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“Understanding The Role Of Design Within The Supply Chain”

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ABSTRACT

Last decades witnessed a growing interest in supplier selection and supplier development in firms all over the world. The reasons for this interest are related to the increasing level of outsourcing faced by industries. Globalization and localization brought to collaboration with new actors of the supply chain. Referring to the upstream part of the supply chain, suppliers are key actors because of multiple motivations: they provide manufacturing service and fundamental capabilities in the product design and development process. Moreover, they help in creating and managing long-term relationships.

Therefore, when coping with suppliers from all over the world, managers need structured procedures for selecting and involving collaborators who can deliver innovation to the final client.

The scientific literature contains lots of papers about supplier criteria utilized by firms in the selection process. However, it lacks in investigating how designers incorporate suppliers in their own activities, exploiting their own supply chain. UK and Italy are well-known for their numerous and qualified designers. According to the Cox Review, design is becoming more and more important in English economy. In addition, Italian design style is proverbial. Nonetheless, researchers have not devoted much attention to assessing best practices and structured procedures for designers in supplier selection. Moreover, when talking about design, literature always refers to design departments within firms or to big design societies. No attention was paid to external design consultancies.

This thesis is aimed at filling in the gaps in the scientific literature.

Our goal is to identify practices set by external design consultants in their process of supplier selection. The focus is on industrial and engineering designers, involving suppliers who provide materials, information, knowledge, technologies and infrastructures. Thanks to their contributions, suppliers are fundamental to provide the clients with innovative products.

This master thesis is a result of an overlapping of supply chain management and design management. It corresponds to a partnership between the department of management engineering in Milan and the Centre for Design in Cranfield University (UK).

The antecedents for this thesis project can be found in a preview research about the role of design in maximizing the contribution of supply chain to product innovation. (Bolton et al., 2010) Following the path already started, this thesis goes deeper into the role played by design inside

the supply chain. The main objective is to understanding how designer consultants utilize their supply chain to innovate.

After a deep and thorough literature review and the identification of emerging issues and gaps in supply chain management, design management and product development with respect to innovation, we determined research questions.

Research Question 0. “What type of supplier capabilities do external designers seek for in the selection process?”

Research Question 1. WHAT supplier capabilities are designers looking for, in the product design and development process?

Research Question 2. WHEN do designers involve supplier capabilities in the product design and development process?

Research Question 3. HOW are supplier capabilities involved in the product design and development process?

Research Question 4. WHY are supplier capabilities involved in the product design and development process?

Research Question 0 consists of pinpointing a list of criteria implied by external design consultants in their supplier selection process. We analysed the literature about SCM criteria utilized by firm managers. In parallel, we conducted focus groups and interviews with industrial and engineering design consultancies who disclosure their needs in terms of supplier selection.

The main classification corresponds to capability nature: hard and soft issues are underlined. After determining the list of supplier capabilities, described through parameters and sub-parameters from SCM criteria, we proceeded to an empirical survey in order to answer the *Research Questions*. We prepared a quantitative questionnaire about WHAT, WHEN, HOW and WHY external design consultants select and involve their suppliers. The result is a screenshot about supplier-designer relationship in designing and developing products.

The research aims at filling in the gaps in the scientific literature with respect to design role within the supply chain and in particular, about external designers and their supplier responsibilities in delivering innovative products.

The main limitation to this research is the little number of interviewees, since it is not easy to find designers willing to disclosure crucial information about their PDD process.

INTRODUZIONE

Negli ultimi decenni si è assistito a un crescente interesse nei confronti dei processi di selezione e sviluppo del rapporto con i fornitori, nelle aziende di tutto il mondo. Le ragioni di tale interesse sono da ricercarsi nell'aumento del livello di outsourcing. Globalizzazione e localizzazione hanno portato alla collaborazione delle aziende con nuovi attori della supply chain. Facendo riferimento alla parte a monte della supply chain possiamo asserire che i fornitori sono attori chiave per molte ragioni: forniscono servizi di produzione e know-how nel processo di progettazione e sviluppo del prodotto. In più, sono di aiuto nel creare e gestire relazioni di lungo termine.

Per questo motivo, quando collaborano con fornitori provenienti da tutto il mondo, i manager necessitano di procedure strutturate per la selezione e il coinvolgimento dei fornitori che sono scelti in base alla capacità di offrire innovazione nel processo di produzione del prodotto.

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Nella letteratura scientifica sono presenti molti articoli riguardanti i criteri di selezione dei fornitori. Regno Unito e Italia sono consapevoli delle competenze dei loro numerosi designer. Secondo la Cox review, il ruolo del design è diventato sempre più importante nel panorama dell'economia nazionale inglese. Inoltre, il design italiano è noto in tutto il mondo.

Nonostante ciò, i ricercatori non hanno dedicato sufficiente attenzione alla ricerca di best practice e di procedure strutturate che i designer potessero utilizzare nella selezione dei fornitori. Quando si parla di design, la letteratura si riferisce a unità di design all'interno di aziende. Non sono mai state prese in considerazione aziende di consulenza esterna.

Questa tesi è finalizzata a colmare il vuoto della ricerca scientifica: il nostro obiettivo è di identificare le pratiche utilizzate dalle aziende di consulenza esterna nel loro processo di selezione del fornitore. I destinatari del progetto di ricerca sono i designer industriali e gli engineering designer che coinvolgono attori della supply chain che possano fornire loro informazioni, materiali, sapere, tecnologie e infrastrutture. Grazie al loro contributo, le aziende forniscono ai clienti prodotti innovativi.

Per questo motivo, quando collaborano con fornitori provenienti da tutto il mondo, i manager necessitano di procedure strutturate per la selezione e il coinvolgimento dei fornitori che sono scelti in base alla capacità di offrire innovazione nel processo di produzione del prodotto.

Questa tesi è il risultato di una sovrapposizione tra design management e supply chain management. Corrisponde ad una collaborazione tra il dipartimento di ingegneria gestionale di Milano e Centre of Design in Cranfield University (UK).

Dopo uno studio completo e approfondito della letteratura e il riconoscimento di tematiche emergenti e temi non analizzati nel supply chain management, nel design management e nello sviluppo dei prodotti in relazione al tema dell'innovazione, abbiamo identificato le seguenti domande di ricerca.

0. “Cosa si intende per competenze dei fornitori nel processo di selezione?”
1. “Quali competenze ricercano le agenzie di design esterno nel processo di progettazione e sviluppo del prodotto?”
2. “Quando le agenzie di design esterno coinvolgono i fornitori nel processo di progettazione e sviluppo del prodotto?”
3. Come le agenzie di design esterno coinvolgono i fornitori nel processo di progettazione e sviluppo del prodotto?
4. Perché le agenzie di design esterno coinvolgono i fornitori nel processo di progettazione e sviluppo del prodotto?

La domanda di ricerca 0 è la base di partenza per la nostra ricerca.

Consiste nell'identificazione di una lista di criteri impiegati dalle agenzie di design nel processo di selezione dei propri fornitori. Come primo passo abbiamo analizzato la letteratura riguardante i criteri di selezione usati da manager della supply chain.

In parallelo, abbiamo condotto focus group e interviste con designer industriali ed engineering design, grazie alle quali abbiamo identificato le esigenze dei designer stessi in termini di competenze e capacità ricercate nella selezione dei fornitori.

La classificazione più importante corrisponde alla natura delle competenze che possono essere hard o soft. Dopo aver determinato la lista di competenze dei fornitori (descritte attraverso parametri e sottoparametri ottenuti dalla letteratura riguardante SCM), abbiamo proceduto ad una ricerca empirica per rispondere alle domande di ricerca.

Abbiamo identificato un questionario tramite cui rispondere alle domande. Il risultato è la descrizione del rapporto tra fornitori e designer nella progettazione e sviluppo del prodotto. La ricerca ha lo scopo di colmare i vuoti della letteratura rispetto al ruolo del design all'interno della supply chain e in particolare, riguardo alle aziende esterne di design che hanno responsabilità nell'innovazione di prodotto.

La maggiore limitazione di questa ricerca è legata al numero di interviste dal momento che non è semplice trovare designer disposti a condividere informazioni importanti riguardo al loro processo di progettazione e sviluppo del prodotto.

INTRODUCTION

This thesis results from an overlapping between supply chain management and design management. It is aimed at understanding the role design acquires within the supply chain. Following a preview on the role of design in the supply chain, we decided to go deeper into the topic and to change perspective: firms are no longer the focus of the research.

External design consultants become the focus of our analysis.

The thesis has been conducted in Cranfield and in Milan. The Centre for Design and the Politecnico of Milan have different perspectives on the same topic. They cooperate to help designers and firm managers to get the most from their supply chain.

The introduction aims at presenting the topic and the reasons for choosing it. The main objective of this research is to understanding how designer consultants utilize their supply chain to innovate. The result of the study is a framework for managerial usage. The introduction ends with the description of the thesis structure.

The introduction is organized as follows:

1. Antecedents to the thesis
2. Two Different Points Of View, A Unique Mission
3. Thesis Structure

1.1 ANTECEDENTS

This master thesis is the result of a partnership between Politecnico of Milan and Cranfield University. The partnership is aimed at studying the role of design within supply chain.

The founders of this relationship are Professors from Department of Management Engineering in Milan and the Centre For Design (C4D) at Cranfield University (Bedfordshire).

Milan is dealing with Supply Chain Management issues meanwhile C4D's primary focus "*is embedding state-of-the-art design-led innovation practice, developed through research and industry collaboration, within business and education to improve commercial performance and develop future innovation leaders*". (Centre for Design – C4D website)

This thesis project follows a PhD thesis by Luca Crippa who conducted a research about the role of design in maximizing the contribution of supply chain to product innovation. His project was the first attempt to a partnership between Milan and Cranfield, that is, between Supply Chain Management and Design. He joined Centre for design for six months in order to contribute to the research field with respect to soft features of products.

In the article "Maximizing supply chain contribution to product innovation: the role of design" investigates "*the issue related to supply chain contribution to product design innovation in contexts where the importance of design is high and the technology is not the only driver for product differentiation*". (Bolton et al., 2010)

Studying the role of internal design function into three companies in UK, Bolton et al. highlight the strong companies' need to continually improve product design and innovation activities managing the partnerships and relationships in supply chain. In this environment, the design function is getting a main role as a communicator of market's requirements to actors involved in the phases of PDD.

Following the path already started, this thesis goes deeper into the role played by design within the supply chain. In particular, there is a change in perspective since the focal company is the external design consultancy. The main objective is understanding how designer consultants utilize their supply chain to innovate. Analyzing the different typologies of supplier capabilities, the research focuses on pinpointing which capability leads consultancies

towards differentiated innovation. The study explores the relationship of design consultants towards the front end of the supply chain (i.e. suppliers), contextualizing the design group unit in its environment. The result of the study is a framework for managerial usage. It is aimed at uncovering the central role of design in enhancing innovation.

The focus is on industrial and engineering designers. Suppliers (in the acceptance of companies who provide the clients with goods and service) contribute with materials, information, knowledge, technologies and infrastructures.

This thesis is the result of the second MICRA (Milan - Cranfield) collaboration. I conducted a 4-month-full-time research experience in C4D. The research is part of a major goal that aims at spreading awareness of the strategic role design has within the supply chain. Demonstrating the proficiency of designers in managing their suppliers in order to address client's needs is a main achievement. Designers create innovation and enhance their activities through relationships with suppliers providing goods and services. Designers are in charge of the innovation process. Through the selection of the most suitable suppliers and the ability to manage a fair relationship, design consultants represent a great source for western companies. Sir George Cox defines the innovation process as "*the challenge to demonstrate how this potential can be exploited without jeopardising the business*". "Innovate or fail.[...]Research shows that businesses which harness creativity and design put themselves at the leading edge. More need to be convinced. Penny Egan, Executive Director, Royal Society for the Encouragement of Arts, Manufactures and Commerce]." (George Cox, 2005)

Sir George Cox, in his Cox Review (2005), underlines the crucial role of design in British enterprise economy. "*Sustained success in business – regardless of sector – increasingly depends on the ability to innovate: to exploit new ideas and new opportunities ahead of the competition.*" Design is what links creativity and innovation. Clients search for new technologies and expertise relying on designers' capabilities and networking. On the other hand, designers quest for high quality products and specific knowledge.

1.2 TWO DIFFERENT POINTS OF VIEW, A UNIQUE MISSION

Supply chain management and design management are pursuing the same scopes from different points of view. The main goal is to maximise supply chain capabilities to design more enhanced customer orientated value propositions.

However, their focuses are different:

Supply Chain Management: “Design activities require suppliers”.

Design Management: “Design activities require supply chain management”.

Supply Chain Management: “Managers can get visibility from designers.”

Design Management: “Designers who can manage their supply chain are more attractive to clients”.

Two topics are driving MI-CRA:

- 1) necessity for developing the best strategies and tools to apply to existing teams;
- 2) necessity to create the “best team” for future projects

As a matter of fact, the main goals are: **effectiveness** and **efficiency**.

Efficiency in exploiting the existing teams with ad-hoc strategies and **effectiveness** in defining the right criteria and tools to create the best team.

Milan and Cranfield use the same approach to analyzing the topics: idea management. The process is divided into phases:

- identification
- generation
- evaluation (market analysis)
- selection (prioritization, pilot test, pick chart)

“Design activities naturally involve supply chain management activities”. This sentence conveys the importance of the relationship between design and supply chain activities.

Design and supply chain have mutual impact on each other. According to Professor Brun’s remarks, supply chain activities and design activities are entangled. Designer can’t provide

clients and consumers with innovative products without drawing on the networks embedded in the supply chain, meanwhile suppliers can get visibility through designers. Designers rely on suppliers to have access to processes, products, infrastructures and new technologies that could enhance innovation. In addition, while co-designing either with in-house designers or external design consultants, suppliers come across new customers and clients. Designers play a key role in correlating suppliers with managers inside the companies they work for.

Alex Jones, chief designer for Cambridge Industrial Design in Newton, claims the designer is “*the centre between customers and suppliers*” and he has “*to manage both [...]*

I think most designers are very good at managing relational capabilities on the contrary most suppliers are not very good at personal skills.[...] Since we have to deal with both sides, customers and suppliers, we need to learn to be supportive and responsive otherwise clients won't come back.”

From the designer’s point of view, Professor Simon Bolton holds that the supply chain is a key source for new innovation drivers. He is firmly convinced that designers can improve their performance and become more and more competitive worldwide if they deliver innovation.

1.3 THESIS STRUCTURE

The thesis is divided into three parts.

Part 1 – Literature review - consists of a thorough literature review about supply chain management, design management and new product development main topics and emerging issues. Moreover, we present gaps of the literature and research questions that will be faced in part 2 and 3.

Part 2 – Supplier selection criteria for external design consultants - corresponds to the identification of a list of supplier capabilities that can be applied by external design consultants when selecting their partners. It corresponds to the answer to RQ 0, about criteria utilized by designers to select suppliers. From SCM selection criteria and designer requirements, we could determine a list of supplier capabilities, described with SCM criteria and factors present in the scientific literature.

Part 3 – Research questions - It consists of the validation of the supplier capabilities identified in part 2. Industrial and engineering designers booked in the design directory website were asked to fill in a questionnaire to answer the research questions. After describing the questionnaire, we present the analyses conducted on the quantitative data.

Final Conclusions

It consists of a summary that includes research contributions, limitations and generalization of the thesis.

We introduced the thesis topic describing the research antecedents and the rationale below it. This thesis derives from a research overlapping between supply chain management and design management. The empirical investigation was conducted in UK (center for design in Cranfield) while the didactic part was run in Milan (Politecnico di Milano).

The result is a thesis organized as presented in “thesis structure”:

PART 1 – LITERATURE REVIEW and RESEARCH QUESTIONS

PART 2 - SUPPLIER SELECTION CRITERIA FOR EXTERNAL DESIGN CONSULTANTS

PART 3 – RESEARCH QUESTIONS

FINAL CONCLUSIONS

PART 1 – LITERATURE REVIEW AND RESEARCH QUESTIONS

PART 1 – INTRODUCTION

Part 1 presents the literature review about SCM, design, NPD and innovation. The main objective is to uncover emerging trends and common issues among the research streams, in order to identify gaps in the literature. Emerging issues, expert opinions and practitioner feedback brought to recognising topics that have not been previously investigated. This thesis aims at filling the gaps of the literature (presented in chapter 4), codified in research questions.

Part 1 is organized as follows:

CHAPTER 2 – INTRODUCING THE THESIS TOPIC: GAPS IN THE LITERATURE

CHAPTER 3 – LITERATURE REVIEW and RESEARCH QUESTIONS – to identify emerging issues

CHAPTER 4 – GAPS IN THE LITERATURE

CHAPTER 5 – CONCLUSION AND RESEARCH QUESTIONS

2. INTRODUCING THE THESIS TOPIC: GAPS IN THE LITERATURE

The objective of this chapter is to present the topic of the thesis.

