

EXPLOITING SUPPLIER CAPABILITIES TO MAXIMISE PRODUCT DESIGN OPPORTUNITIES IN THE FUZZY FRONT END ACTIVITIES

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ABSTRACT

This paper explores the Fuzzy Front-End (FFE), i.e. the first phase of the Product Design and Development process where a company formulates a product concept to be developed and decides whether or not to invest resources in the further development of an idea. Our goal is to understand how companies leverage supply chain capabilities to improve product design opportunities in order to obtain optimized product concepts in the FFE. From the analysis of our pilot study, the results suggest that FFE is organized differently depending on design requirements and supply chain capabilities and that matching design requirements with supplier capabilities during the FFE improves performance. Therefore, the findings indicate that the proposed Conceptual Framework has the potential to be used by companies to design their FFE and to enhance the use of supply chain capabilities in their product design activities.

Keywords: Fuzzy Front-End, Design, Supply Chain.

1 INTRODUCTION

Aligning supply chain with product design is a fundamental and essential process for any business and it brings relevant benefits to companies (Brun et al., 2013; Pero et al., 2010). As stated by Doyle and Broadbridge, (1999), it is through the product design-supply chain interface that ideas are transformed into products for customers. Integrating suppliers into Product Design and Development (PDD) process is a way to pursue alignment. Suppliers integration in PDD had been widely analysed in relation to the phases of Product Development (Handfield, et al.1999; Johnsen, 2009).

The front-end of innovation, or what is often called the Fuzzy Front-End (FFE), presents one of the greatest opportunities for improving the overall innovation process. This stage, which is defined by Koen et al. (2001) as activities that take place prior to the formal, well-structured PDD (Cooper, 1990), is the target of increasing attention because of the widely-perceived lack of high-profit ideas entering the PDD process. In fact, effective idea management has the greatest impact on successful product innovation as great ideas can disappear into a “black corporate hole” (Cooper, 2011). During the FFE new ideas are generated and evaluated. How ideas are managed and implemented is more important than generating a high number of ideas (Koen et al., 2001), since organisations understand the need for creativity but only a few succeed in translating theory into practice (Majaro, 1992). In the FFE, suppliers and supplier managers can play a fundamental role in unlocking suppliers innovation capabilities, since as the recent study by Bjørk and Magnusson (2009) contends that idea providers with a high network centrality provide a better quality ideas due to the increased knowledge and information sources. Moreover, firms should take a pragmatic approach to fulfilling the need for customization by considering market requirements and supply chain constraints and opportunities

together (Salvador et al., 2002). Despite this, there is a dearth in literature on how companies organize the FFE to allow the involvement of main suppliers in order to increase design opportunities. This paper aims at tackling this gap in the literature. To this aim, a systematic review of approaches to FFE and suppliers involvement during the PDD process has been undertaken in order to develop a Conceptual Framework for the study. Then, a series of empirical case studies have been developed to explore the main findings. The study confirms the relevance of supplier capabilities during product development and it shows the critical role played by supplier capabilities on the FFE to increase design opportunities for product features.

2 LITERATURE REVIEW

According to Petersen et al. (2005), supply chain design should be determined during the PDD process, when product, process and information systems decisions are specified. Furthermore, the nature of relationships between customers, manufacturers and suppliers are often established early in the PDD process (Handfield and Bechtel, 2002; Ragatz et al., 2002). Early Supplier Inclusion or Involvement or Integration (ESI) during the PDD process, i.e. the general term used to define a form of vertical collaboration in which manufacturers involve suppliers at an early stage of product development projects (Bidault et al., 1999; Dowlatshahi, 1998), is an important coordinating mechanism for decisions that link product design, process design, and supply chain design together (Petersen et al., 2005). Research on ESI maintains that earlier involvement is always better (Handfield et al., 1999) and suggests that technology uncertainty can be mitigated through openly sharing cost and technology information with suppliers (Hagedoorn and Narula, 1996; Teece, 1986). Consequently, Ragatz et al. (2002) have developed a conceptual model to test the effect of elements of the supplier integration process on cost, quality and PDD time, under conditions of technology uncertainty. Handfield et al. (1999) proposed a model for achieving consensus on suppliers integration into PDD process providing a theoretical framework to assist outsourcing decisions. Since it is at the stage of FFE that critical and strategic decisions are made, not only with respect to the functionality of the product for the customer, but also the logistics, the packaging, the materials and technological processes, involving suppliers can be critical and relevant. Although many researchers present different categorizations of supplier involvement during the first phase of PDD process (Le Dain et al., 2011), how to involve suppliers in the FFE to increase idea management efficiency is still an open question.

