, many manufacturing companies share product concepts with suppliers early in the product development process. This lets suppliers contribute their ideas about how to make high quality parts at a lower cost.

Supply chain management seeks to improve performance through elimination of waste and more efficient use of internal and external supplier capabilities and technology, creating a seamlessly coordinated supply chain and

thus elevating inter-firm competition to inter-supply chain competition. Many firms have recently embraced the notion of strategic buyer-supplier relationships to improve efficiency and effectiveness across the value chain and seamlessly integrate their physical distribution function with supply partners to achieve greater benefits.

**Technological differentiation.** Many firms pursue differentiation through R&D investment to achieve a competitive edge in the marketplace. Uncertainty requires that strategy focus less on specific actions and more on establishing a clear direction, within which short-term flexibility can be reconciled with the overall coordination of strategic decisions [4].

Technological differentiation aiming at building noticeable differences in product offerings and marketing differentiation related to creating a superior brand image through marketing. A firm's pursuit of the former occurs mainly through R&D investments in the product, process, and manufacturing technology.

A posture of technological differentiation depends on the firm's ability to maintain intrinsic differences in the face of competitor imitation and customers' willingness to value offerings from non-price perspectives. A company's prior strategic commitment may limit its ability to imitate rivals and thereby causes a competitive disadvantage.

The Internet is certainly a *disruptive technology* that has eliminated geographical and location barriers. Disruptive technologies cause businesses to rethink and reshape their operations. For example, the travel agent industry will definitely be impacted by the increased use of online booking sites, such as the Romanian company "TAROM" is.

Business firms are using Internet technologies to help them reengineer and integrate the flow of information among their internal business processes and their customers and suppliers. In addition, companies all across the globe are using the Web and their intranets and extranets as a technology platform for their cross-functional and inter-enterprise information systems.

A vigorous pursuit of cost reductions along the value chain driven by experience, tight cost and overhead control, and cost minimization in areas such as R&D and advertising, among others. Customer increasingly demands both low costs and high quality.

The cost advantages based on economies of scale and scope are considered the enduring logic of industrial success. A low-cost strategy is most viable when customers are sensitive to price and there is a fighting chance to maintain a cost advantage because of economies of scale, proprietary technologies, or unique access to cheap materials or channels of distribution.

**Technological opportunity** reflects the extent to which a firm believes its primary industry offers major opportunities for innovations. An investment offers a greater potential upside, if the scope of an opportunity area is greater, rich

technological opportunities may lead firms to depart radically from the prevailing practices, which may increase their risk of failure [5]. In addition, dynamic environments compel firms to innovate rapidly for survival but may be insufficient to predict the success of the firm's various choices in the short term, especially during an economic decline.

Knowledge and innovation management plays an essential role in technological differentiation. While assets such as labour, capital, processes, and technology continue to be important, the organization's ability to think is now widely recognised as crucial. Innovative companies do more than spread knowledge; they make a habit from using knowledge creatively. Inventing is characterized as a process of breaking old connections. Learning is characterized as a process of making new connections, and adopting new habits and beliefs. That is, learning means gaining knowledge or understanding and inventing means using knowledge or understanding.

A generic strategy of differentiation aims to create a product that consumers perceive as unique and thus enables the firm to command a premium price that exceeds the accumulation of extra costs generated during the product development. A differentiation strategy typically must be supported by heavy investments in research, product or service design, and in marketing. Along this line of reasoning, we offer the following hypothesis with respect to the direct performance effect of technological opportunities:

**H1: Technological differentiation is positively associated with the level of supplier integration in new product development**

**The business performance.** The effective companies display a high degree of four specific characteristics: efficiency, agility, adaptability and flexibility. *Efficiency* allows a company to implement and follow routines. The efficient company follows well-structured, stable routines for delivering its core products in high quantities, with high quality and at low cost. Routines include the procedures and technologies around which companies are constructed and through which they operate. But in a changing world, efficiency alone is not enough.