Supply chain environment has changed in these years, witnessing an increasing role of upstream actors in the supply chain.

Therefore, researchers and academics studied the emerging trends, publishing numerous papers from the firm's point of view.

In PART 1, we present a literature review about SCM, designs and NPD emerging issues with respect to innovation. It results in a description of paramount subjects and a list of unexplored topics.

The conclusion is the necessity for shifting the focus and investigating unexplored fields of analysis.

Last decades witnessed a dramatic change in perspective since firms realized the necessity of widening their networks and opening their boundaries to integrate new knowledge and create new relationships with different actors. The reasons are numerous and related to outsourcing and globalization, which imply greater reliance on suppliers and a commensurate need to manage the supplier base. The consequence of new trends corresponds to the flourishing of theories and models about the "supply chain". Central to the notion of SCM is the degree to which each member views the other as essential to the success of the venture and recognizes that each SC partner is dependent on the other. (Spekman et al., 1998)

For example, firms need suppliers to gain competitive advantage since they represent drivers for successful and performing outputs.

In 1998 Spekman and others hold the necessity of a new paradigm of supply chain, where skills, expertise and capabilities of the firms who comprise the competitive network are leveraged. The rationale is the incessant growing of networks of cooperating-companies.

Upstream actors (i. e. suppliers) are acquiring a more and more crucial role in the innovation process. Therefore, the scientific literature contains several articles about suppliers role and its responsibilities in a buyer-supplier relationship. However, little evidence exists about the role of suppliers in a supplier-designer-client relationship.

This thesis is aimed at filling in the gaps of the literature, starting from a review of the literature itself.

We conducted a thorough investigation of what the literature contains about supply chain management characteristics, the role of design within supply chain, the development and growing responsibility of (new) product development, and finally SC-design alignment with respect to innovation.

Subsequently we identified the following gaps within research.

Therefore, firms are always in need of identifying and applying a structure and exhaustive procedures to involve new suppliers in their processes.

First, in nearly the totality of articles analyzed, the main focus is a firm or a factory. Very little work has been written in relation to design as focus of the analysis. However, design is a fundamental activity in the product design and development process. Academics and designers argue the importance of shifting the view and focus from firms to design activities. In particular, they put the attention on industrial and engineering designers. Additionally, they pinpoint the importance of external designers (design consultancies).

Since external designers participate to different projects required by different clients, they have knowledge about many fields, a broader understanding of new technologies, new products and trends (Petersen et. al., 2005). Therefore they can provide customers with innovative products and new ideas.

In conclusion, the research analyzes the product design and development process for external design firms.

Second, the literature fails to explain how suppliers represent the drivers of innovative design. Designers state suppliers are a great source of product innovation. Von Hippel's research concludes that the crucial role of suppliers in product development process has been considered a source of innovation both from researchers and practitioners.

Our research investigates the upstream relationship between designers and their suppliers.

The main objective of the study is to understand how designer consultants utilize their supply chain to innovate, uncovering the central role of product design in enhancing innovation.

Suppliers are linked to designers (considered as actors) through the concept of capabilities.

According to professor Verona, an exponent of the resource-based view of product development, “agents create capabilities through the activities they are involved in. [...] Capabilities originate from agents, while at the same time influencing their actions”.

Our research represents a breakthrough to stimulate academics to shift focus in favour of product design and to investigate the procedures to deliver innovative products to clients.

In this part of the thesis we present the literature review with respect to the topic presented above. We revealed gaps in the existing research and conclude with a description of research questions that originate from research gaps.

Part I consists of a literature review about emerging topics of the research and the identification of scientific gaps.

Researchers failed to investigate some subjects that are becoming more and more urgent among practitioners.

CHAPTER 3 presents gaps in the literature while CHAPTER 4 concludes part I listing the research questions.

3. LITERATURE REVIEW

The main objective of this chapter is to identify emerging issues and common topics in the scientific literature about supply chain management, design management and product development with respect to innovation. Therefore, we conducted a thorough review about their definition, role and characteristics.

In order to be rigorous, the literature review is presented according to the field of research (SCM, design, NPD) with a conclusion about product design and supply chain interface and a paragraph about innovation.

The following chapter contains a review of the literature about:

3.1 supply chain management (SCM)

3.2 design

3.3 product / new product development (NPD)

3.4 alignment and management of product design – supply chain interface

3.5 Innovation

3.1. SCM

3.1.1 SCM Definition And Role

The Supply Chain Council proposed an official definition of Supply Chain as “the entire network of firms who interact to turn raw materials into finished goods and services and to deliver them to end customers”.

According to La Londe and Masters, raw material and component producers, product assemblers, wholesalers, retailer merchants and transport companies are all members of the supply chain. (La Londe and Masters, 1994)

The global supply chain forum in 1996 defined supply chain management as the integration of business processes from end user through original suppliers that provides products, services and information that add value to customers.

SCM is the approach to designing, organizing, and executing all the activities from planning to distribution along the entire value chain, including the network of suppliers, manufacturers

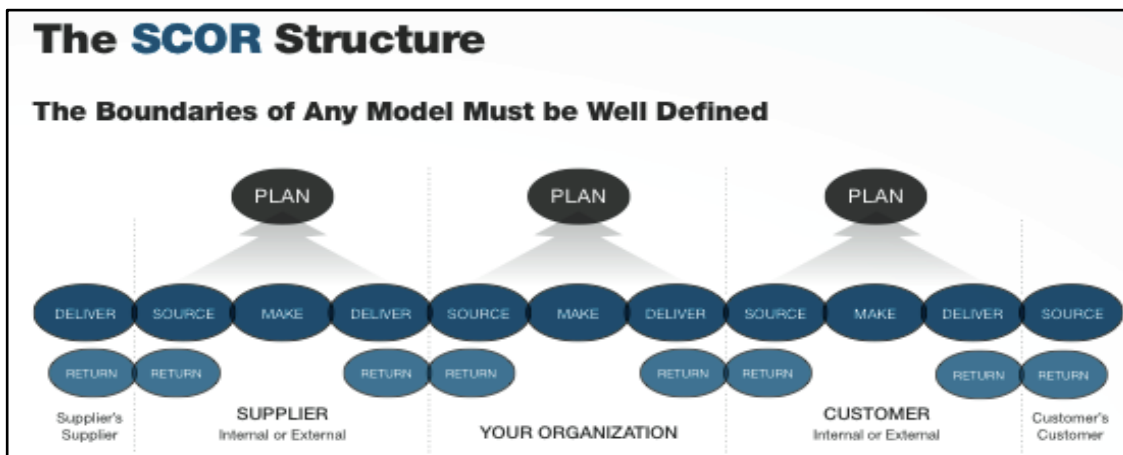
and distributors. (Childerhouse et al. 2002).

Supply Chain management comprehends the following disciplines:

- logistics and transportation
- purchasing and supply
- operations management
- marketing
- industrial economics and organization
- systems dynamics
- organizational behaviour
- institutional sociology
- economic development
- knowledge management

The supply chain council regularly updates the SCOR (Supply Chain operations Reference) model, a framework used to evaluate and compare supply chain activities and performance. (O. Gassman, 2006)

Figure 1 - The SCOR Structure



3.1.2 SCM Evolution

At the beginning of last century, big companies had control on the whole product chain, from raw materials to distribution to customers.

In the last sixty years the new trends of economy and the change in society and in the market brought to a new paradigm of “competition”, as to say a network of co-operating companies competing with other firms along the entire supply chain. (Spekman et al., 1998)

Growing of competition in markets led companies towards specialization in core business with an increase of outsourcing and off-shoring. “Firms are now facing a high degree of competition and as the nature of the design process is changing then the opportunities for changing organizational forms are increasing and the pressures for switching to forms perceived as more effective are intensifying” (Bruce et al., 1994). Firms began to understand that they could not consider themselves as stand alone entities but they were forced to interact with each other. In some cases collaboration, even if expensive and long, was necessary to survive.

Referring to outsourcing, Kannan and Choon Tan state that outsourcing is the means through which companies exploit the capabilities, expertise, technologies and efficiencies of their suppliers: the consequence is a great need of managing the supplier base. (Kannan et al., 2006)

After the second world war, the world witnessed a flourishing of small and medium companies that tried to compete with the existing “biggs”. The reason was that customers were asking for differentiated and personalized products that had to be produced with faster and more efficient processes. The industry was facing a need for managing processes and flows of tangible and intangible inputs and outputs that went beyond the boundaries of the single company.

Search for the latest technologies and processes, ambition to offer the highest quality conducted to internationalization and market globalization.

However, up until the 1960s, firms didn’t consider the idea of creating a partnership with their suppliers or customers.

In 1958, Forrester claims “Management is on the verge of major breakthrough in

understanding how industrial company success depends on the interactions between the flows of information, materials, money, manpower, and capital equipment. The way these five flow systems interlock to amplify one another and to cause change and fluctuation will form the basis for anticipating the effects of decisions, policies, organizational forms, and investment choices.” (Forrester, 1958)

The change in perspective was dramatic: each member viewed the other as essential to the success of the venture and recognized that each SC partner was dependent on the other. It was not only a matter of involvement but also a matter of necessity.

After the mindset change, firms began to view themselves as “closely linked functions whose joint purpose was to serve their customers”. In addition, management functions involved in the material flow were grouped together. (Garvin, 1984)

Such a big and complex entity had to be managed with efficient and effective techniques.

This need drove to a new discipline called supply chain management, for which there is not a unique definition.

In 1998, Spekman and others wrote “we are witnessing a transformation in which suppliers and customers are inextricably linked throughout the entire sequence of events that bring raw material from its source of supply, through different value-adding activities to the ultimate customer.” (Spekman et al., 1998)

The reasons for firms to rely on a wider network are numerous.

The main goal is to gain strategic advantage for the whole supply chain. In that process, the first step is recognizing the network structure. (Spekman et al., 1998)

Companies want to manage the suppliers throughout the entire supply chain.

Through the management of supply chain upstream and downstream networks, buyers could achieve the advantages of the reduction of product development time, improvement of product quality and minimization of product costs.

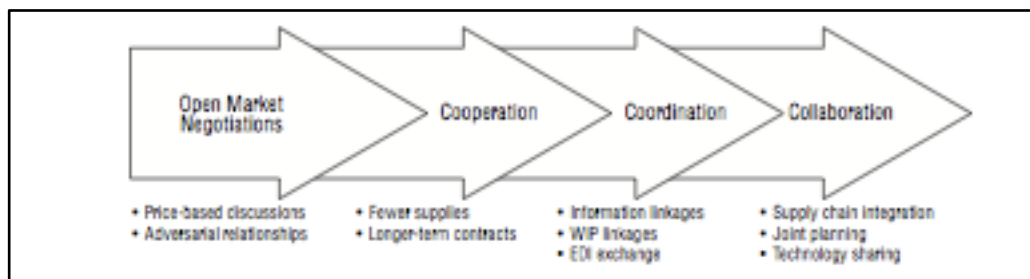
The traditional view of Supply Chain Management addresses two objectives: achieving the lowest initial purchase price and developing a sustainable competitive advantage by reducing investment without sacrificing customer satisfaction. (Spekman et al., 1998)

US leading companies such as Boeing, Hewlett Packard and 3M employed a new paradigm of supply chain management, according to which SCM is a process for designing, developing,

optimizing and managing the internal and external components of the supply system, including material supply, transforming materials and distributing finished products or services to customers. It is a new synchronized co-operation within the supply chain. The first level of intensity in the relationship within supply chain is cooperation. The second level is coordination where workflow and information is exchanged with new tools. The passage to collaboration is based on trust and commitment.

The figure illustrates the process of a supplier that starting from being an important supplier, becomes a supply chain partner.

Figure 2 - Flow of involvement



3.1.3 Relationship Management

Firm's competitive advantage arises from the set of relationships between the upstream level (suppliers) and the downstream part (clients and costumers) of the supply chain. Therefore two networks compose the firm supply chain: upstream and downstream network. The firm relationships are becoming more and more complex and entangled: relationships must be studied in depth in order to give the companies right tools to face the complicated environment.

The focus of this thesis is on the upstream network. The upstream firm network is composed of suppliers and suppliers' suppliers, at different tier levels. Since the literature offers a great deal of research about Studies of Buyer-Supplier Relationships (SBSR), this section of the literature review is focusing on buyer-supplier relationships.

The underlying rationale of the relationship management is the willingness of working together to increase rather than redistribute value within the supply chain.

“The supplier’s supplier relationships and the customer’s customer relationships may become of increasing importance”. (Dubois et al., 2002)

Some authors refer to a win-win situation in which both buyer and supplier gain benefits from the connection.

The literature offers numerous reasons for buyers and suppliers to engage a relationship. According to Krause and Ellram, buyers tend to prefer closer relationships when they wish to control “the dependability of supply or influence supplier quality and delivery schedules”. (Krause et Ellram, 1997).

Kannan and Choon Tan claim it is easier for both parties to solve quality problems and for supplier to produce the right process or component when the relationship brings to strategic commitment of the supplier and jointly, they share the same objectives and expectations. (Kannan et. al., 2002)

Handfield says both parties must share objectives and have complementary future roadmaps for performance, cost and technology characteristics of future products and plans: it is a matter of compatibility. The technology roadmap is a set of performance criteria and undiscovered products and processes. It describes the performance, cost and technological characteristics of future products each company plans to develop/introduce over a specified time horizon. (Handfield et al., 1999; Petersen et al. 2003)

Moreover, Handfield talks about “synergies” in the firm and suppliers capabilities: experts of the firm are willing to exploit suppliers’ know-how and expertise in order to get the most and to reach innovation before their competitors. (Handfield et al., 1999)

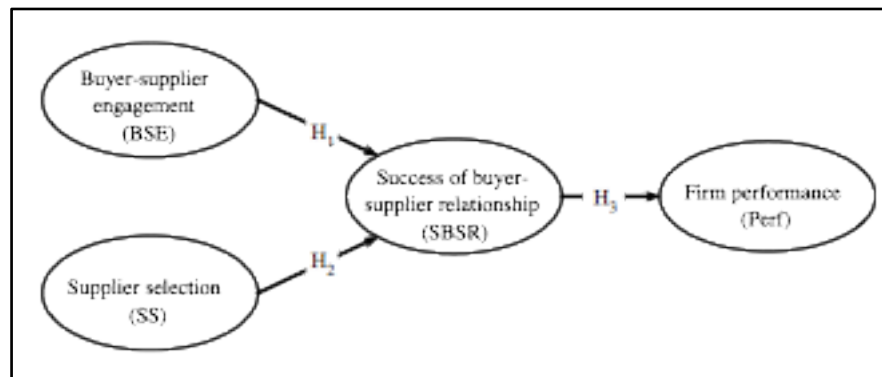
Finally, managing interface it is possible to capture vital aspects of interdependences within and between relationships. (Dubois, 2002)

In the last 20 years, researchers have studied the attributes of relationships and the impact of relationships on the dimensions of performance: financial performance, lead time performance, responsiveness and customer loyalty, quality and relationship strength, closeness and physical proximity.

However, no attention was paid to the performance of relationship itself. (Kannan et al., 2006)

Therefore, in 2005 two American researchers decided to fill the gaps in SBSR literature about the relationship performance. They conducted a study which gave birth to an interesting model about what affects SBSR and, consequently, firm performance. They were measuring the performance of buyer-supplier relationship. The procedure of selecting the right supplier and the process of developing a successful buyer-supplier infrastructure influence the success of SBSR.

Figure 3 - What influences firm performance



As we can notice from the figure above, the relationship between buyer and supplier and the supplier selection are main factors in influencing firm performance. The model successfully explains the rationale of the thesis: supplier selection applied to buyer-supplier relationships affects firm competitiveness.

A. Relationship models

Academics proposed numerous models to describe buyer-supplier relationship. I decided to cite the most remarkable to the research.

In 1997 Cooper proposed a buyer-supplier interface model called “bow-tie” and diamond”. The “bow tie” represents the competitive market in which the linkage between buyer and supplier is purchasing and sales department. The “diamond” represents a partnership: all the different firm functions by both sides are involved. Partnership implies change in buyer’s point of view: he assumes the leading role in managing contacts with suppliers.

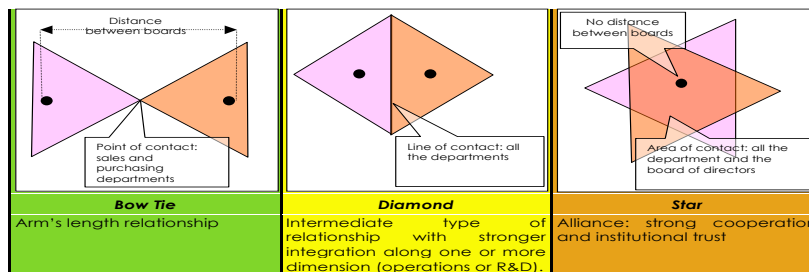
Moreover, Partnership means both technological and operative collaboration. (Cooper, 1997)

Cooper’s “bow-tie” and “diamond” model was extended by Brun, Pero and Sadighian who presented a third typology of interaction between buyers and suppliers.