3 RESEARCH FRAMEWORK

The study aims to answer to two main Research Questions:

1. How do companies organize the Fuzzy Front-End of Product Design and Development process to allow the involvement of main suppliers in order to increase design opportunities?
2. How does the organization of Fuzzy Front-End of Product Design and Development process change depending on variation of product, process and supply chain characteristics?

To tackle these Research Questions, a Conceptual Framework has been developed (see Figure 1).

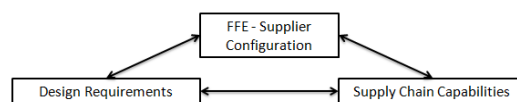


Figure 1: Conceptual Framework

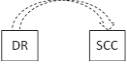


FFE - Supplier Configuration: it represents the kind of integration with supplier in the FFE in line with Clark and Fujimoto (1991) and Petersen et al., (2003). It is composed of two variables, i.e. level of interaction and innovation learning. *Level of Interaction* represents the kind of communication between designers and suppliers. It can assume the two levels, shown in Table 1.

Table 1: Spectrum of “Level of Interaction” (readapted from Petersen et al., 2003)

| | |
|--|--|
| Communication, discussions on the definition of the specific component | Partial / Full Integration, strategic collaboration with suppliers |
| ↔ | → |

Innovation Learning is the level of responsibility assigned to the supplier and the exchange of information among team members (internal) and suppliers (external) to conduct the development activity. The representation is through a couple of dashed edges arrows and values are reported in the Table 2 below.

Table 2: Spectrum of “Innovation Learning” (readapted from Petersen et al., 2003)

| | | |
|---|---|---|
| Supplier “makes to print” | Joint development activity, PDD team consults with supplier on project design | Design is primarily supplier driven |
|  |  |  |

Combining the configuration variables in order to analyze different supplier involvement during the FFE, we report six theorized FFE – Suppliers Configurations shown in the following Figure 2.

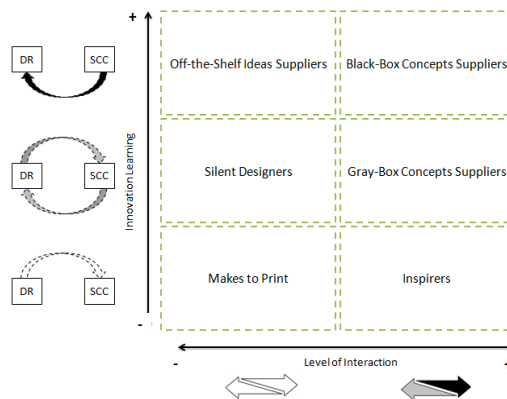


Figure 2: FFE - Suppliers Configurations (for the suppliers involved in FFE)

Design Requirements and Supply Chain Capabilities: represent product, process and supply chain characteristics considered during the FFE. Design requirements are: Technology, Materials / Processes, Intellectual Property Rights (IPR), Innovativeness / Lifecycle positioning, Architecture / Variety, Volume / Size, Form / Shape, Price / Costs. Supply chain capabilities that companies can exploit during the FFE are: Technology Capabilities, Manufacturing / Processes Technologies, Materials Technologies, Volume / Variety Capacity, ICT Capabilities, Logistics Capabilities, Lead Time Minimization, Efficient Cost Structures.