*Agile* manufacturing is defined as the capability of surviving and prospering in a competitive environment of continuous and unpredictable change by reacting quickly and effectively to changing markets, driven by customer – designed products and services. Critical to successfully accomplish agile manufacturing are a few enabling technologies such as the standard for the exchange of products, concurrent engineering, virtual manufacturing, component – based hierarchical shop floor control system, information and communication infrastructure.

*Adaptability* is a proactive process: it allows the company to deliberately and continually change its routines to increase quality, productivity and cost-effectiveness, and also to introduce new products, services, and routines. Adaptable companies anticipate problems and opportunities, and develop timely solutions and new routines. Adaptability requires looking outside the company for new technologies, ideas and methods that may improve or completely change its routines. Adaptable companies are willing to accept new solutions quickly rather than reject them as disruptive. The most effective companies are both efficient and highly adaptable.

A typical supply network consist of inter firm relationships that may connect multiple industries. Complex interconnections between multiple suppliers, manufactures, assemblers, distributors, and retailers are the norm for industrial supply networks.

Along with managing the complexity inherent in the interconnectivity of their supply networks, organizations have also started to learn the benefits of being adaptive in their behaviour. We look for example to an adaptive firm behaviour in a cellular telephone supply chain. There are different approaches that Nokia and Ericsson took when a fire disrupted the supply from Philips, the sole supplier for a particular chip common to both manufacturers. While Ericsson suffered an estimated \$2.34 billion loss, Nokia engaged directly with Philips to restore supply using alternate supply options. They modified designs of the handsets where possible and secured worldwide manufacturing capacity from Philips to ensure a steady supply of the chips. Meanwhile, the direct interaction between the top management of Nokia and Philips further enhanced the ability of Nokia to adapt in the future [10].

In car industry, there is another example of how Honda has adapted to the changing automotive sector environment by leveraging the notions of learning and path dependency of adaptive systems. They used their Accord and Civic platform as the basis of several of their most recent sport utility vehicles, and, as a result, they gained significant market share in that segment even though they were slow to enter the four-wheel-drive market.

*Flexibility* allows the company to react quickly and effectively to unexpected situations. While adaptability is a continual, proactive process, flexibility is intermittent and reactive. It allows the efficient company to deal with unforeseen disruptions while maintaining its routines.

Some companies derive competitive edge by being superior in efficiency – in continuously restoring and improving routines. Toyota, for example, employs total quality management tools such as six-sigma and lean manufacturing to find root causes of errors and reduce waste.

Adaptability and flexibility depend on innovative thinking. The 3M Corporation establishes strategic goals for inducing adaptability; for example, one goal is that 30% of the company's products must be renewed every five years.

Established companies should aim to create, and sustain networks of young, entrepreneurial firms or to develop the formal strategic alliances with them. Since the younger firms do not have the resources, power, marketing ability, and distribution chain to scale up their creations. The established companies could serve as a venture capitalist to these firms.

In small firms, the owner has a dominant role because he can constraint innovation activity if he does not have the necessary vision and systematic thinking when diagnosing and progressing innovation activity.

Participation of SMEs in European research, development and innovation activities is vital for the European economy. SMEs are important in the innovation process since they can guarantee that innovative efforts bring practical results, and contribute to economic development. There are around 23 million SMEs in the EU providing over 65 million jobs, in some sectors more than three quarters of all jobs, and generating 56.9% of total value added. SMEs account for the majority of new jobs created, and make an important contribution to the EU's goal of more growth and better jobs [17].

Entrepreneurship and Innovation Programme (EIP) aims at achieving better access to finance for SMEs, at support services for business and innovation delivered through a network of regional centres, at the promotion of entrepreneurship and innovation. Therefore, the following hypothesis was formulated:

**H2: *The business performance is positively associated with the level of supplier integration in new product development***

**The innovation** consists of the generation of a new idea and its implementation into a new product, process, or service, leading to the dynamic growth profit for the innovative business companies. Therefore, the innovation is a "means" to achieve sustainable competitiveness.

The findings describe the process of innovation as being predominantly behavioural and characterized, as shown in Figure 2, by interplay between forces of "action" and "reaction" over time which bolsters or inhibits the closing of the "innovation gap" between the current level of performance and the desired level of performance.