It consists of an alliance and a physical colocation of an expert from the supplier firm within the buyer enterprise. (Brun, 2011)

- a. “Bow-tie” : it is a arm’s length relationship characterized by a complete buyer and supplier independence; the only points of contact are sales and purchasing departments.
- b. “Diamond” : it is a partial integration relationship in which there’s a stronger integration along operations or R&D: the goal is a joint solution to a problem.
- c. “Star” : it consists of alliances. Buyers and suppliers cooperate and share the same vision of the future.

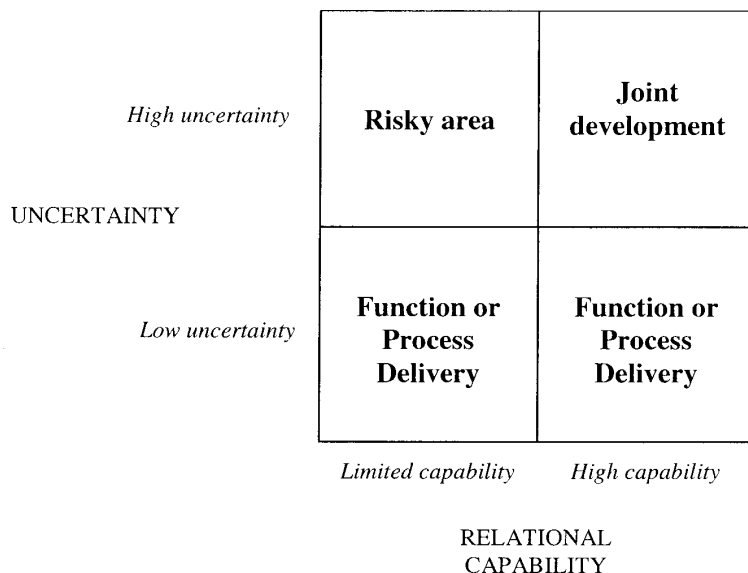
Figure 4 - An extension of the bow-tie and diamond model by Cooper et al.(1997)



In 2002, Spina, Verganti and Zotteri, in their study propose a model of technological collaboration: co-design. (Spina et al., 2002)

Conducting a case-study research, they defined a contingent model of co-design that is function of two dimensions: relational capability and uncertainty.

Figure 5 - A contingent model of co-design relationships



The types of interaction shown in the previous model can be clarified through a simple matrix. Suppliers can deliver the process or the component plus process to the client; conversely, they can develop jointly with the buyer either the process or process plus component.

Figure 6 - A taxonomy of co-design relationships

know-how supplied	component and process	Function delivery (case a)	Joint function development (case b)
	process	Process delivery (case c)	Joint process development (case d)
		split decision making	joint decision making
characteristics of the decision making process			

Afterwards, other authors faced the theme of relational capabilities. In particular, some researchers stated the necessity of developing a relational infrastructure to leverage the capabilities and expertise of suppliers. Relational infrastructure means trust, information sharing, the integration of activities in a sharing environment. (Kannan et al., 2006)

B. Portfolio models

There are numerous purchasing portfolio models that can offer suggestions to buyers on how to deal with suppliers according to different types of product. The firm’s buying motivations determine the purchasing strategy.

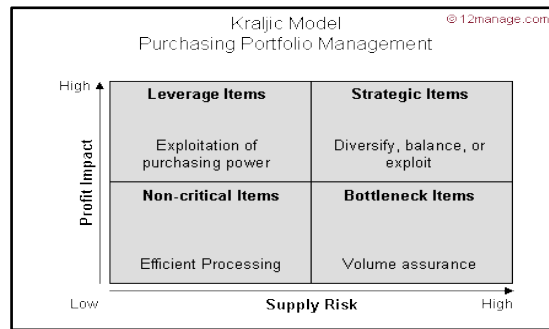
The purchasing function improves firm effectiveness developing supplier relationships.

Purchasing functions enhance competitive advantage in contemporary strategies since it deals with complex inter-organizational setting of numerous suppliers. (Svahn et al., 2009)

Therefore, supplier development and network of capable suppliers are objectives for the purchasing functions. (Kannan et al., 2002)

In 1983 focusing on the power balance between the companies, Kraljic proposed a matrix and suggested buying strategies. (Kraljic, 1983)

Figure 7 Kraljic model – Purchasing portfolio management

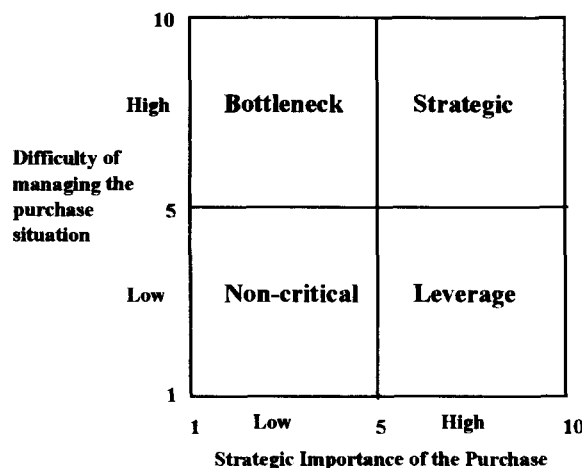


In 1996 Choi and Hartley suggested a framework of purchasing strategies (Choi et al., 1996). The construction of the framework involves two dimensions:

1. different purchasing strategies in supply networks (transactional exchange, relational partnership, collaborative network = evolution from transaction-based activity, to dyadic relationship, to strategic alliances or network)
2. differentiation between efficiency and effectiveness in a purchasing situation. (Svahn, 2009)

In 1997 Olsen and Ellram questioned Kraljic’s hypothesis “this seems to be a very dangerous strategy in today's world because market conditions change rapidly.” Therefore, they proposed a new portfolio model with different new dimensions. (Olsen et Ellram, 1997)

Figure 8 Portfolio Model from Olsen and Ellram



In 1999 Handfield wrote “the purchasing function will pay an increasingly important role.” The reason is that purchasing can identify leading suppliers into a commodity class. (Handfield, 1999)

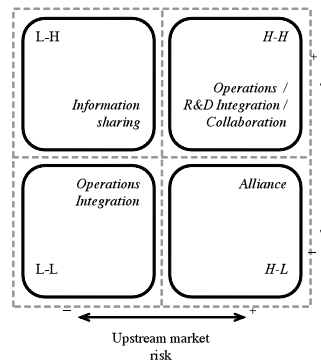
Brun and Pero built a new portfolio model with the aim of proposing a new and easy to read tool for supplier selection (Brun et al., 2011) It is an extension of Kraljic matrix, in which the new dimensions are: upstream market risk and difficulty of the downstream market. The contribution the model gives, is related to the difficulty of the downstream market (price volatility, demand volatility due to speed in changing of the purchased component design, demand volatility due to technological development and changes or to other factors).

Since collaboration and alliances are recurring words in the literature, it is fundamental to clarify their meanings.

Collaboration is a type of integration (buyer-supplier relationship) used to obtain operational and technological integration.

Alliance is a high-risk relationship in which there’s a total commitment and long-term commitment by both sides.

Figure 9 Portfolio model revised (source Kraljic, 1983, adapted)



Proactive purchasing is crucial to enhance relationships between suppliers and designers. Purchasing-design teams necessitate information plans and procedures to involve suppliers. (Brun et al., 2011)

To conclude, there is a second approach to the analysis of purchasing and supplier relationships: the industrial network approach. It considers inter-firm relationships as focal units of analysis: relationships are not regarded as isolated dyads. The product is seen as a “network entity”.

3.1.4 Supplier Importance In SCM

Portfolio models and buyer-supplier relationships originate from the same rationale: supplier role is fundamental to successful firm performance and outputs.

Academics accept the urgency of studying how managers integrate suppliers in the production process, creating a new research stream. Supplier importance and consequently their involvement in the design and production process is presented in the second part of this thesis.

A. Supplier selection and criteria

In 2006, Huang and Keskar claimed that the right suppliers, and consequently their selection have become a key factor for the success of Original Equipment Manufacturer. (Huang et al., 2007)

Supplier selection is a decision-making problem.

The supplier selection is a phase of the strategic purchasing, the application of strategic choices on procurement its described in the second part of the thesis.

B. Supplier involvement

Supplier involvement refers to “the integration of capabilities or the information suppliers provide and their participation in decision making”. (Dowlatshahi, 1998 and Handfield 1999)

According to Petersen, supplier involvement may vary from simple consultation with suppliers on design ideas to making suppliers fully responsible for the design of components or systems. (Petersen et al., 2003)

Hartley’s claims that involving suppliers with strong technical capabilities reduced the risks of design-related delays. (Hartley, 1997)

In the same year, Wasti and Liker declared that technology uncertainty together with supplier technical capabilities influence supplier involvement. (Wasti et al., 1997)

In 2003, Wynstra wrote that “managing supplier involvement implies decisions and activities related to prioritizing, mobilizing, coordinating, timing, and informing with regards to these resources, tasks and responsibilities”. (Wynstra et al., 2003)

In 2009 Johnsen wrote “Supplier involvement in new product development and innovation: Taking stock and looking to the future”. He conducted an empirical research into supplier involvement in NPD. Clustering papers according to the period of time, he highlighted some important issues.

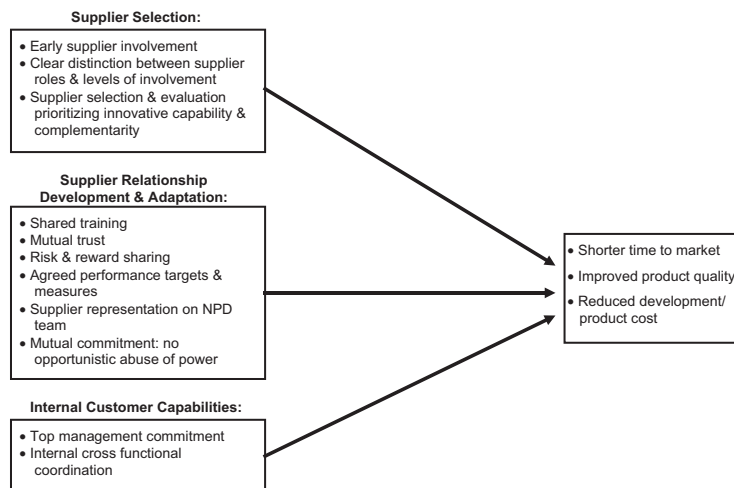
Johnsen presented some authors who studied supplier involvement from the supplier’s point of view. (Johnsen, 2009)

The latest researches observed the topic of supplier selection process and adaptation. Authors outlined the importance of supplier involvement “in agreeing technical metrics and targets.”

Despite his accurate research, Johnsen concluded that there is still no consensus about the situations in which supplier involvement is more successful.

However, thanks to his thorough literature research, Johnsen proposed a framework that illustrates factors affecting supplier involvement success:

Figure 10 Factors affecting supplier involvement success.



Some benefits of supplier involvement are:

- 1) efficient and effective collaboration in future projects, suggestions for improvement of design and performance of products
- 2) creation of permanent access to suppliers’ new technologies which can be of strategic importance
- 3) alignment of technology strategies with key suppliers through roadmaps
- 4) transfer of specific solutions developed during the collaboration to the other projects
- 5) information and expertise of new ideas, technology and problems

-
- 6) outsourcing and external acquisition possibilities that decrease internal complexity of projects and reduce critical path for NPD projects
 - 7) elimination of rework (Handfield, 1999; Petersen, 2003)
 - 8) quality improvement
 - 9) decrease of cost development
 - 10) enhanced speed
 - 11) according to Song and Benedetto “*There is a positive impact of supplier involvement on new product performance.*” (Johnsen, 2009)

Involvement of suppliers implies more need for effective coordination mechanisms and appropriate tools.

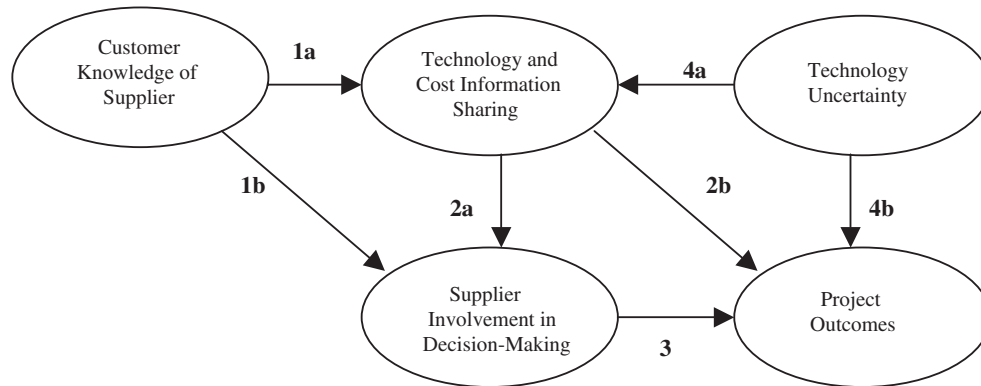
Wasti and Liker found that 3 elements are critical during a process of supplier involvement:

- 1) the extent to which the supplier influences decision-making
- 2) the amount of control the buyer retains over the design
- 3) the frequency of design-related communication (Wasti et al., 1997)

C. Models for supplier integration and involvement

Petersen proposed a simplified structural equation model of factors that affect supplier integration [Figure below]. He employed case studies to develop the model, whose conclusions are:

- a. company successful at supplier integration employed a systematic process for overcoming perceived technological risks
- b. company tended to create a bookshelf of current and emerging technologies that meet future requirements
- c. managers took the time to ensure that the supplier was included actively in the team decision making process. The supplier’s insight were considered in decisions, especially when the team confronted technological issues with which they were not familiar (Petersen, 2003)

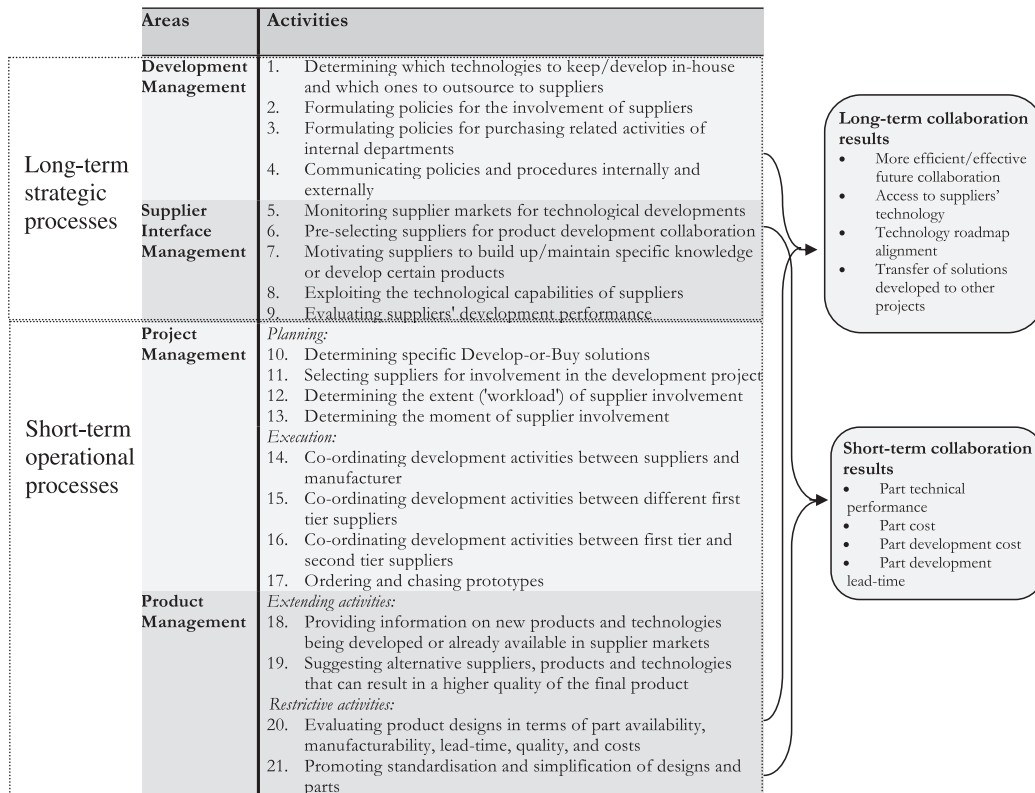
Figure 11 Simplified Structural Equation Model and Hypotheses

The third implication is the most significant: “the physical collocation of a supplier engineer at a buying company increasingly is becoming a part of the normal NPD structure. [...] Suppliers participate as members or even lead the subteams for the product system with which they are involved, giving the suppliers an active role but still maintaining a high level of confidentiality for the overall project.”