4 METHODOLOGY

In this study, we adopted multiple case study approach since, it is a very powerful method for building a rich understanding of complex phenomena (Eisenhardt and Graebner, 2007), that requires the capability to answer to “how” and “why” questions (Yin, 2008). In order to examine different product categories developed through PDD practices in various industries, we collected nine examples of product development projects from six different companies analyzed through field research and other four examples from literature case studies. The six case study were performed using a web-based questionnaire and in-depth interviews. In each company we interviewed one or two managers. The person interviewed was chosen among: Procurement Director, R&D Director, CEO, Purchasing Product Development Manager, Designers. The questionnaire allowed us to collect general data and the interviews were planned around a structure that permitted tracking the decision-making process involved in the development of a new product, with focus on the FFE. Secondary information was collected in the form of company reports (when available) and project-specific documentation. All interviews were tape-recorded and transcribed; generally, a telephone follow-up with the respondents was conducted to assess the outcomes and, in case, to gather missing data. Data and information gathered through the case studies were manipulated before being analysed. In particular, we applied data categorisation and data contextualisation. Therefore, the examples of projects we gathered in each case study was then classified according to the FFE-Suppliers Configurations matrix. In Table 3, we summarize main information reporting case study, source, example and relative supplier category of each case study from literature and field research.

Table 3: Case studies from field research and literature with examples of supplier involvement practice during the FFE

| Case study | Industry | Revenues | Source | Example | FFE - Supplier Configuration |
|----------------|------------------------|----------------|----------------|---|-------------------------------|
| SMART | Automotive | € 106 billion | Literature | Konzept-Wettbewerb | Gray-Box C. Suppliers |
| IKEA | Furniture | € 27 trillion | Literature | Children's IKEA | Silent Designers |
| PHILIPS | Electronics | € 24 billion | Literature | Innovative Products & "one roof" strategy | Gray-Box C. Suppliers |
| BANG & OLUFSEN | Electronics | € 586 million | Literature | Key and System Suppliers | Gray-Box C. Suppliers |
| ARISTON THERMO | Home and water heating | € 1,35 billion | Field Research | Hydraulic module | Silent Designers |
| DONDUP | Fashion | € 65 million | Field Research | Silk Jeans | Inspirers |
| MAX MARA F.G. | Fashion | € 1,26 billion | Field Research | Upholstered Outerwear | Inspirers |
| LUBE | Kitchen | € 160 million | Field Research | Brava kitchen | Gray-Box C. Suppliers |
| | | | | Adele kitchen | Black-Box C. Suppliers |
| MASERATI | Automotive | € 588 million | Field Research | Seat Belt | Makes to Print |
| | | | | Bridge | Gray-Box C. Suppliers |
| | | | | Airbag System | Off-the-Shelf Ideas Suppliers |
| NISSAN | Automotive | € 73 trillion | Field Research | Supplier Development Team (SDT) | Gray-Box C. Suppliers |

5 EXPLORATORY CASE STUDIES FINDINGS

Answer to RQ1: By comparing the features the FFE - Supplier Configurations adopted in the analyzed examples, we provide answer to the first research question. In particular, during the FFE, Makes to Print and Silent Designers suppliers are managed in a similar way, similarly Gray-Box Concepts Suppliers and Black-Box Concepts Suppliers. The first group is characterized by a low Level of Interaction and primarily a poor responsibility assigned to suppliers during the FFE. On the other hand, the second group includes suppliers to which extensive responsibility for the design is given and suppliers are highly integrated. Interestingly, the main features of the two identified groups can be summarized readapting a classification proposed by Spekman et al. (2000). In particular, we refer to **Concept Dalliances** for relations with supplier categories *Makes to Print* and *Silent Designers* whereas **Concept Alliances** include strategic partnerships with *Gray-Box* and *Black-Box Concepts Suppliers*. All main characteristics and information found through our study are outlined in Table 4.

Table 4: Characteristics of Concept Dalliances and Concept Alliances (from Spekman et al., 2000)

| Characteristic | Concept Dalliances (Makes to Print / Silent Designers) | Concept Alliances (Gray-Box / Black-Box Concepts Suppliers) |
|-----------------|--|--|
| Communication | Focus on main information and compliances, sharing limited to the project | Integration and high compatibility that supports close working |
| Commitment | Short-term agreements, limited to the duration of the project | Long-term agreements and joint development activities demonstrated by sharing of sensitive information |
| Interdependence | Low level of responsibility assigned to suppliers, both parties may behave opportunistically | Partners must co-operate in order to achieve their targets |
| Coordination | Limited and structured | Linked and fundamental to the future of the relationship |
| Effectiveness | Reactive suppliers that must respond quickly and exhaustively | Pro-active suppliers that must possess key competences needed and take own initiatives |

This study, therefore, suggests that different approaches to supplier involvement should be used during the FFE, and that suppliers should have different characteristics depending on the kind of alliance pursued.