Examples of action and reaction forces are: strong senior management support for the innovation (action), resistance to change from staff (reaction), allocation of capital to purchase needed technology (action) and lack of

appropriate work routines to coordinate and channel the innovation activity (reaction).

The cycle starts with sensing an opportunity or need to innovate in response to market condition are predominantly filtered and prioritized by the owner of the company.

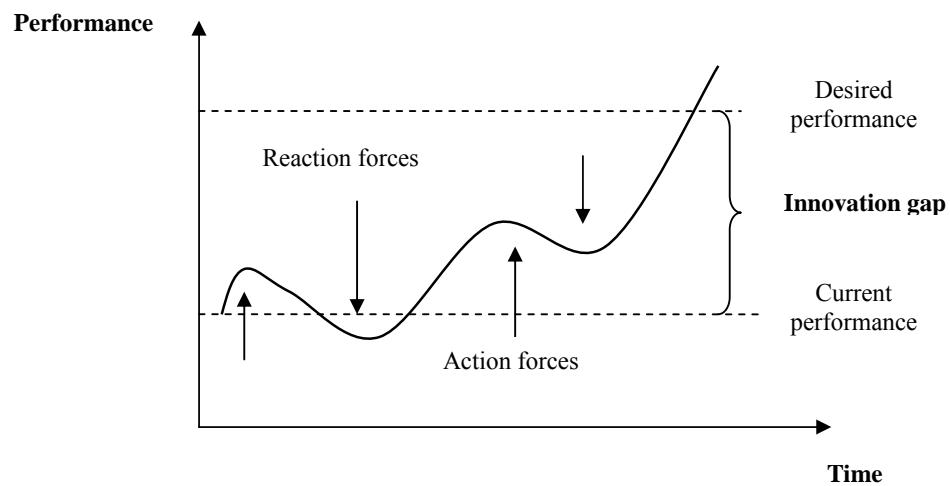


Figure 2. Action and reaction innovation

We can describe a structured innovation process that allows companies to think creatively not only to improve routine work (efficiency) but also for the non-routine work of adaptability and flexibility. This process consists of four stages (see Figure 3). Stage 1 is the proactive acquisition and generation of new information, and the sensing of trends, opportunities and problems. Stage 2 is the conceptualization of new challenges and ideas. Stage 3 is the development and optimization of new solution and stage 4 is the implementation of the new solutions.

Effective innovation requires that the suppliers and companies must learn to combine their individual preferences and skills in complementary ways. Some companies display excellent skills in one or two stages of the innovation process while being weak in the others.

*Radical innovation* is disruptive to consumers because they introduce products and value that disturb prevailing consumer habits and behaviours in a major way. It also is disruptive to producers because the markets undermine the competences and complementary assets on which existing competitors have built their success. Because it is disruptive to consumers and producers, radical

innovation is rarely driven by demand. Instead, it results from a supply-push process originating from those responsible for developing new technologies.

Given that more radical innovation takes a longer time to develop and implement. The investments in R&D require more time than others (such as marketing investment, for example) to generate profits, compensation based on results would have to be applied over the long term. Consequently, a company that set out to obtain radical innovations should design a compensation system that incorporates forms based on long-term results. Also, this kind of long-term incentive seems to promote risk-taking behaviours, which are necessary for radical innovations.