Many authors propose the concept of bookshelf of technologies and suppliers. It is a description of what companies are looking for: a list of suppliers and technologies they can access whenever they need. It is the result of researches within the network of relationships (supply chain) each firm has. (Handfield, 1999; Petersen et al., 2003; Petersen et al., 2005)

Van Echtelt, et al. (2008) identified a framework related to the activities for managing supplier involvement in product development. The framework is divided into long and short term results that highlight the importance change of mind according to which suppliers are involved also as enablers of competitive advantage for the future.

Figure 12 Activities for Managing Supplier Involvement in Product Development



Other authors wrote about “*supplier interface management.*” In particular, a framework named “Relations between the four management areas of purchasing involvement in product development” (Wynstra et al., 1999) presents the supplier interface management as the common activity among development management, product management and project management.

According to some authors, the supplier involvement interface consists of different activities (Echtelt, 2008):

- monitoring supplier markets with regard to technological developments: this type of research excludes research for more competitive suppliers that produce an existing standard product and ad-hoc quest for specific development projects but it includes pro-active research with the aim of identifying suppliers/technologies that could be interesting for the development of new products.
- pre-selecting collaboration partners for building and maintaining collaborative supplier relationships

-
- motivating or getting suppliers interested in developing products that the customer firm needs or wants; the manufacturer needs to become attractive (in terms of volume, image, new product ideas, access to production technologies) to the supplier in order to mobilize his resources
 - exploiting the technological capabilities of suppliers: it refers to letting the manufacturer adapt to the capabilities of its suppliers
 - evaluating supplier development performance

(Wynstra et al., 1999)

According to Peterson, Handfield and Ragatz, supplier involvement is more important when technology is complex or when the buying company does not have a high level of internal expertise in the area. (Petersen, 2003)

Suppliers are involved in the determination of appropriate technology metrics and target for the projects. Smith and Reinertsen wrote that “suppliers particularly need to be included as team members when the new product involves critical technologies in which the company is not expert”. (Handfield, 1999)

Suppliers should be motivated to participate in technological collaboration. (Petersen, 2005; Wynstra, 1999)

Antecedents to successful involvement in new product development are:

- the length of a buyer-supplier relationship
- supplier’s existing knowledge of the buying firm’s internal processes and objectives that enables the supplier to plan for future product development
- ability to create and sustain fruitful collaboration
- three forms of assessment: detailed assessment of the suppliers being considered for involvement, leading to selection of a supplier with capabilities well-matched to the buying company’s needs, technical assessment and assessment of cost, schedule and other business factors

Two factors are considered when integrating the supplier into the product development process:

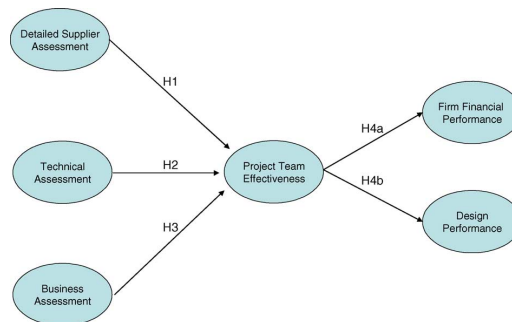
- 1) the rate of change of the technology (assuming that the buying company can establish that the supplier’s technology roadmap is aligned with its own)
- 2) level of supplier expertise in the given technology

Two are the critical elements of the process:

- 1) sharing information
- 2) incentive or motivation for suppliers to work at alignment with the buying company

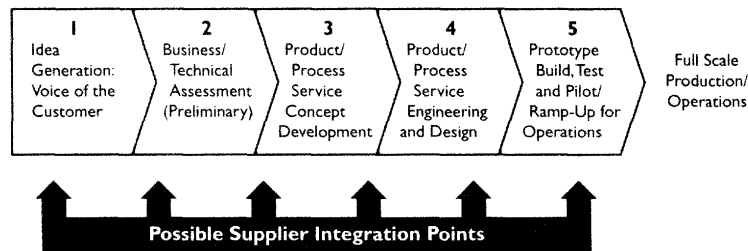
In 2005, Petersen developed a conceptual model that characterized the major activities required to successfully integrate suppliers into NPD process.

Figure 13 Theoretical model



Possible supplier’s integration points: new product development process. (Handfield, 1999)

Figure 14 New Product Development Process



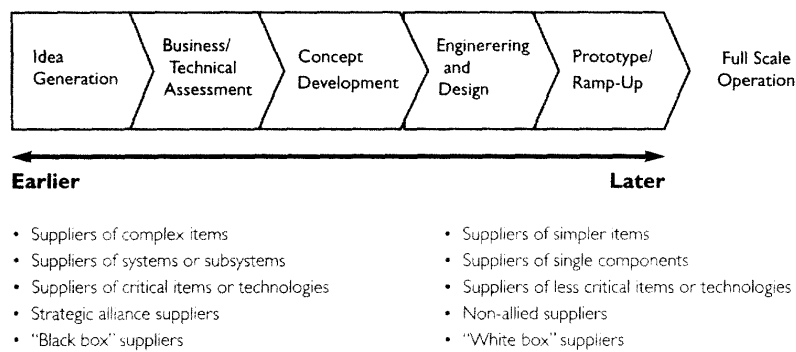
The idea generation is the first stage in which designers and marketing experts define the need for the product and ask the costumers for their ideas, the costs and so on. In addition, potential technologies may be assessed.

The last stage is the creation of a working prototype, which enables testing and verification of existing production systems. At the end, the product enters full-scale production and supplier volumes are ramped up. In this context, suppliers may provide materials and services that constitute a majority of the cost of many products.

Supplier input and/or the active involvement of suppliers may be required at any point in the development process.

The figure below explains what type of suppliers can be integrated according to the process phase. (Handfield, 1999)

Figure 15 Integrate Suppliers at Different Stages



Petersen referred to a spectrum of supplier integration:

Figure 16 Spectrum of supplier integration

None	"White Box"	"Gray Box"	"Black Box"
No supplier involvement. Supplier "makes to print."	Informal supplier integration. Buyer "consults" with supplier on buyer's design.	Formalized supplier integration. Joint development activity between buyer and supplier.	Design is primarily supplier driven, based on buyer's performance specifications.

Direct supplier participation in team meetings can make the difference between a successful and unsuccessful outcome. (Petersen, 2003)

D. Early Supplier Involvement

The concept of ESI refers to the involvement of suppliers in the first stages of the design process, especially in the NPD.

Esi is considered an important coordinating mechanism for decisions that link product design, process design and SC design together. Earlier integration is beneficial in cases of higher technology uncertainty.

Handfield sustains that early decisions in the design process have significant impact on the product quality, cycle time and cost. Making changes in later phases of the process could be more difficult. (Handfield, 1999)

Mikkola and Larsen wrote: “The integration of supply chain has a tremendous influence in how manufacturers of complex products manage the stream of innovative products”.

In 2002, Ragatz et al. affirmed that the extensive and early involvement of suppliers in NPD can improve NPD performance.

Petersen in 2003 claims that sharing technology and cost information early in product development process, leads the development team to begin active discussion of technological options that can meet market requirements and results in a faster process. (Petersen, 2003)

3.1.5 Conclusions

Relationships analyzed above don't include the increasingly important role of design within the supply chain. They all focus on firm's point of view, without considering the primary role of design activities in competitiveness and performance.

In 2000 Dowlatshahi built a conceptual framework of designer-buyer-supplier interface, where the design function is part of the firm. It consists of three levels with different planning horizons and different involvement of suppliers:

- operational (short period): it is related to component production; the contacts are inspection and receiving policy;
- tactical (medium term): information sharing, supplier plant visitation, supplier selection, evaluation, and certification, supplier training/meeting;
- strategic (long term): long-term strategic alliances, supplier R&D investment and financial strength, confidential relationships, reduction in the number of suppliers;

That framework was one of the first attempts to explain the increasing responsibilities of design in the process of cooperation and collaboration in supply chain.

3.2. DESIGN

3.2.1. The Word “Design”

The word “design” comes from the latin word de-signare that means “making something, distinguishing it by a sign”. (Verganti, 2009)

The Oxford dictionary reports the following meanings of the noun “design”:

- a plan or drawing produced to show the look and function or workings of a building, garment, or other object before it is built or made
- the art or action of conceiving of and producing such a plan or drawing

The definitions above emphasize the physical and practical meanings of the word or the acceptance of making a plan.

In modern times, design has achieved dignity of discipline. Especially in UK, it is regarded as “a key to future business success and to national prosperity”. (Cox, 2005) In addition, “ the design consultancy profession has burgeoned to become one of the fastest growing service sectors in UK”. (Bruce et al., 1994)

There have been an evolution of meaning and addition of new acceptations that characterize the new status of design.

The new definition of design integrates services, brand and communication.

Therefore the question is: “What do we mean by design?”

According to Mat Hunter, Chief Design Officer at Design council, “there are countless definitions of design”.

Mainly, design is seen in a twofold form since it can be related to engineering and art, it can be “some sort of marriage between form and function”. The activity of design can apply both to technical and creative fields. It represents the act of planning projects but it also refers to styling or, in a broader meaning, to creative and innovative activity.

Design is also defined as a complex activity that involves innovation, change, invention and creativity.

Sir George Cox, in the Cox Review:

Design is what links creativity and innovation. It shapes ideas to become practical and attractive propositions for users or customers. Design may be described as creativity deployed to a specific end. (Cox, 2005)

In a practical way, design is what makes ideas tangible and what makes things simple.

Mostly, “Design is all around you, everything man-made has been designed, whether consciously or not”. (Design council website)

Petersen’s definition of design: “design is not considered in isolation but as an integral part of a process involving its management and supported by appropriate tools and techniques”.

Design is the process that can help seek to optimize consumer satisfaction and company profitability through the creative use of major design elements.

Design is a tool for managers that want to achieve success. It can be used at every level of the organization, since it is part of the strategy of the company. (Beltagui et al., 2008) Roberto Verganti, in his “Design driven innovation”, states that “design innovates meanings and meanings make a difference in the market”. His thesis presents a new vision of the twofold nature of design: “the dialectic is not between function and form, but between function and meaning”. That means companies have to rethink about the meaning their products give to the market and “design” new acceptations. In addition, design should create innovation that relates to “successfully bringing a new or significantly improved product/service to market”. (Verganti, 2009)

The citation explains the reason for which supply chain and design are working together to give birth to new paradigms and operative feedback for managers and experts.

Design and SC have the same goal: to bring radically new or slightly new products or services to customers.

Professor Simon Bolton, in his presentation of the concept of Design driven-innovation, claims that Business design relationship focuses on the creative alignment of business objectives to design strategies in order to generate multiple solutions, thus enabling more strategic choices to be made (Bolton S. et Brun A.).

De Mozota cites design as a source of increased sales, better margins, improved brand values, greater market share, better ROI and deliverer of socially responsible design. Moreover, he

states that the value of design consists of its ability to help organizations to differentiate, integrate and transform innovation opportunities. Referring to this meaning, design can improve new product development processes.

Literature about design suggests that design has an active role in creating a direct contact between customers and end users. This activity brings to unlock hidden innovation and new product ideas. (Beltagui et al., 2008)

Verganti states that design requires prediction of the future, anticipating what customers will want and it can be a leverage “to enable the organization to innovate” (Verganti, 2009)

The aim of design is the satisfaction of customers. Verganti sees design in its new role: understanding customer requirements, translating them into design requirements and involving suppliers to transform design projects into products.

In 2005, the Design Council classified the design disciplines in:

- communications, branding and graphics
- interiors
- architecture/landscape
- new product development
- industrial design
- packaging design
- engineering design
- service design

(Design Council website)

Because of the development of technology and the change in society, design disciplines continue to evolve, thus making it impossible to define an exhaustive list of design disciplines.

However, the thesis focuses on industrial design. The International Council of Societies of Industrial Design (ICSID) in 1969 proposes the following definition of Industrial Design:

“It is a creative activity whose aim is to determine the formal qualities of objectives produced by industry. These formal qualities are not only the external features but are principally those structural and functional relationships which convert a system to a coherent unity both from the point of view of the producer and user. Industrial design extends to embrace all the aspects

of human environment, which are conditioned by industrial production”.

3.2.2. History Of Design

In 1980's, industrial design and industrial design engineering sectors started focusing on the application and use of design specifications that integrated market requirements and technical feasibility. That general interest conducted towards formalizing and developing more systematic approaches to design management.

Figure 17 – The evolution of the role of design in NPD

Table 1. The Evolution of the Role of Design in New Product Development

Period	Design Role
1800s	Business-Oriented
1920s to 1950s	Specialist
1960s to 1970s	Professional
1980s	Brand Dominated
1990s	Subprocess of NPD
Early 2000	NPD Process Leader

Perks, Cooper and Jones wrote: “designers developed business based on ideological response to the human condition.” They believed that beautiful design could improve people’s life and that designers were responsible for reaching the greater good.

From 1920’s to 1950’s designers became specialists in producing what customer asked for. In this period, people looked for aesthetic and stylish products.

Between 1960’s and 1970’s design became a profession with the birth of professional associations like British Council for Industrial Design.

The 80’s were brand-driven years. The world witnessed the flourishing of designer labels such as Alessi or Gucci. Mostly, British had the strongest design consultancy industry in the world.

The 90’s was a difficult period for design that was considered as a discrete functional sub-activity, to be integrated at specific stages of the product development process. New notions of team-based and parallel NPD forced designers to work closely with other functions. Mechanisms were prescribed to facilitate cross-functional information ex-change.

Early 2000 - Harsh competition has led to increased emphasis on creativity and innovation as crucial dimension in more recent business strategy. Designers are undertaking a leadership role in the product development process. Scholars suggest their responsibilities should expand to roles that support the whole NPD effort. Understanding the customer is becoming a pre-requisite for new product success.

(Perks et al., 2005)

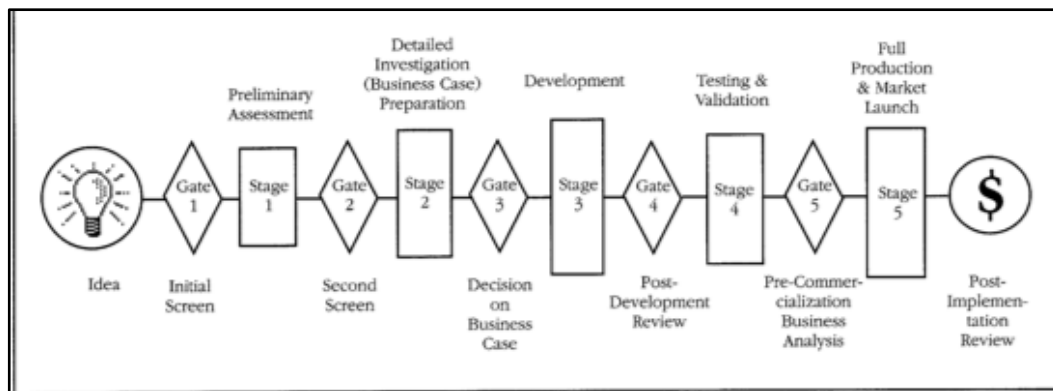
3.2.3. Design Thinking

It is a process for solving problems or issues that looks for an improved future result, combining empathy, creativity and rationality to meet user needs and drive business success based around the “building up” of ideas.

3.2.4. Design Process

Cooper proposed a description of NPD process, as a stage-gate process (Figure). He claimed that “stage-gate systems recognize that product innovation is a process. And like other processes, innovation can be managed. Stage-gate systems simply apply process-management methodologies to this innovation process.” (Cooper, 1988)

Figure 18 – Stage-gate system of the product innovation process



In 2005, the design council proposed a “Double diamond” design process model. The process is divided into four distinct phases: Discover, Define, Develop and Deliver.

3.2.5 Design importance in business

Designers play a key role in correlating suppliers with managers inside the companies or firms they work for. Professor Bolton, in his presentation of the concept of Design driven-innovation, claims that Business design relationship focuses on the creative alignment of business objectives to design strategies in order to generate multiple solutions, thus enabling more strategic choices to be made.

Moreover, he states that the value of design consists of its ability to help organizations to differentiate, integrate and transform innovation opportunities. Referring to this meaning, design can improve new product development processes.

Professor Simon Bolton gives an important contribution in spreading the awareness of the design importance in business. He claims the need to establish a mindset shift in how both businesses and designers use the design brief to align objectives with measurable design outcomes. In addition, he explains the rationale of why design is important to business growth: 1) design sustains the tactical delivery of improved performance and company growth through innovation; 2) design helps firms to transform innovation into competitive advantage; 3) design thinking helps solving complex problems; 4) design helps organizations to cope with change, interpret new markets; 5) user centered design approaches develop deeper understanding of users, enabling companies to unlock hidden innovation.

Philips advocates that for design the only way to make the design profession be accepted as a core competence is valuing measurable business outcomes. (Bolton and Brun)

3.2.6 Design Management

Last decades observed a raising interest with respect to design and how to manage it within firms and supply chain.