Answer to RQ2: The analysis performed on quantitative data from questionnaire revealed that Design Requirements and Supply Chain Capabilities have different importance during the FFE. Despite we analyzed companies from various industries that are characterized by different product, process and supply chain characteristics, there are some features that are generally considered essential. Specifically, fundamental Design Requirements are: Technology, Materials / Processes, Architecture / Variety and Volume / Size. The most important Supply Chain Capabilities are: Technology Capabilities, Manufacturing / Processes Technologies and Materials Technologies.

Other questionnaire results are related to PDD Project Typology. Comparing the literature with our exploratory case studies, we found that companies develop more collaborations with suppliers for incremental changes (product improvement in existing line or new product in existing line). In fact, they exploit external sources of expertise in order to acquire the necessary capabilities. For radical

changes (new line in existing market or new product/product line in new market) more distant and less frequent contacts or “weak ties” (Granovetter, 1973) are deemed important.

Moreover, observing questionnaire results, we identified two main groups of analyzed companies that highlight different product complexities and architectures. According to Salvador et al. (2002), the first group can be distinguished as “Component Swapping modularity” and is characterized by two main elements: product body and swappable components. Product variants are obtained by swapping components maintaining a basic body (kitchen, furniture, home-water heating). The second group contains products that have a more complex “Combinatorial modularity”. In fact, product variety is obtained through a combination of several components (automotive, audio systems).

Summarizing questionnaire and interviews results, we found that the relational features mentioned above in Table 4 can be directly linked to the architecture of the product; in particular, Component Swapping modularity requires Concept Dalliiances whereas Combinatorial modularity calls for Concept Alliances. For example, the interview with Lube R&D Director or the IKEA case study revealed that these firms generally manage short term agreements with suppliers during PDD process. We specify that kitchens or furniture are characterized by a body structure composed of a frame and swappable components that permit the generation of product variety (Component Swapping modularity). On the other hand, a car is an intuitive example of a product that have an architecture related to Combinatorial modularity. We observed that all automotive companies analyzed integrate main suppliers in order to obtain more business opportunities. Therefore, when companies develop different product modules or, in other words, pass from Component Swapping to Combinatorial modularity, they should enhance communication with their suppliers and the level of responsibility given to them. Hsuan (1999), for example, has shown that higher degree of modularization is possible when more collaborative forms of partnership are shared between the partners during PDD process.

6 CONCLUSIONS AND FURTHER DEVELOPMENT

We summarize the main implications observed through the related units of analysis as following:

1. PDD Practices and Product Categories: Two different approaches to FFE activities that imply related suppliers profiles can be clearly recognized; Differentiated importance levels are given to product, process and supply chain characteristics considered during the FFE (Design Requirements and Supply Chain Capabilities);
2. Project Typology: During the FFE, incremental PDD projects (product improvement in existing line or new product in existing line) imply a higher supplier involvement than radical PDD projects (new line in existing market or new product/product line in new market);
3. Product Architecture: There is a connection between modular product architectures and suppliers involvement within FFE activities.

The managerial implications involve the development of a structured configuration of the supplier involvement in the PDD process based on the project innovativeness and the characteristics of product architecture. Our approaches facilitate the definition of the different roles and levels of responsibility to be assigned to suppliers within FFE activities. In particular, two different approaches to FFE that we named **Concept Dalliiances** and **Concept Alliances** were outlined. These approaches define the main guidelines for the supplier involvement and coordination of FFE activities in order to obtain new business opportunities. The best strategy depends on the nature of innovation and the architecture of the product offered to the market. This strategy will allow companies from different industries to increase effectiveness and efficiency of PDD process exploiting supplier capabilities in order to generate added value ideas.

The main findings of the study are the starting point for further research on the issues of suppliers involvement and integration during the PDD process. The relevance of these topics deserves a more in-depth study of the ways in which manufacturing companies can take advantage of the skills and competencies of suppliers during the development of innovations.

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