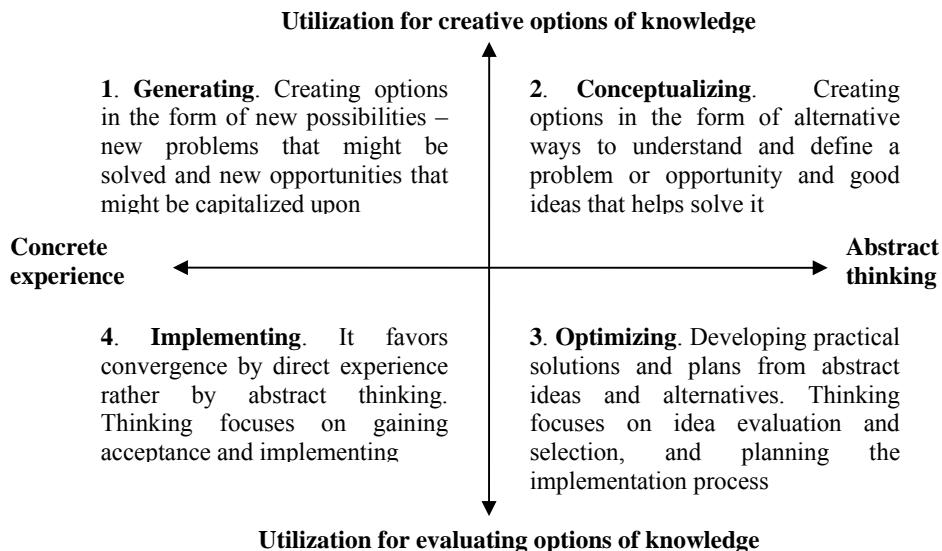


Figure 3. A structured innovation process

Nevertheless, some authors indicate that radical innovation is reduced when the compensation focuses on rewarding innovation results rather than innovation behaviours. That is, for innovations with long development cycles, the team must stay motivated over the course of the development process [10].

The early pioneers that create these new-to-the-world markets are very rarely the ones that scale them up from little niches to big mass markets. The eventual winners involve making heavy investments in exploiting scale economics, travelling down learning curves, developing strong brands, and controlling the channels of distribution to the mass market. In particular, whereas early pioneers emphasize the technical attributes of the product, latecomers shift the basis of competition away from technical performance to other product

attributes such as quality and price by cutting the price of the product to a mass-market level while simultaneously improving the quality of the product to make it acceptable to the average consumer. The product becomes attractive to the mass market, and rapid growth follows. The relevant hypothesis was:

**H3: *The innovation is directly and positively related to increased levels of supplier integration in new product development***

In many cases, a late entrant captures the market even when their product is not as good as the products of the early pioneers. This happens for two reasons. First, the early pioneers improve the new product in performance to levels that either are good enough or even surpass customer needs. At that stage, any additional investments to improve the performance of the product further are not really necessary. In this case, more and more money goes into research and development (R&D) to improve the product further and to add to its functionality. All of this occurs even if their customers do not need – nor will they ever use – the added functionality.

Product over engineering is linked to a second change taking place. The extra investments and incremental additions to the product's performance do not come for free. The rising costs lead to rising prices. The high price, in turn, limits the attraction of the product to a small segment made up of technology enthusiast adopters.

The latecomers know that all they have to do is to produce a product good enough in performance but cheaper than what is on the market. The early adopters are not attracted to these inferior products, but the average consumer is. To them, this product is good enough and cheap. Honda motorcycle, Canon copiers, and Seiko watches are really examples of companies scaling up a niche market into a mass market.

**Supplier performance measures.** Using performance measures to evaluate a supplier help focus managerial attention on areas such as innovation and communication that are important to supply chain integration.

New product development has become increasingly important to the long-term success and growth of a business. It is difficult, however, for a single firm to possess all the resources, knowledge and capabilities required to innovate effectively and thus companies are increasingly involving suppliers in the product development process. Integrating suppliers into the design and development process has been found to facilitate learning, speed capability development and minimize exposure to technological uncertainties [2]. It also helps a firm to achieve improved speed to market, higher product quality and lower costs, and improved product manufacturability. However, the literature has paid limited attention to the factors influencing the process of supplier integration.

Price has been considered traditionally as the single and most important factor in evaluating and monitoring suppliers. Other dimensions of performance, including quality, delivery and flexibility and innovation have also become increasingly important. Technological differentiation is an average of the firm's annual R&D expenses divided by its annual revenues. Consequently, the buyer must continuously monitor supplier performance across multiple dimensions and provide feedback for improvement.

**H4: The communication and sharing knowledge are associated with the level of supplier integration in new product development**

Supplier integration in product development entails collaborative and interdependent work efforts with mutual planning and problem solving. Suppliers may be assessed on a number of dimensions of performance, including their technical, quality, cost, delivery and managerial capabilities. In Table 1 some of the key variables for measuring the supplier performance are illustrated.