Creazza and Khan claim designers and managers' priority is to rethink the processes of managing design and the ways of communicating the value of design within the company. "This requires a better understanding of the design process, establishing a design-aware business culture and the integration of design with other key functions that are responsible for business success and competitiveness." (Creazza et al., 2009)

Blaich defines design management as "harnessing of design expertise to reinforce the strategic objectives of the organization" "It is necessary to implementing a formal design policy within the company, and emphasizing the importance of design to long-term corporate goals."

According to Vasquez and Bruce, there's a need to co-ordinate design resources at all company levels to achieve the company's strategic objectives.

Design management was recognized as a discipline and role within commercial design practices in 1980's since in that period interest in design grew rapidly. (Bolton and Brun)

Design management was created with the aim of helping organizations and designers manage the design process and projects more effectively within manufacturing organizations.

3.3 PRODUCT DEVELOPMENT

3.3.1 Product Design

In the 1990's, the rapid rate of technological change, the shortened product life cycles, and the globalization of markets resulted in renewed executive focus on new product development processes.

Walsh claims product design is more important than price alone in determining the competitiveness of firms. (Creazza et al., 2009)

The process of preparing design specifications is shared by both customers and potential suppliers for defining their requirements and capabilities.

New Product Development (NPD)

In 2000, Dowlatshahi gave a definition of NPD that fits our research focus:

“NPD is the integration of capabilities that suppliers can contribute to NPD projects”.

In 2008, Van Etchtelt et al. amplified the definition adding that NPD refers also to the tasks the suppliers are able to carry out on behalf of the customer, and the responsibilities they assume for the development of a part, process or service.

NPD is the process of transforming a market opportunity and a set of assumptions about product technology into a marketable product.

A new product is any product that includes some of the following novelties:

- * Technological: When its technical features, uses and/or functions significantly differ from those of an existing product. These changes may involve radically new technologies, new uses for already existing technologies, or new knowledge.
- * Aesthetic: When it offers a new appearance, designed to fulfil non-functional demands based on social, stylistic or fashion criteria.

“Organizations that use multi-disciplinary team approaches tended not to separate design from other parts of the product development process.” (Bruce et al., 1994)

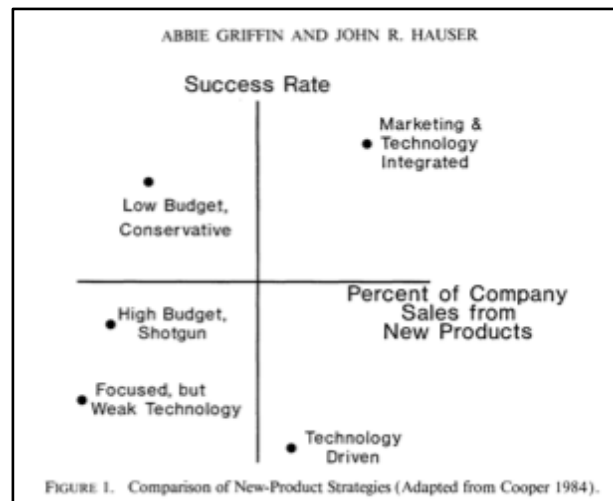
Product design specification should form the bedrock upon which any competitive design should be based. (Bruce et al., 1994)

Littler, Leverick and Bruce concluded that frequent inter-company communication, building trust and establishing partnership equity contribute to the success of collaborative new product development efforts. (Handfield, 1999)

The role of communication is relevant for firms to achieve success at new-product development. Empiric analysis suggests that communication among marketing, engineering and manufacturing leads to success. The types of information to communicate are: information on customer needs and segments, technology and manufacturing capabilities, competitor strategies, business strategy and pricing. However, there are barriers in achieving the cross integration of functions: R&D engineers and market people don't speak the same language since they have their own "thoughtworld". (Griffin et al., 1992)

Comparison of new product strategies:

Figure 19 – Comparison of New-product strategies (adapted from Cooper, 1984)



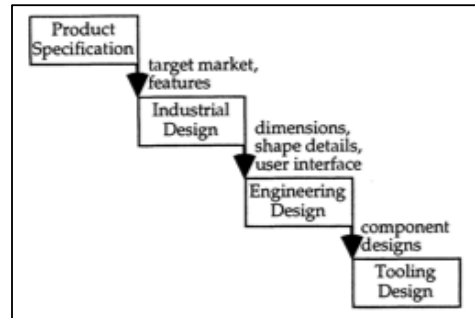
3.3.2 Product Development Process

The literature contains some different description of PDD process.

Product development process phases

In 2007, Krishnan, Eppinger, and Whitney proposed a PD process for a manufactured component as:

Figure 20 – Product development process for a manufactured component



(Krishnan, 1997)

Song and Montoya-Weiss, basing on their extensive case-studies and focus group interviews, identified six sets of general NPD activities: (Song et al., 1998)

1. strategic planning: preliminary assessment and integration of a project's resource requirements, market opportunities, and strategic directives
2. idea development and screening: generation, elaboration and evaluation of potential solutions to the identified strategic opportunities
3. business and market opportunity analysis: execution of the marketing tasks required for converting new product ideas into well-defined sets of attributes that fulfill consumers' needs and desires
4. technical development: designing, engineering, testing, and building the desired physical product entity
5. product testing: testing the product itself, as well as individual and integrated components of the marketing and advertising programs
6. product commercialization: coordinating, implementing, and monitoring the new product launch

Krishnan and Ulrich (2001) summarized the literature about product development, dividing in broad categories:

- a. single project level:
 - concept development
 - supply chain design
 - product design
 - performance testing and validation
 - production ramp up and launch
- b. setting up a development process:
 - product strategy and planning
 - product development organization
 - project management

However, this thesis assumes Ulrich and Eppinger's points of view, explained in the book named "Product design and development" (2000). They distinguished the typical development process in 6 different phases:

0. planning (that includes identification of opportunities and that has to be carried on before the development process)
1. concept design
2. system design (that includes both product architecture and supply chain design)
3. industrial design
4. testing and improvement
5. production ramp up and launch

New product development depends on:

- * the supplier's relative level of experience and capability
- * the supplier's relative level of expertise with a given technology
- * sharing of technology
- * cost information

The last two elements enables product development team to begin active discussion of the technology options that can meet market requirements.

3.3.3. Role Of Design Into NPD

Design function is adopting a more prominent position in the management of the product development effort since designers are undertaking multiple activities along the whole development activity spectrum. (Perks et al., 2005)

Initially, the use of design was triggered by a need to change.

In 2005, Perks, Cooper and Jones conducted an empirical study about the role of design in NPD. The conclusion was: “ *Where industry conditions indicate a need for radical product differentiation through creativity, nurturing a more central role for the designer may bring benefits to the development process.*”. Porter considers differentiation as being one of the strategies that a firm can use to achieve competitive advantage, distinguishing the firm as superior to others.

According to Crippa, design communicates the product values and meanings.

The importance of design is related to multiple reasons: (Creazza et al., 2009; Bolton et al., 2010)

1. design generates creative ideas;
2. design has a strategic and competitive role;
3. design coordinates effort of Supply Chain
4. design is used in the mitigation of risks

3.4 ALIGNMENT AND MANAGEMENT OF PRODUCT DESIGN-SUPPLY CHAIN INTERFACE

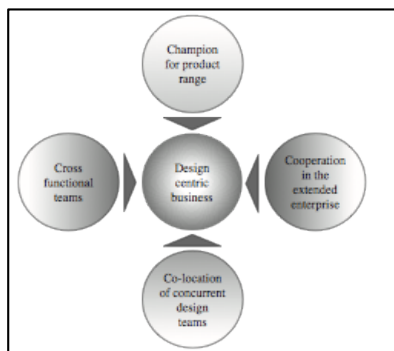
SCM and NPD are related to each other since the supply chain produces and distributes the product, which is the output of the development process.

A research conducted in 2008, showed the need for firms to develop products in an integrated way, “aligning” supply chain operations and processes in order to increase the capability to react and reducing inefficiencies. The conclusion from this analysis is that product design should be placed at the centre of the business. The study resulted in a framework called “design centric business”: the products are designed concurrently with the supply chain. The approach requires cooperation and co-location of cross-functional teams, individuals who take responsibility for the management of the interface between design and supply chain functions. (Creazza et al., 2009)

Figure 21 - Roadmap for the design centric business

Design-supply chain transformation process. . .		
From	To	How to we get there?
Design as a stand alone function	Design as part of a cross-functional approach	“T” shaped skills, training, “boundary less” business-organisational change
Supply chain as an after thought – for a design orientated business	Supply chain starts on the drawing board	Supply chain involvement at the product design stage
Designers “design”	Designers integrate across the “concept to delivery” process	Designers lead the orchestration of the product development process
Free “unconstrained” design	Constrained design	Range architectures aware of supply chain constraints, possibilities
Design for manufacturing/assembly	Design for supply chain	Establish appropriate de-coupling points – how far do we make a vanilla product before we stop? Balance design strategy against supply chain impact

Figure 22 - 4 C approach to organizational change



A research paper of 2010, introduced the topic claiming that “the supply chain must be aligned with product development decisions, it should be designed and managed, so that the products

are delivered at the targeted cost, time, and quality.” (Beltagui et al., 2008)

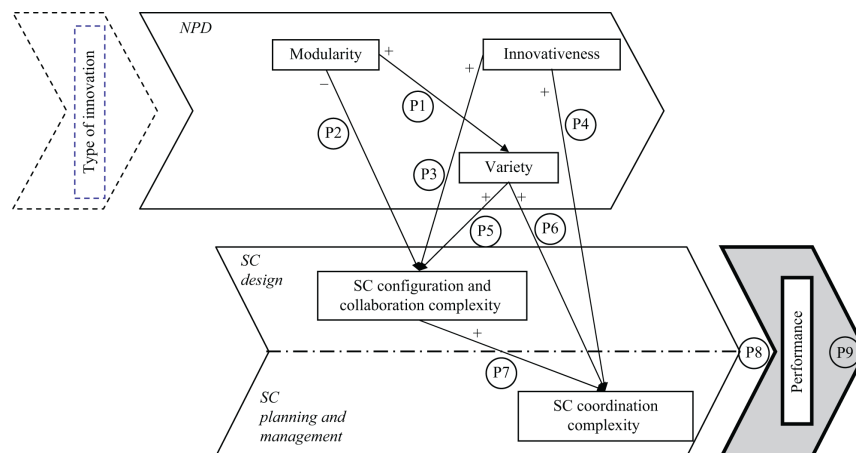
The reason is that NPD-SCM alignment leverages supply chain capabilities, enhances the effectiveness of new product introductions and improves firm’s performance (Van Hoek and Chapman, 2007).

Managing product design and the supply chain especially in fast moving markets, is an essential process for any business since it allows the transformation of ideas into products for customers.

In 2009, Khan and Creazza conducted a research that showed that companies recognized the crucial role of design in their business but are not managing the alignment between product design and the extended supply chain although some measures are being taken to improve the process. A framework resulted necessary to address companies towards alignment.

Since 2010, there was no comprehensive framework dealing with NPD-SCM alignment. However, Pero et al. produced a framework on NPD-SCM alignment that is shown in the figure below (Pero et al., 2010):

Figure 23 – A framework for the alignment of new product management



It shows the correlation between NPD (modularity, variety, innovativeness) and SCM (supply chain configuration, collaboration and coordination) variables.

Moreover, Simon Bolton talks about alignment between design strategies and business objectives.

Two types of alignment that refer to the same concept: cooperation and collaboration of functions within the process of producing products for the end user.

3.5 INNOVATION

The aim of the thesis is to understand how designers leverage their supply chain to innovate. Afterwards, innovation is a main concept in this thesis. What does exactly innovation mean? Some authors refer to innovation, some others to innovativeness.

The Oxford dictionary doesn't include a definition of innovativeness. It only includes a definition of innovation as "the action or process of innovating".

However, Pero, Abedelkafi, Sianesi and Blecker refer to innovativeness as attribute of NPD.

Garcia and Calantone define it as "the degree of newness of an innovation from the viewpoint of an entire industry or a firm."

Professor Bolton argues "innovation remains a strategic priority for many companies and design remains a key strategic and tactical component of that process".

Mutlu and Er (2003) define design innovation as:

"Design innovations comprise the incremental novelties in the design of an existing product or service, or radically new products or services obtained by design effort with no or minimal technical novelty." (Mutlu et al., 2003)

3.5.1 Different Type Of Innovativeness / Innovation

The following section deals with classifications of the two words, innovation and innovativeness.

Ulrich and Eppinger defined four "degrees of innovativeness":

- radical new products
- new product platform
- new products from existing platforms
- improvement of existing products

Song and Montoya-Weiss define product Innovativeness in terms of the product's newness relative to the firm and newness relative to the outside world (Song et al., 1998). They affirmed that the design process should be applied differently depending on the product type. They conducted a research related to the differences between really new versus incremental products. The results were:

* technical development activities don't impact profitability differently for really new and

incremental products

- * really new products are receiving greater emphasis on technical development activities
- * strategic planning and product commercialization deserve much more attention than technical development for both products
- * product commercialization activities have the same importance for both products but firms are currently placing greater emphasis on product commercialization when developing really new products: this means suboptimal resource utilization.

A combination of definitions by Ulrich and Eppinger and Garcia and Calantone, brought to the following distinction (Ulrich and Eppinger, 2002; Garcia et al., 2002):

- * radical innovation (that brings to a new market structure and new technologies)
- * really new innovations (that could be new product lines or new products in existing lines)
- * incremental innovations (adaptation, refinement and enhancement of existing products)

According Crippa the level of innovativeness required impacts on the relative importance and level of proficiency of the actors involved in different design and development activities internally and externally.

Crippa says we can classify an innovation activity in terms of its innovativeness:

- * level of technological discontinuity for the company:
 - technology/resources/materials already in use
 - technology/resources/materials new to the company
 - technology/resources/materials new to the industry
 - technology/resources/materials new to the world
- * level of marketing discontinuity:
 - product improvement
 - new product in existing line
 - new line in existing market
 - new product/product line in new market

In 2007 Bessant and Tidd, defined 3 levels of innovation according to 2 dimensions (degree of newness to the market and degree of added):

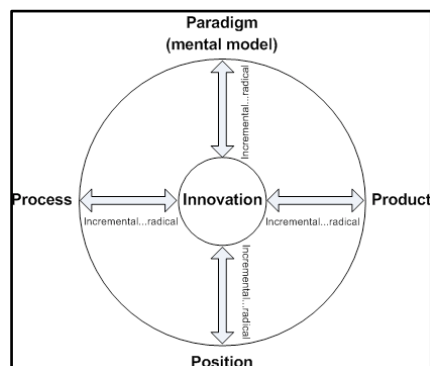
1. Incremental innovation: focuses on continuous improvement in both product and process related aspects of the business. Its emphasis is on preventing a company from falling behind its competitors and maintaining long-term survival;
2. substantial innovation: focuses on greater value-add and creation of business opportunities aimed at industry/sector leading strategies. Emphasis is on developing a competitive advantage. Achieving this level of innovation requires considered investment and an effective strategy for managing the innovation process;
3. radical innovation: focuses on redefining industry sectors/industries, creating new bases of performance, new competitors and new business models. Radical innovation often comes from outside an industry and is frequently technology based.

(Bessant et al., 2007)

They also defined an innovation space (Figure 24):

- a. product service innovation: focuses on changes in the things (products/services) which an organization offers;
- b. process innovation: focuses on changes in the ways in which things (product/services) are created and delivered;
- c. position innovation: focuses on changes in the context in which the products/services are introduced;
- d. business model innovation: focuses on changes in the underlying mental models which frame what the organization does.

Figure 24 – a new innovation space



3.5.2. From Closed To Open Innovation

For years, firms adhered to the philosophy of “closed innovation”, according to which companies must generate their own ideas. It was considered the right way to bring new ideas to market so firms invested in internal R&D and they controlled IP (intellectual properties).

Towards the end of the 20th century, the raising number of knowledge workers and private venture capital which financed new firms, conducted to a new model of innovation: open innovation. In the open innovation, firms commercialized internal and external ideas by deploying outside and in-house pathways to the market. It was a generation of new value for the organizations. (Chesbrough et al., 2006)

Innovation is linked both to design and technology. In particular, according to Ocker and Fjermestad, the team climate for innovation enhances design team performance, that is design creativity and quality of design.

Many authors suggest that innovation needs technology. The proactive firms usually have a wider variety of technology sources than less innovative firms.

The literature review focuses on SCM, NPD and design with respect to their processes and contribution to innovation.

Some emerging issues can be identified:

a.the reasons for firms to rely on wider networks are manifold (strategic advantage, reduction of product development time, low prices, etc)

b.supplier role, selection and involvement are paramount topics in SCM

c.relationship management and SC-design alignment are crucial topics in design, NPD and SC

d.researchers have not paid much attention to the important role of design within supply chain

4. GAPS IN THE LITERATURE

This chapter is aimed at presenting the gaps identified in the literature review (Chapter 3). Several authors helped in determining the gaps, underlining the importance of design and upstream part of the supply chain in delivering innovation.