The inclusion of non-financial measures allows firms to balance the dimensions of performance in quality, innovation and relationships against the more short-term limited financial measures.

The benefits gained from the integration, in terms of higher returns on investment in new product, higher sales and market-share growth must also exceed the risk that suppliers will share the knowledge and technology with competitors.

*Table 1*  
**The key variables to measure the supplier performance**

Notation	Explanation
<i>Innovation-focused supplier performance</i>	
$Q_{imp}$	Quality improvement
$Pr_{imp}$	Process improvement
$P_{inn}$	Product innovation
$Ch_{R&D}$	Technological differentiation
<i>Collaboration</i>	
$T_{feedback}$	Feedback from supplier
$R\%_{supplier}$	Risk and reward sharing
$K\%_{supplier}$	Shared capital investment
<i>Business performance</i>	
Sales	Increased sales
$R_{CH}$	Improved cash flows
Prof	Profitability
$ROI_{np}$	Return on investment in new product

One of the outcomes from innovation-focused performance measures is an increase in integration with suppliers facilitating the transfer of information and knowledge about technologies, products and processes.

### **3. The conceptual model of supplier integration in new product development**

In the following section, the paper presents the theoretical constructs included in this study and the logic of the substantive relationships among the study variables. The framework emphasizes the development of the *collaborative advantage*, as opposed to the competitive advantage.

Firms that integrate with their suppliers across the product development cycle, including product design, engineering and market testing are able to achieve a variety of benefits at the product level, including a short cycle time, high quality and reduced costs. At the organizational level, involving suppliers in product development facilitates the achievement of broader benefits, such as technology road mapping, and enhanced technological capabilities. In addition, closer ties in product development may lead to agreements in sharing capital investment for the manufacturing of the product, sharing risks and rewards of innovation and greater integration of business processes.

Early participation of suppliers in the design process helps firms select the best components and technologies, and choose between different solutions. The relationships with suppliers are an additional means of transferring tacit knowledge that cannot be accessed through open-market transactions. Effective supplier integration can also lead to vast improvements in quality, cost and new product development cycle time.

Supplier integration is also particularly important in situations where product development takes place across organizational boundaries. Effective product development requires cross-functional teams, and high levels of knowledge-sharing at the organizational level. The effectiveness of the knowledge-transfer process is dependent on the way the firms manage and transmit knowledge.

The increase in information and knowledge exchange allows for higher levels of product integration with suppliers. Collaboration between buyers and suppliers is considered a necessary condition for effective buyer-supplier interactions that go beyond contractual relationships.

Typical benefits include higher quality, lower cost, improved reliability and functionality and quicker time to market. The benefits gained from involving suppliers must also exceed the risk that suppliers will share the knowledge with competitors. These returns may be in the form of higher returns on the investment

in new product, thereby generating higher sales, improved cash flows, reduced time to market and achieving market share growth.

New product development processes involve a series of stages aimed at delivering a functional commercial benefit to customers. Proficiency in executing new product development processes is important because it determines the degree to which business can meet and/or exceed demand, and thus succeed.

We use a new product development process model that facilitates action across functions by providing a common language and framework to enhance communication with suppliers. Meanwhile, rapid technological change and global competition lead firms to focus on customer relationship building and embrace coordination mechanisms with suppliers.

Figure 4 depicts the flow of stages and the different design elements employed at each stage, and highlight both the internal and external climate surrounding the new product development processes and include the variables which determine the level of supplier integration in this process.