Gaps in the literature are related to an empirical necessity and an academic interest in the role of design within the product supply chain.

By contrast, our literature review showed that there is very little work about the role of product design, in spite of its importance, as Khan and Creazza claimed in 2009.

Despite a raising interest in the responsibility of design within supply chain and in its contribution to product innovation, design is never addressed as focus of the analysis.

Product design is a key determinant in supply chain success: successful companies will seek to extend and integrate design issues into all aspects of their business. (Creazza et al., 2009)

According to Roberto Verganti design and SC have the same goal: “*to bring radically new or slightly new products or services to customers*”. (Verganti, 2009)

Creazza claims that “*design decisions can dramatically impact the risk profile of the business*”.

(Creazza, 2009)

The Cox review assesses the crucial role of design in UK and all over Europe. However, the literature always refer to design within structured firms. The design world is sprinkled with small and medium design consultancies that work for different clients on different projects. Those realities have never attracted the interest of academics. We receive the spreading need to study structures and modalities used by design consultants to enter the supply chain world. Design consultants require sharing of suggestions, procedures and ideas to be more and more innovative. Designers deserve visibility in a competitive world.

The motivations above constitute the rationale for our research.

Firstly, it is time to shift the focus from big firms to design activities. In particular, after interviewing design consultants, we identified the exigency to study how external designers

behave within supply chain. More and more academics and experts consider suppliers to have a fundamental role in their supply chain. According to Dowlatshahi (1998), the literature doesn't focus on the relationships among product designers, suppliers and purchasing professionals with respect to supplier development. Suppliers can offer new ideas, materials, new infrastructures to designers.

Therefore, our research is interested in describing the relationships between suppliers and designers. The resource-based model identifies capabilities as the result of actors' actions. We consider suppliers as the actors who provide and perform capabilities with respect to designers. The literature contains numerous papers on the supplier selection process undergone by firm managers. However, nobody mentions the supplier selection process applied by external designers.

Secondly, the literature presents numerous models of buyer-supplier relationship. By contrast, researchers have not considered designer-supplier relationship. External design consultancies have never been addressed in scientific papers.

However:

- a. design is necessary to deliver innovative products
- b. the role of suppliers has been detailed in the literature review

We decided to fill in scientific gaps, focusing on the upstream part of the supply chain.

In particular, the centre for design (C4D) deals with innovative design: they study the drivers to achieve performing outputs. In supply chain upstream, capabilities provided by suppliers are a main source of innovation. (Bolton)

Our research analyses capabilities that suppliers provide to designers thus conveying more value to delivered products. Supplier capabilities are considered the linkage between suppliers and designers. Designers look for the specific capabilities suppliers can provide.

Therefore, we conducted a second change in focus. We want to identify capabilities designers seek for when selecting suppliers. The literature was not much interested in design criteria for the selection process. We are conducting an empirical investigation into designer's needs and expectations in supplier selection.

Lastly - the importance of soft issues in supplier selection.

We investigated the role of soft capabilities in supplier selection. (Bolton et al., 2010). As reported in the literature review of part 2, soft criteria are cited by numerous authors but they are not commonly implied. Soft issues need to be investigated. Therefore, capabilities can be hard or soft issues, according to their measurability. According to Jones chief designer for Cambridge Industrial Design, claims the designer is “*the centre between customers and suppliers*” and he has “*to manage both*”.

“I think most designers are very good at managing relational capabilities on the contrary most suppliers are not very good at personal skills”: he states the urgency to working with suppliers sharing the same objectives and features. He is firmly convinced that relational capabilities (that he considers the service fulfillment) can make the difference in a relationship: they are cross-boundaries capabilities whose effects can be seen on outputs.

Through literature review and academics and designers opinions, we want to determine a list of capabilities classified according to their nature.

How can designers identify the supplier who has the capabilities they are seeking for?
Through the supplier selection process.

The literature doesn't deal with the process of supplier selection applied by designers.

All the more so, there is not a structured list of supplier capabilities for design consultants. It is necessary to plug this gap in order to explain the relationships among suppliers-designers-product design and development.

Our research approves the necessity of the designer world to understand how it participates to product design and development.

In particular, since design consultancies are numerous in Europe and provide their facilities to small as well big firms, we limit our analysis to external designers.

Three are the main gaps identified in the literature:

1. researchers did not focus on the cases of the external design consultants;
2. there is little work about the role of supplier-designer relationship within supply chain;
3. soft criteria were not considered important in supplier selection;

Therefore, we need to:

1. shift focus from firm's perspective to external design consultancy's perspective;
2. determine supplier-design relationship characteristics through the analysis of supplier capabilities;
3. analyse the role of soft criteria in the supplier selection process conducted by designers;

5. CONCLUSION AND RESEARCH QUESTIONS

The previous chapters presented the literature review and its gaps. This chapter sums up the main topics described in Part 1 and concludes offering the list of research questions that descend from the literature lacunas.

“There is very little work focusing on the relationships among product designers, suppliers and purchasing professionals with respect to supplier relation” S. Dowlatshahi (1998)

The title of the thesis is “Understanding the role of design within the supply chain”.

The topic was outlined after a deep and thorough review of the literature concerning design, supply chain and product development.

The reasons for choosing this topic are manifold.

Companies are pursuing more intensive and interactive relationships with suppliers because of the new trends in the market. On one hand, the increase in complexity and the shortening of product life cycle require experts from different fields; on the other hand the use of technologies in the design process leads to the involvement of technical consultants in manufacturing.

Outsourcing keeps on having a huge impact on interactions among companies. In particular, outsourcing is having a great influence in relationships between industry and design firms. (Bruce et. al., 1994)

Outsourcing of design is taking place since the role of design is crucial in the supply chain (Bolton et al., 2010). Furthermore, outsourcing of design brings to selecting people with solid competences in design and new ideas. External designers can contribute with effective solutions to design problems. In 1994, Bruce and Morris wrote “over the past ten years [...] design activities are being displaced from the firm and outsourced externally”. (Bruce et. al., 1994)

There is the need to study the relationship between designers and the SC.

Two are the main reasons.

First, designers require new innovation drivers to deliver competitive goods to clients and final

consumers. Supplier capabilities are examples of the required drivers.

Moreover, companies don't have a proper structure to cope with innovation.

Johnsen sustains that supplier involvement in NPD is important because "suppliers possess specialized product and process capabilities" in a context where products are becoming increasingly complex. (Johnsen, 2009)

Second, the necessity to decrease uncertainty in the development process. Uncertainty is the major pitfall in the process since it conducts to time and cost waste and to the impossibility for the downstream part to count on the upstream. The motivation for analyzing the supply chain relationships is to state a framework with elements that can decrease uncertainty.

To support our considerations, it is necessary to cite Johnsen (2009):

"Some research suggests that technological uncertainty may further necessitate the need for supplier participation on the customer's NPD team. Other research, however, has found the opposite that existing suppliers may be less important than new suppliers under conditions of technological uncertainty, i.e. radical innovation."

It means that there's no agreement on the role of suppliers within supply chain and that supplier involvement is influenced by uncertainty in technological aspects.

It is important to develop the product design-SC interface with the aim to concurrently manage product design process with the SC in an integrated way. A serious problem in implementing supply chain management practices is that supply chain actors don't share the same values and beliefs regarding the advantages of supply chain management.

The supply chain should emphasize leveraging the skills, expertise and capabilities of the firm who comprise the competitive network. An increasing amount of research focuses on the role of networks in NPD and innovation (Johnsen, 2009; Hakansson, 1987; Freeman, 1991; Dhanaraj and Parkhe, 2006; Birkinshaw et al., 2007)

Doyle and Broadbridge, in 1999 said "managing product design and the supply chain, especially in fast-moving markets, is an essential process for any business as it is through the product design-supply chain interface that ideas are transformed into products for customers."

In 2005, Johnsen introduces his paper in this way "As more and more companies are outsourcing parts of their New Product Development activities to suppliers, it is not surprising to find that research into how to manage supplier involvement in NPD and innovations has

greatly expanded during the last 30 years. [...] However, despite the apparent benefits of supplier involvement in NPD, research remains fragmented”. (Johnsen, 2009)

As explained in the literature review, authors dealt with the supplier integration in different points of the product development process. However, there was no reference to how the integration was undertaken.

Many authors stress the positive function of design on business: Sir Cox claims design has a positive impact on measures of business; moreover, design decisions can change the risk profile of the business. According to the Cox review “sustained success in business [...] increasingly depends on the ability to innovate: to exploit new ideas and new opportunities ahead of the competition.[...]The ability to innovate, in turn, depends on the availability and exploitation of creative skills.”.

Design is a great product of UK companies but they sell it mainly overseas: British entrepreneurs fail a potentially much larger return for an early income. (Cox, 2005)

Design is mainly regarded by managers as a waste of time and a cost to the firm.

A recent study by Khan and Creazza (2009) claims that, whereas PDT design is a key determinant in SC success, there is little published work on the importance of PD in SC.

Understanding how external designers use their suppliers to create innovation can lead to the definition of a framework that can be used by managers of design companies and supplier firms in order to leverage their supply chain.

In this research, there is a shift on the point of view: from the firm’s point of view to the designer’s one. Mainly, since the literature doesn’t consider how external design consultancies work, the focus is on design consultants.

Reviewing the literature, we identified the following gaps:

1. external design consultancies have not been taken into consideration so far;
2. there is little work about the role of supplier-designer relationship within supply chain
3. soft criteria have not been considered important in supplier selection

Therefore, we want to investigate the role external design consultants have within supply chain. In particular, because of the crucial role of suppliers in delivering innovation, we

decided to analyse the capabilities suppliers offer to designers.

Considering all the reasons above, some research questions can be defined in this field.

“How do external designers work with suppliers to enhance innovation?”

“How is it possible to move away from technologies towards value-driven aspects in order to enhance innovation?”

In order to answer these questions, we have to study supplier capabilities that are the linkages between external designers and suppliers. If we identify the typologies of supplier capabilities, we can understand the drivers that conduct external designers to competitiveness and innovation.

Therefore, we can determine a first research question that corresponds to a RQ 0:

“What type of supplier capabilities do external designers seek for in the selection process?”

The answer to RQ 0. brings to other research questions:

Research Question 1. WHAT supplier capabilities are designers looking for, in the product design and development process?

Research Question 2. WHEN do designers involve supplier capabilities in the product design and development process?

Research Question. HOW are supplier capabilities involved in the product design and development process?

Research Question. WHY are supplier capabilities involved in the product design and development process?

Part 2 of the thesis contains the answer to RQ 0. Through a literature review on supplier capabilities and supplier selection, filtered by designer insights, we identified the list of supplier capabilities utilized by external design consultants in the selection process.

In part 3 we present the methodology through which we answered to the research questions. The chosen tool is questionnaire from which we collected qualitative data. Analysing those data we determined answers to the research questions.

Numerous authors argue that there is little work focusing on supplier-designer relationship. Moreover, they claim the importance of developing the product design-SC interface to deliver innovation.

Since design is becoming more and more important in business, we assert the necessity to shift point of view from the firm's to the designer's perspective, in order to characterize supplier-design relationship and to understand its contribution to product innovation.

Supplier capabilities are the linkages between suppliers and designers.

Therefore, we identified research questions whose rationale is related to supplier capabilities.

PART 1 - CONCLUSION

Part 1 describes the reasons for our research. The literature about SCM, design, NPD and innovation doesn't deal with supplier selection criteria utilized by external design consultancies. Therefore, we decided to fill in the following scientific gaps, through answers to the following research questions.

Literature gaps:

1. researchers did not focus on the cases of the external design consultants;
2. there is little work about the role of supplier-designer relationship within supply chain;
3. soft criteria were not considered important in supplier selection

To fill in the gaps, we need to:

1. shift focus from firm's perspective to external design consultancy's perspective
2. determine supplier-design relationship characteristics through the analysis of supplier capabilities
3. analyse the role of soft criteria in the supplier selection process conducted by designers

Research Questions:

Research Question 0. "What type of supplier capabilities do external designers seek for in the selection process?"

Research Question 1. WHAT supplier capabilities are designers looking for, in the product design and development process?

Research Question 2. WHEN do designers involve supplier capabilities in the product design and development process?

Research Question 3. HOW are supplier capabilities involved in the product design and development process?

Research Question 4. WHY are supplier capabilities involved in the product design and development process?

Part 2 deals with Research Question 0, while Part 3 answers the research questions from 1 to 4.

PART 2 - SUPPLIER SELECTION CRITERIA FOR EXTERNAL DESIGN CONSULTANTS

PART 2 - INTRODUCTION

The objective of part 2 is to answer Research Question 0 in order to determine selection criteria suitable for design consultancies.

We follow a methodology with two starting points: literature review about SCM selection criteria and designer requirements.

Literature about SCM criteria is noteworthy. It presents numerous criteria utilized by firm designers to select suppliers.

However, researchers did not pay much attention to criteria utilized by designers.

Therefore, we organized focus groups and designer interviews in order to point out designer's needs and feedback with respect to the supplier selection: they need specific supplier capabilities. The crossing between SCM criteria and designer requirements corresponds to supplier capabilities for external design consultants

Research Question 0. "What supplier capabilities do external design consultants utilize to select their suppliers?"

Part 2 is divided as follows:

CHAPTER 6. WHAT DO EXTERNAL DESIGN CONSULTANTS MEAN BY "SUPPLIER CAPABILITIES"

CHAPTER 7. METHODOLOGY – HOW TO IDENTIFY SUPPLIER CAPABILITIES

CHAPTER 8. LITERATURE REVIEW ABOUT SUPPLIER CAPABILITIES

CHAPTER 9. DESIGNER INTERVIEWS: IDENTIFICATION OF REQUIREMENTS

CHAPTER 10. SUPPLIER CAPABILITIES FOR EXTERNAL DESIGN CONSULTANTS

CHAPTER 11. HOW WE IDENTIFIED SUPPLIER CAPABILITIES - CONCLUSIONS

6. WHAT DO EXTERNAL DESIGN CONSULTANTS MEAN BY “SUPPLIER CAPABILITIES”

Chapter 6 is an introduction of Part 2

There is a vast literature about the criteria used by firms to select their suppliers. The motivations are multiple since suppliers are becoming more and more important in the product development, bearing design and development responsibilities, accessing new and emerging technologies, leading to a better decision making, improving the quality of products and increasing competitiveness. Supplier selection is based on the concept of supplier capabilities as a blend of skills and resources to provide clients with.

Supplier selection is a valuable tool to enhance the competitive power of the firm since it enhances capabilities and expertise of suppliers. (Kannan et al., 2006)

Despite the literature contains numerous articles in relation to supplier selection methodologies, little has been written about supplier selection criteria utilized by designers.

Literature fails to identify the capabilities designers seek for during the supplier selection process.

Therefore, our objective is to answer *Research Question 0*. “*What supplier capabilities do external design consultants utilize to select their suppliers?*”, paying particular attention to the distinction between soft and hard criteria.

Part 2 is aimed at identifying what types of supplier capabilities external designers look for, when involving suppliers to deliver innovation.

We decided to start from SCM selecting criteria in order to have an overview about the supplier selection process. We realized that some of those criteria can be applied also by designers. However, the new list must be validated by practitioners. Therefore, we conducted focus groups and interviews to identify designer requirements.

The crossing between SCM criteria filtered according to design needs and the list of supplier capabilities determined through designer feedback brings to a detail record of capabilities explained by parameters and subparameters.

This chapter aims at presenting part 2, explaining the reasons for *Research Question 0* and how we are identifying the answer.

7. METHODOLOGY – HOW TO IDENTIFY SUPPLIER CAPABILITIES

We are showing the methodology to answer Research Question 0.

The methodological setting is necessary to display the path and to guarantee the accuracy of results.

In order to identify a list of capabilities industrial designers look for when selecting suppliers, we applied a four-step methodology.

The first phase consists of a thorough literature analysis about the topic of supplier selection in firms. We reviewed the main articles on the supplier selection subject in order to determine a list of selection criteria used in supply chain management. Those criteria are numerous and related to different fields: finance, operational, cultural, strategic, time-based, etc.

The second stage corresponds to the determination of designer needs, requirements and expectations. Through in-depth individual semi-structured interviews, focus groups, forum and experts opinions. Designers both from the academic and industrial world were involved to express their opinions and suggestions about supplier selection and involvement. Industrial designers were selected through a research into the designer directory website. They were asked to describe problems and gaps in the design world. The use of those tools brought to a deep and empirical understanding of difficult situations in the existing practices and gaps in the literature. Suggestions, problems and different points of view presented were decoded and linked together to create specific requirements.

The third step is the identification of the list of supplier capabilities, clustered according to their nature. From designer requirements, we drafted a list of supplier capabilities used by external design consultants.

The fourth phase consists of detailing the list of supplier capabilities for designers, through a crossing between SCM criteria and supplier capabilities. SCM criteria were previously filtered

according to their suitability to design management: not all the criteria reported in the literature can be applied to the design world.

We presented the four – step methodology utilized to answer to the research questions:

PHASE 1 – Literature review about supplier selection: identification of SCM selection criteria (Chapter 8)

PHASE 2 – Identification of designer requirements (Chapter 9)

PHASE 3 – Identification of the list of supplier capabilities (Chapter 10 – Paragraph 1)

PHASE 4 – Supplier capabilities: SCM criteria suitable for external design consultants (Chapter 10 - Paragraph 2)

8. LITERATURE REVIEW ABOUT SUPPLIER SELECTION: IDENTIFICATION OF SCM SELECTION CRITERIA

This chapter contains the scientific literature about the supplier selection process in SCM. Its goal is to create list that contains the most crucial criteria managers apply to select their suppliers.

We report what researchers wrote about the supplier role in the supply chain and in the processes of supplier selection and development. A important paragraph is devoted to the description of the various papers reviewed to identify the list of general criteria utilized in supply chain management.

Chapter 8 is organized as follows:

8.1 definitions

8.2 the role of suppliers

8.3 supplier selection

8.4 supplier development

8.5 SCM criteria for supplier selection

8.1 DEFINITIONS

In the Oxford dictionary, supplier capabilities are defined as the external skills and resources (investments, information, knowledge, ideas) that supplier provide, the tasks they carry out and the responsibilities they assume regarding the development of a part, process or service for the benefit of a buyer's current or future product development project. Suppliers provide infrastructures, materials and tools to enhance innovation.

The definition demonstrates the importance of suppliers in a design and development processes. (Wagner, 2009)

The research focus is on industrial firms which consider innovation as a main driver to competitiveness. In this field, suppliers are often involved in the early phases and are active members in the new product development.

We can distinguish two types of suppliers:

1. productivity suppliers who are expected cost reductions. They have mainly a manufacturing role.
2. innovation suppliers: focal company makes industrial production of the innovation from this type of suppliers. They are asked to design and make industrial production from innovative requirements.

8.2 ROLE OF SUPPLIERS

The role of suppliers is twofold.

SCM literature claims that supplier's responsibilities range from technical assistance to crucial position in creating a good supplier-designer relationship. They offer "measurable" aid in the PDD process but they also provide human attitudes to enhance relationship performance.

Stephan Wagner claims suppliers count for the largest portion of value delivered to the customer since they are bearing more design and development responsibility than before. (Wagner, 2009)

Suppliers are valuable resources and provide fundamental capabilities in the product design and development process. Whenever both suppliers and firm managers are willing to cooperate and collaborate over a long period of time, suppliers become non substitutable for the company.

According to Creazza and Khan, suppliers can give contribution to technical aspects of design process. (Bolton et al., 2010). In 2005 Petersen holds that suppliers can give opportunity to access new and emerging technologies. Moreover, suppliers work together with the company for a feasibility assessment. Handfield is conscious that suppliers are able to give potential design contributions to design and technology experts. (Handfield, 1999)

Krause and Ellram assert suppliers are valuable to companies which want to “reduce cycle times in order to increase competitiveness”. (Krause et al., 1997 b)

In 2003, Petersen, Handfield and Ragatz summarize the supplier role with this sentence: “the ability to tap the knowledge and expertise of suppliers, for design as well for manufacturing, is likely to lead to better technology decisions and ultimately to better products.” (Petersen, 2003)

When participating to a project for a product system, suppliers have two roles. They have to present their knowledge and expertise but they can also act the role of leaders of a subteam. They need technical and managerial capabilities. The physical colocation of supplier engineers is becoming a part of the normal NPD structure. (Petersen, 2003)

In addition, suppliers can contribute to successful relationships and performing products through their culture, human and relational capabilities and their attitude towards cooperation. Suppliers may also accelerate the creation of long-term relationships or to influence quality. (Kannan et al., 2006)

Kannan and Choon Tan (2006) claim the role of suppliers in the buyer-supplier relationship is to sustain the buyer competitive advantage towards competitors. “To sustain” means “not to create occasional or short-term relationship but long-term collaboration that is reinforced day by day”. It is the concept of supplier involvement.

8.3 SUPPLIER SELECTION

In order to select the more competitive and suitable suppliers, firms apply a strategic tool called “supplier selection”. It is a multi-criteria problem that considers both tangible and intangible (Humphreys, 2007), strategic and operational factors (Sarkis and Talluri, 2002). Since it is mathematically complex, there are numerous methodologies to solve it: from linear weighting methods, analytic hierarchy process, analytic network process, mathematical programming, etc.

Our research stresses the difference between measurable and not measurable criteria. The former are easily identifiable while the latter require deeper investigation. Through designer focus groups, we accessed the necessity of supplier selection for external design consultants as well. External designers don’t have the possibility to produce prototypes and products in-house. They must rely on suppliers. Therefore, they need to choose good suppliers to realize their projects.

According to Luca Di Filippo, external design consultants select different types of suppliers with respect to project nature. He claims designers involve new suppliers when they deal with innovative projects. By contrast, when following adaptive projects, they depend on a “bookshelf” of suppliers.

Designers need to select suppliers. In some cases designers are conscious of the selection process and they have structured procedures. However, in small consultancies it is mainly a matter of “feeling”.

Our research is a first attempt to identify what capabilities designers are looking for when involving suppliers.

Petersen and other authors speak about the necessity to develop a “bookshelf” of current and emerging technologies and suppliers. (Petersen et al., 2005)

According to Wagner, for firms to reach competitive advantage and to deliver innovation to customers, two changes are necessary: they have to transform the supplier selection process in firm core procedures and improve the supplier’s understanding of customers along the SC. (Wagner, 2009)

Petersen in 2003 affirmed that customer/supplier integration in an NPD project requires “a detailed formal evaluation and selection of potential suppliers” before their involvement. (Petersen et al., 2003)

In 2002, Kannan and Choon Tan demonstrate the importance of supplier selection and assessment on a buying firm’s business performance. (Kannan et al., 2002)

However, there is little work about supplier selection and especially about the testing of relationships between selection criteria and relationship outcome.

Supplier selection affects relationship success development of relational infrastructure since it enhances capabilities and expertise of suppliers as a source of competitive advantage. (Kannan et al., 2006) Another topic is missing in literature: the role of closeness of relationship and continuous improvement of capabilities in selection of suppliers. (Svahn et al., 2009)

8.4 SUPPLIER DEVELOPMENT

Supplier selection is the first step of a supply chain strategy. Firms recognize supplier selection importance to deliver innovative products.

Consequently to supplier selection, firms start a process of supplier development that can lead to competitive advantage.

In a famous article, Krause and Ellram define supplier development as “any effort of a buying firm with its suppliers to increase the performance and/or long-term supply needs.” Krause writes that supplier development range from limited efforts (limited supplier evaluation, supplier performance etc) to extensive efforts (ex. training of the supplier’s personnel and investment in the supplier’s operation, raising performance expectations). (Krause et al., 1997b) Dulmin and Minnino consider supplier capabilities and efforts in the development stages of significant importance. (Dumin et al., 2003)

Some elements can hamper the supplier development process. First of all both the companies must be willing to build a long-term relationship, even if it takes long time and it requires resources in terms of human efforts and investments. Pay-off for the great effort may show after more than 5 years. Secondly, suppliers must be willing to communicate with buying firms: there’s the need for an effective two-way communication about performances, results of supplier evaluation and top management involvement. Hahn in 1990, claimed that top

management may consider supplier development as a strategic activity since it has feedback from the marketplace. In addition, Addison and Weitz refer to “genuine risk” in commitment: a spill-over of knowledge and resources can occur. However, in 1997 a research identified UK auto industry as lacking of commitment: it was a barrier to the development of a relationship. Both buyers and suppliers must be eager to create cross-functional teams with designers, engineers, quality control functions and others. According to a research of 2006, joint action and trust are the most critical elements that influence supplier development. (Humphreys, 2002)

8.5 SCM CRITERIA FOR SUPPLIER SELECTION

8.5.1 List of SCM criteria

We analysed numerous articles about supplier selection. Some of them reported the criteria according to which firms select their suppliers.

In order to summarize criteria utilized by supply chain management to selecting suppliers, we drafted a list of factors cited by researchers. Our list isn't exhaustive but it is the first step to identify selection criteria that can be used by external design consultants to select their own suppliers. Since the literature doesn't focus on criteria employed by designers to involve their suppliers, our goal is to provide external designers with a practical and easy tool to apply in order to shorten and enhance the supplier selection process.

The supplier capability list has been identified through a literature review about supplier selection criteria employed by firms and structured organizations.

The list are organized as follows:

1. factors: groups of criteria
2. parameters: sub-factors which explain criteria groups
3. nature of parameters: each parameter is classified according to its measurability. Hard issues are measurable while soft issues are not measurable. Sub-factors identified as Hard/Soft are characterized by both measurable and not measurable features.
4. Design related: not all firm criteria are suitable for designers. Therefore, we point out the parameters that can be used by external design consultants as well.

Figure 25 – SCM selection criteria

FACTORS	PARAMETERS	SUBPARAMETERS	SOFT/HARD ISSUES	DESIGN RELATED	
A. FINANCES strategic performance metrics	1. financial record disclosure	a. company size	HARD		
		b. % of supplier's work commonly subcontracted	HARD		
		c. annual orders of firm as % of supplier's overall business	HARD		
		a. financial stability and staying power	HARD		
	2. financial conditions	a. increasing margins	HARD		
		b. improved profits	HARD		
	3. profitability of supplier	c. gains in strategic market position	HARD		
		d. improvement of competitive market position	HARD		
	4. performance awards	e. economic profit	HARD		
		f. supplier's ability to make decent profit for supplying	HARD		
	B. QUALITY strategic performance metrics	1. consistent delivery		HARD	
		2. conformance quality		HARD	DESIGN
		3. commitment to quality		SOFT	DESIGN
		4. quality philosophy		SOFT	DESIGN
		5. project quality		SOFT	
		6. product quality		HARD	DESIGN
7. process quality			HARD	DESIGN	
C. HONEST AND INTEGRITY organizational factor	1. insurance and litigation history		SOFT	DESIGN	
	2. open to site evaluation		SOFT	DESIGN	
	3. reputation for integrity		SOFT	DESIGN	
	4. supplier's efforts in eliminating waste		SOFT	DESIGN	
	5. reference of supplier		SOFT	DESIGN	
D. TIME strategic performance metrics	1. product development time		HARD	DESIGN	
	2. delivery speed		HARD		
	3. ability to meet delivery due dates		HARD		
	4. prompt response		HARD		
	5. short set-up time		HARD		
	6. reducing NPD time		HARD	DESIGN	
	7. reduce lead-time		HARD		
	8. partnership formation time		SOFT		
	9. continuous firm-customer contact		SOFT		
E. CULTURE organizational factor	1. top management compatibility		SOFT	DESIGN	
	2. feeling of trust		SOFT	DESIGN	
	3. strategic fit		SOFT	DESIGN	
	4. management attitude/ onlook for the future		SOFT	DESIGN	
	5. compatibility among levels and functions		SOFT	DESIGN	
	6. organisational structures and personnel		SOFT	DESIGN	
	7. geographic compatibility/proximity		SOFT	DESIGN	
	8. cultural match between the companies		SOFT	DESIGN	
	9. past and current relationship with supplier		SOFT	DESIGN	
	10. ethical standards		SOFT	DESIGN	
	11. commitment to creating a greater level of trust among SC's members		SOFT	DESIGN	
	12. political		SOFT	DESIGN	
	13. fair play		SOFT	DESIGN	
	14. ability to meet buyer's needs		SOFT	DESIGN	
F. RELATIONSHIP organizational factor	15. level of client orientation	a. willingness to integrate SCM relationship	SOFT	DESIGN	
		b. supplier supports the importance firm gives to customer service	SOFT	DESIGN	
	1. participating in the sourcing decisions of supplier		SOFT	DESIGN	
	2. a long-lasting relationship		SOFT	DESIGN	
	3. relationship closeness		SOFT	DESIGN	
	4. important relationship		SOFT	DESIGN	
	5. firm wants to devote extra efforts to this relationship		SOFT	DESIGN	
	6. plans to continuing relationship		SOFT	DESIGN	
	8. faith in customer		SOFT	DESIGN	
	9. supplier knows what firm is doing		SOFT	DESIGN	
	10. trustworthiness		SOFT	DESIGN	
11. communication openness	a. honest and frequent communications		SOFT	DESIGN	
	b. supplier's order entry and invoicing system (also EDI)		SOFT	DESIGN	

		c. creating compatible communication system	SOFT	DESIGN
		d. formal/ informal info sharing	SOFT	DESIGN
		e. supplier's willingness to share confidential information	SOFT	DESIGN
		f. communication of firm's strategic needs to suppliers	SOFT	DESIGN
		g. continuous firm-customer contact	SOFT	DESIGN
	12. ability to meet buyer's needs		SOFT	DESIGN
		a. willingness to integrate SCM relationship	SOFT	DESIGN
		b. supplier supports the importance firm gives to customer service	SOFT	DESIGN
G. FLEXIBILITY				
strategic performance metrics	1. product volumes changes		HARD	
	2. conflict resolution		SOFT	DESIGN
	3. flexible contract terms and conditions		HARD	DESIGN
	4. short set-up time		HARD	
	5. short delivery lead time		HARD	DESIGN
	6. service capability		HARD	DESIGN
	7. reserve capacity or the ability to respond to unexpected demand		HARD	DESIGN
H. TECNOLOGICAL CAPACITY				
organizational factor	1. design capability		HARD	DESIGN
	2. technological capability		HARD	DESIGN
	3. testing capability		HARD	DESIGN
	4. industry knowledge		SOFT	DESIGN
	5. process capability		HARD	DESIGN
	6. potential synergy		HARD	DESIGN
	7. commitment to continuous improvement in product and process		SOFT	DESIGN
	8. technological expertise		HARD	DESIGN
	9. scope of resource		HARD	DESIGN
	10. tech compatibility		HARD	DESIGN
	11. assessment of future manufacturing capabilities		HARD	DESIGN
	12. speed in development		HARD	DESIGN
	13. improving the integration of activities across SC		SOFT	DESIGN
	14. improved productivity		HARD	DESIGN
	15. current manufacturing facilities/ capabilities		HARD	DESIGN
	16. incremental / radical innovation capacity		HARD/SOFT	DESIGN
	17. workforce qualification		HARD	DESIGN
I. SUPPORT and FOCUS ON CLIENT				
organizational factor	1. after sales support		HARD/SOFT	DESIGN
	2. sales rep's competence		SOFT	DESIGN
	3. goodwill trust		SOFT	DESIGN
J. RELIABILITY				
organizational factor	1. incremental improvement		SOFT	DESIGN
	2. product liability		SOFT	DESIGN
	3. secure reliable source/market for a item		SOFT	
	4. reliability and consistency		SOFT	DESIGN
K. PRICE AND COST				
strategic performance metrics	1. low initial price		HARD	
	2. price of materials, parts and service		HARD	DESIGN
	3. compliance with cost analysis system		HARD	DESIGN
	4. cost reduction activities		HARD	DESIGN
	5. compliance with sectorial price behaviour		HARD	DESIGN
	6. reduce overall operating costs		HARD	
L. STRATEGIC				
strategic performance metrics	1. strategic consistency		SOFT	DESIGN
	2. brand		SOFT	DESIGN
M. OPERATIONS				
organisational factor	1. logistics		HARD	DESIGN
	2. safety		HARD	
	3. facilities		HARD	
	4. production team		SOFT	
	5. project team		SOFT	

The first criteria to be used in supplier selection have always been measurable issue such as time, cost, productivity, etc.

However, thanks to a growing awareness of managers, firms began to include not measurable issues in their selection criteria.

8.5.2. References

In 1996, Choi and others proposed “an exploration of supplier selection practices across the supply chain”. They borrowed supplier selection criteria from Dickson and Weber and colleagues who included criteria which had not been included in earlier studies but had been considered as important. The result is a list with “relational and attitudinal criteria”.

The article accords importance to incremental-improvement capabilities, conformance to specifications and meeting delivery deadlines, criteria that are considered important across the levels.

In his paper “An empirical investigation into supply chain management: a perspective on partnerships” Spekman expresses the urgency of new capabilities from each supply chain partner. (Spekman, et al., 1998)

Littler, Leverick and Bruce assert that frequent inter-company communication, building trust and establishing partnership equity contribute to the success of collaborative new product development efforts.

The role of communication is relevant for firms to achieve success at new-product development. Empiric analysis suggests that communication among marketing, engineering and manufacturing leads to success. (Handfield, 1999)

An important parameter with respect to relational capabilities is “*cultural match and compatibility*”. Spekman states the necessity for firms to create networks with firms whose primary objective is to gain strategic advantage for the whole supply chain (Spekman, et al., 1998). Interdependence and information sharing are considered key ingredients in an integrated supply chain.