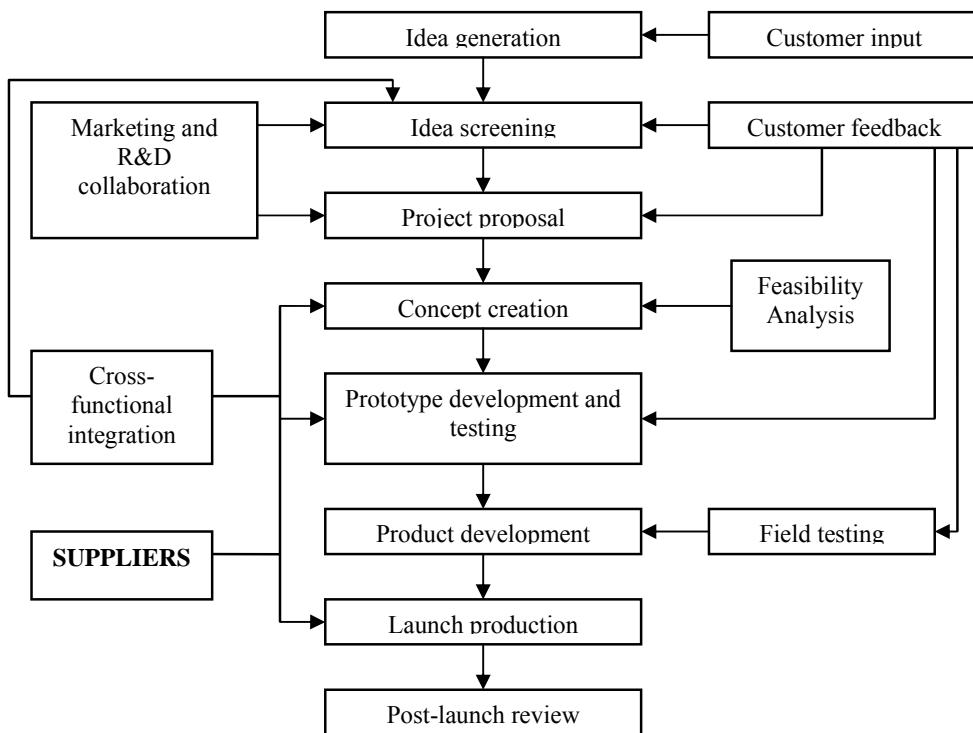


Figure 4. The new product development model and suppliers involving

We view the product innovativeness as the degree of market newness of the products commercialized by the company, ranging from “new to the world” and radical innovations to incremental products such as line extensions and product upgrades.

The extent of cross-functional integration signifies the nature of the collaboration among the suppliers, manufacturing companies, and distributors having an active role in the new product development.

We think that the management must focus on the gap between product development and customer needs by adding the three stages of idea generation, idea screening, and project proposal to allow customer input. In addition, the feedback customer is incorporated in concept creation and prototype development.

The opportunity identification is what the market place needs. Then we are building the project proposal and the manufacturing, marketing and suppliers are involved (since they are manufacturing the parts). In the next phase we get to concept development and make the prototype, where we are starting to make that transition from engineering to manufacturing. Thereafter development and launch comes, which is mostly driven by manufacturing.

In concept creation, the preliminary product concept is created. The management and the main supplier select the most feasible concepts. Subsequently, engineers begin concept testing and prototyping and conduct field tests with lead customers, followed by production launch.

#### **4. Research design and methodology**

The research context of this study is focused about technological differentiation and performance measurement on supplier integration in new product development. To test our hypotheses, we collected data from a sample of 12 respondents (project managers from ICPE, and Dacia-Renault organizations) utilizing self-report survey. Additionally, based on qualitative interviews, and published case studies. The main sources were in-depth individual interviews and annual reports of companies. There interviews helped to confirm the variables of importance, and provide a practical perspective on supplier integration in new product development.

Using the results of previous sections we can specify the theoretical regression model. In this case, we consider the following model:

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \beta_3 X_{3i} + \beta_4 X_{4i} + \varepsilon_i \quad (1)$$

where:  $Y_i$ , the level of supplier integration in new product development (dependent variable);  
 $X_{1i}$ , technological differentiation (independent variable);

$X_{2i}$ , the business performance (independent variable);  
 $X_{3i}$ , the innovation (independent variable);  
 $X_{4i}$ , the communication and sharing knowledge (independent variable);  
 $\varepsilon_i$ , represents the error term

We used regression analysis (Ordinary Least Squares) to obtain numerical values for the coefficients of the regression equation. Then using the regression results we can test the hypotheses. The first step to use the t-test consists of set up null ( $H_0$ ) and alternative ( $H_A$ ) hypotheses. From regression equation the one-sided hypotheses are set up as: (1)  $H_0: \beta_1 \leq 0$ ;  $H_A: \beta_1 > 0$  (2)  $H_0: \beta_2 \leq 0$ ;  $H_A: \beta_2 > 0$  (3)  $H_0: \beta_3 \leq 0$ ;  $H_A: \beta_3 > 0$  and (4)  $H_0: \beta_4 \leq 0$ ;  $H_A: \beta_4 > 0$ . Then we can calculate t-values for each of the estimated coefficient in the equation. The larger in absolute value this t-value is, the greater the likelihood is that the estimated regression coefficient is significantly different from zero [16].

Further on we choose a level of significance and therefore a critical t-value about 5 percent as the level of significance with which we want to test. There are 12 observations in the data set that is going to be used to test these hypotheses, and so there are  $12-4-1=7$  degrees of freedom. At a 5 percent level of significance, the critical t-value is  $t_c = 1.895$ . We consider that the level of significance is the same for all the coefficients in the same regression equation.

## 5. Analyses and results

Now we must run the regression by using a computer package and obtain an estimated t-value. Results of the regression model are reported in Table 2.

Table 2

Regression results

Independent variable	Estimated coefficients	Estimated standard errors	t-value
Technological differentiation	7.3	5.2	1.4
The business performance	24.3	9.4	2.585
The innovation	18.9	7.5	2.52
The communication and sharing knowledge	16.1	4.3	3.744

For our  $H_1$  ( $\beta_1 = 7.3$  and  $t = 1.4$ ), we cannot reject the null hypothesis, because  $1.4 < 1.895$ . In this case, our results are not conclusive and other sample is necessary to test the first hypothesis.

The results  $H_2$  ( $\beta_2 = 24.3$  and  $t = 2.585$ ) show support for us, because  $2.585 > 1.895$  and the sign of the multivariate regression coefficient  $\beta_2$  is positive

then we reject the null hypothesis. Therefore the business performance is positively correlated with the supplier integration in new product development.

In the case of the innovation ( $H_3$ ), we reject the null hypothesis, because  $2.52 > 1.895$  and the sign of the coefficient is positive. Then the innovation will have a significant effect on the supplier integration in new product development.

For the communication and sharing knowledge impact, as expected, we find that t-value calculated ( $t = 3.744$ ) is greater than the critical t-value ( $t_c = 1.895$ ) and the calculated t-value has the sign implied by  $\beta_3$ . Thus, we can reject the null hypothesis.

## 5. Conclusions

This paper summarizes what the academic literature has to say about the integration of suppliers in new product development demonstrates that technological differentiation, business performance, the innovation and the communication between company and its suppliers is positively associated with the level of supplier integration. The level of exchange occurring within the relationship is an important driver in a successful integration effort.

The findings confirm that the level of supplier integration in new product development is defined as the extent to which the company is integrated with the suppliers in terms of basic technology research, new product development and product engineering.

In this research the author has noticed that innovation in one part of the supply chain often has significant implications for other companies of the chain especially for suppliers, which need to be considered and brought together in an integrated way. The innovation effort leads to closer integration of innovation process with the supplier. The supplier's performance along dimensions that reflect their contribution to transfer of information and knowledge about technologies, products and processes are positively associated with the level of supplier integration.

The simple involvement of suppliers in product development does not automatically guarantee that the transfer of new knowledge and subsequent capability development will occur. New knowledge is often fragmented, vague and widely dispersed throughout the organization. High levels of supplier integration improve coordination, increase interactions between various groups involved in the innovation process, encourage joint problem solving, cross-learning, and lead to successful technology commercialization.

At this point, the author acknowledges some limitations of this study that might provide opportunities for future research. In this study, a conceptual model has been developed to represent the supplier integration in new product development. This model, however, must be validated. Another limitation of this

research refers to inclusion of broader factors such as supplier certification, supplier commitment, supplier selection, and so on.

Further detailed research across a number of industries is required in order to test the validity and robustness of the concepts and model presented here.

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