The table criteria borrowed by Spekman reply to the questions: “To what extent do you apply the following practices?”, “To what extent does this reflect your reasons for selecting a supply chain partner?” (1998)

He investigates buyers’ and suppliers’ concerns in generating relationships. He concludes noticing that suppliers are more concerned on soft issues (in particular, information sharing) than buyers are.

Four years later, Kannan and Choon Tan's survey demonstrated that hard issues quality, on-time delivery, response time and service rank are the most used selection criteria (2002).

However, soft factors had a broader impact on performance than others. Consequently, he states the need for reassessing the supplier performance tactics, giving greater importance to soft issues. This is the reason why for supplier selection they distinguish into 5 clusters (strategic commitment of supplier to buyer, ability to meet buyer needs, buyer-supplier fit, honesty and integrity, capability), four of them are soft issues.

Kannan and Choon Tan in their "Buyer-supplier relationships" state that despite the tendency on measurable specifications, subjective criteria such as technical capability, flexibility, and the willingness of a supplier to work in a collaborative manner, can be important according to the buying situation. They focus their attention on "relational infrastructure", underlining the necessity of selecting suppliers who share their own goals.

In 2002, Sarkis and Talluri asserted "a holistic system evaluation model consisting in strategic and operational factors is required for more strategically oriented relationships." (Sarkis and Talluri, 2002)

The sentence expresses the need for evaluating suppliers according to different points of view. Not only their cost, quality, delivery and lead time are important. Their ability to listen to designers' requirements and their capacity to maintaining long and cooperative relationships are crucial.

It is addressed to external industrial design consultancies. Criteria implied by supply chain management are appropriate to industrial designers since they are mainly applied by managers of manufacturing, high-tech electronics and automotive industry.

According to Kannan and Choon Tan, soft issues and long-term relationships with suppliers take time and efforts. (Kannan et al., 2002) Sarkis and Talluri affirm that factor importance evolves in time according to the stage of product life cycle or to the period measures. (Sarkis et Talluri, 2002)

In 2010, an important article by Brun and Pero categorizes criteria in factors with an empirical analysis. From their point of view, suppliers need to be considered as "extensions" of the

buying firm itself. (Pero et al., 2010)

Some parameters are presented in the article “A model for strategic supplier selection” which proposes a specific factors clustering. It groups them into strategic performance metrics (cost, quality, time and flexibility; tangible and intangible factors) and organizational factors (culture, technology and relationship).

Brun and Pero presented the following supplier selection criteria (Fig. 26).

Figure 26 - Selection criteria identified through empirical research

<i>Factors from empirical analysis</i>	<i>Parameters</i>
Technological factor	Project group Radical innovation capability Product improvement
Importance of price with respect to quality	Process quality Project quality Product quality Price Flexibility
Support and focus on client	Goodwill trust After sales service Firm size Workforce qualification
Operations	Logistics Safety Facilities Incremental innovation capability
Production teams	Production team
Stability	Political stability Firm financial position
Service level	Lead time Delivery
Strategic	Strategy consistency
Geographical position	Geographical position
Transversal factor	Reputation Relationship capability Level of client orientation Capability of using IT systems Brand Trust

Chapter 8 ends with a list of SCM criteria included in the literature.

It is the first phase described in the methodology.

It is important to underline that the authors and articles that cite the SCM criteria are presented.

9. DESIGNER INTERVIEWS: IDENTIFICATION OF REQUIREMENTS

In this chapter we present the designer requirements identified through focus groups and interviews to industrial designers.

Focus groups and interviews were necessary to investigate designer's needs in supplier selection and involvement.

We can identify a list of designer requirements:

- 1) R&D department in-house
- 2) Technological expertise
- 3) quality
- 4) process awareness
- 5) Reliability
- 6) Risk sharing between suppliers and designers
- 7) Human compatibility

According to Michele Camerlengo, “human compatibility is fundamental” and “technological capabilities are essential”. He holds “relational capabilities are chosen to get benefits such as communication celerity, communication clearness and reliability”.

He affirms that “a quality product needs so many entangled bricks. These bricks are results to good relationships along the supply chain (designers, shareholders, stylists, suppliers, etc)”.

Luca di Filippo (a designer who work both in Italy and London) claims that relational capabilities can be summarized in one: “*overall complicity*”. “*Risk sharing, reliability and human compatibility can make the difference.*”

“Overall complicity” is more than relational capabilities since it corresponds to designer becoming part of the internal team.

Jones suggests that the most important motivating factor for supplier selection is “*quality*”. Moreover, in small realities, “*flexibility*” in terms of time and product type is crucial.

Spreading of outsourcing and globalization brought to a shift of focus.

A new type of capabilities makes the difference: they are the so called “soft capabilities”. Firms have to select the right supplier to increase their competitiveness: they realize that hard issues are not enough.

This is true also for designers, whose role is in between technical and relational.

Designers need to understand client’s requirements and to convert them into technical requirements. Supplier's role is to help the designer translate what users are looking for (user service).

Jones affirms the urgency for suppliers to be selected according to different criteria with respect to quality, cost and technical feasibility: “*the relational capability is a big thing*”. According to Gecchelin, a designer from Milan, the supplier’s most important capability is its “*ability to listen to what designers suggest and propose in order to deliver innovation*”. He stressed the importance of personal characteristics on designer-supplier interaction. He affirms the output quality is superior when supplier is willing to collaborate with the designers. However, because of the small dimensions of his company and subsequently of his bargaining power, the interaction with his client’s suppliers is just about technical improvements.

As explained above, the main clustering among capabilities is related to “hard” and “soft” capabilities. Hard capabilities are measurable, easy to identify and evaluate. All designers agree about the clustering.

By contrast, soft capabilities are related to human attitudes. They are not measurable and not all interviewed designers stressed their importance in supplier selection. Despite the difficulty in identifying them, all designers agree on their increasing utilisation during the supplier selection and development processed.

In this chapter we showed a record of designer requirements. As assessed by the interviewed designers, the main classification is related to their measurability. Therefore, designer requirements are clustered as hard or soft issues.

10. SUPPLIER CAPABILITIES FOR EXTERNAL DESIGN CONSULTANTS

The objective of this chapter is to set a list of supplier capabilities that can be utilized by external design consultants in their selection process.

Through designer requirements identified in the previous chapter and SCM criteria, we identified a detailed list of supplier capabilities.

This chapter is divided into two paragraphs:

The first paragraphs ranks the 6 supplier capabilities while the second links supplier capabilities identified through design requirements, to SCM criteria. The result is a detailed list where each supplier capability is explained through parameters and subparamters from SCM literature.

10.1 SUPPLIER CAPABILITIES

Through designer requirements, we pointed out a list of supplier capabilities that designers look for when selecting their suppliers.

They are ranked according to their measurability nature: from the hardest to the softest capability.

The list consists of only six capabilities that are easy to understand for all audiences: designers, suppliers and experts.

Supplier capabilities utilized by external design consultants are:

1. Manufacturing service
2. Technological capabilities
3. Specific design capabilities
4. User research service
5. Market research service
6. Relational capabilities



HARD ISSUES

SOFT ISSUES

10.2 SUPPLIER CAPABILITIES AND SCM CRITERIA: A DETAILED REPORT

“What exactly does each capability refer to?”

In order to answer this question, we crossed supplier capabilities indentified through designer

requirement with SCM criteria determined from the literature review.

The result is a report in which each supplier capability is explained through SCM criteria. The latter are organised in factors and parameters.

The report is organised as follows:

1. factors: groups of criteria
2. parameters: sub-factors which explain criteria groups
3. nature of parameters: each parameter is classified according to its measurability. Hard issues are measurable while soft issues are not measurable. Sub-factors identified as Hard/Soft are characterized by both measurable and not measurable features.
4. Reference: title of the paper in which each parameter is cited

Each capability is explained by parameters grouped into factors. Factors and parameters are the same presented in chapter 3. We decided to group them into “supplier capabilities” that could be easily assessed by designers. Therefore, supply chain management criteria have been utilized to identify design criteria.

The list of supplier capabilities presented in Fig. 27 is color-coded.

Figure 27 – Detailed list of supplier capabilities

FACTORS	PARAMETERS	NATURE of PARAMETERS	REFERENCES	SUPPLIER CAPABILITIES
A. PRICE AND COST				1. MANUFACTURING SERVICE
strategic performance metrics	1. low initial price	HARD	Barb. And Yazgac (1997) "A model for strategic supplier selection" (2002)	
	2. compliance with cost analysis system	HARD	Barb. And Yazgac (1997) "A model for strategic supplier selection" (2002)	
	3. cost reduction activities	HARD	Barb. And Yazgac (1997) "A model for strategic supplier selection" (2002)	
	4. compliance with sectorial price behaviour	HARD	Barb. And Yazgac (1997) "A model for strategic supplier selection" (2002)	
B. QUALITY				
strategic performance metrics	1. consistent delivery	HARD	"An exploration of supplier selection practices across the supply chain"(1996) "A model for strategic supplier selection" - Sarkis and Talluri (2002) "An exploration of supplier selection practices across the supply chain"(1996)	
	2. conformance to quality	HARD	"A model for strategic supplier selection" - Sarkis and Talluri (2002)	
	4. project quality	HARD	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	5. product quality	HARD	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	6. process quality	HARD	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	C. TIME			
strategic performance metrics	1. short product development time	HARD	"An exploration of supplier selection practices across the supply chain"(1996) "A model for strategic supplier selection" - Sarkis and Talluri (2002) "An exploration of supplier selection practices across the supply chain"(1996)	
	2. delivery speed	HARD	"A model for strategic supplier selection" - Sarkis and Talluri (2002) "Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002)	
	3. ability to meet delivery due dates	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	
	4. prompt response	HARD	"A model for strategic supplier selection" - Sarkis and Talluri (2002)	
	5. short set-up time	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	
	6. reduce lead-time	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	

D. FLEXIBILITY				
strategic performance metrics	1. product volumes changes	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	
	2. flexible contract terms and conditions	HARD	"A model for strategic supplier selection" - Sarkis and Talluri (2002)	
	3. short set-up time	HARD	"Supplier Selection and Assessment: Their Impact on Business Performance"	
	4. short delivery lead time	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	
	5. service capability	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	
	6. speed in development	HARD	"A model for strategic supplier selection" - Sarkis and Talluri (2002)	
	7. current manufacturing facilities/ capabilities	HARD	"An exploration of supplier selection practices across the supply chain"(1996)	
	8. workforce qualification	HARD	"A model for strategic supplier selection" - Sarkis and Talluri (2002)	
A. TECHNICAL CAPACITY				2. TECHNOLOGICAL CAPABILITIES
1. speed in development	HARD	"A model for strategic supplier selection" (2002)		
2. current manufacturing facilities/ capabilities	HARD/SOFT	"Assessing suppliers for strategic integration: a portfolio approach" (2011)		
3. workforce qualification	HARD	"Supplier Selection and Assessment: Their Impact on Business Performance"		
4. testing capability	HARD	"Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002)		
5. process capability	HARD/SOFT	"An empirical investigation into SCM: a perspective on partnership" (1998)		
6. potential synergy	HARD	"Supplier Selection and Assessment: Their Impact on Business Performance"		
7. technological expertise	HARD	"Supplier Selection and Assessment: Their Impact on Business Performance"		
8. scope of resource	SOFT			
			ElIram 1990; Barb. And Yazgac 1997	
	10. tech compatibility	HARD	"A model for strategic supplier selection" (2002)	
			ElIram 1990; Barb. And Yazgac 1997	
	11. assessment of future manufacturing capabilities	HARD	"A model for strategic supplier selection" (2002)	
	12. incremental / radical innovation capacity	SOFT	"An exploration of supplier selection practices across the supply chain"(1996)	
	13. improving the integration of activities across SC	SOFT	"Supplier Selection and Assessment: Their Impact on Business Performance"	
	14. improved productivity	HARD	"An empirical investigation into SCM: a perspective on partnership" (1998)	
B. OPERATIONS				
organisational factor	1. logistics	HARD	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	2. safety	HARD	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	3. facilities	HARD	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	4. production team	SOFT	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	5. project team	SOFT	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
C. QUALITY				
	1. commitment to quality	SOFT	"A model for strategic supplier selection" (2002) "Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002)	
	2. industry knowledge	SOFT	DESIGNERS	
			ElIram 1990; Barb. And Yazgac 1997	
Organizational factor	1. design capability	HARD	"A model for strategic supplier selection" (2002)	3. SPECIFIC DESIGN CAPABILITIES
	2. commitment to continuous improvement in product and process	SOFT	"Supplier Selection and Assessment: Their Impact on Business Performance"	
	3. incremental / radical innovation capacity	SOFT	"Supplier Selection and Assessment: Their Impact on Business Performance"	
	4. brand	SOFT	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
SUPPORT and FOCUS ON CLIENT		SOFT	"A model for strategic supplier selection" (2002)	4. USER RESEARCH SERVICE
organizational factor	1. after sales support	HARD/SOFT	"Assessing suppliers for strategic integration: a portfolio approach" (2011)	
	2. sales rep's competence	SOFT	"A model for strategic supplier selection" (2002)	
	3. ability to meet buyer's needs	SOFT	"Supplier Selection and Assessment: Their Impact on Business Performance"	

Strategic performance metrics	<ol style="list-style-type: none"> 1. market research tools (empathic design) 2. strategic marketing management 3. marketing complementarities 4. strategic consistency 	<p>HARD/SOFT HARD/SOFT HARD/SOFT SOFT</p>	<p>Professor Verona DESIGNERS DESIGNERS "Assessing suppliers for strategic integration: a portfolio approach" (2011)</p>	5. MARKET RESEARCH CAPABILITIES
A. HONEST AND INTEGRITY organizational factor	<ol style="list-style-type: none"> 1. open to site evaluation 2. reputation for integrity 3. reference of supplier 4. continuous firm-customer contact 	<p>SOFT SOFT SOFT SOFT</p>	<p>"Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002) "An exploration of supplier selection practices across the supply chain"(1996) "An empirical investigation into SCM: a perspective on partnership" (1998) "Purchasing strategies in supply relationships" (2009) "Supplier Selection and Assessment: Their Impact on Business Performance" "Supplier Selection and Assessment: Their Impact on Business Performance"</p>	6. RELATIONAL CAPABILITIES
B. CULTURE organizational factor	<p>Eliram 1990</p> <ol style="list-style-type: none"> 1. cultural match between the companies / synergy a.top management compatibility b. compatibility among levels and functions c. geographic compatibility/proximity 2. feeling of trust 3. management attitude/ onlook for the future 4. organisational structures and personnel 	<p>SOFT SOFT SOFT SOFT SOFT SOFT SOFT</p>	<p>"Supplier Selection and Assessment: Their Impact on Business Performance" "An empirical investigation into SCM: a perspective on partnership" (1998) "A model for strategic supplier selection" (2002) Eliram 1990 "A model for strategic supplier selection" (2002) "Supplier Selection and Assessment: Their Impact on Business Performance"; "Assessing suppliers for strategic integration" Eliram 1990 "A model for strategic supplier selection" (2002) Eliram 1990 "A model for strategic supplier selection" (2002) "Supplier Selection and Assessment: Their Impact on Business Performance"</p>	
C. RELATIONSHIP organizational factor	<ol style="list-style-type: none"> 5. ethical standards 6. commitment to creating a greater level of trust among SC's members 7. political advantages 8. fair play 9. reliability 1. participating in the sourcing decisions of supplier 2. a long-lasting relationship 3. relationship closeness 4. communication openness 5. supplier supports the importance firm gives to customer service 	<p>SOFT SOFT SOFT SOFT SOFT SOFT SOFT SOFT SOFT</p>	<p>"Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002) "Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002) "Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002) "Buyer-supplier relationships. The impact of supplier selection and buyer-supplier engagement on relationship and firm performance" (2002) "An empirical investigation into SCM: a perspective on partnership" (1998) Geccchelin "An exploration of supplier selection practices across the supply chain"(1996) "An empirical investigation into SCM: a perspective on partnership" (1998) "A model for strategic supplier selection" (2002) "An exploration of supplier selection practices across the supply chain"(1996) "A model for strategic supplier selection" (2002) "An exploration of supplier selection practices across the supply chain"(1996) "An empirical investigation into SCM: a perspective on partnership" (1998) "A model for strategic supplier selection" (2002) "Supplier Selection and Assessment: Their Impact on Business Performance"</p>	

Chapter 10 consists of the presentation of criteria utilized by external design consultants. The chapter ends with a color-coded list of detailed supplier capabilities, described by SCM criteria.

11. HOW WE IDENTIFIED SUPPLIER CAPABILITIES

Part 2 represents a crucial contribution of our thesis to the research.

It presents the whole methodology followed to determine the list of supplier capabilities utilized by external design consultants in their supplier selection process. The literature contains numerous papers related to SCM selection criteria. However, it doesn't deal with the selection carried out by designers when selecting their suppliers.

Therefore, our main goal is to answer RQO. We followed a methodology that consists of four phases.

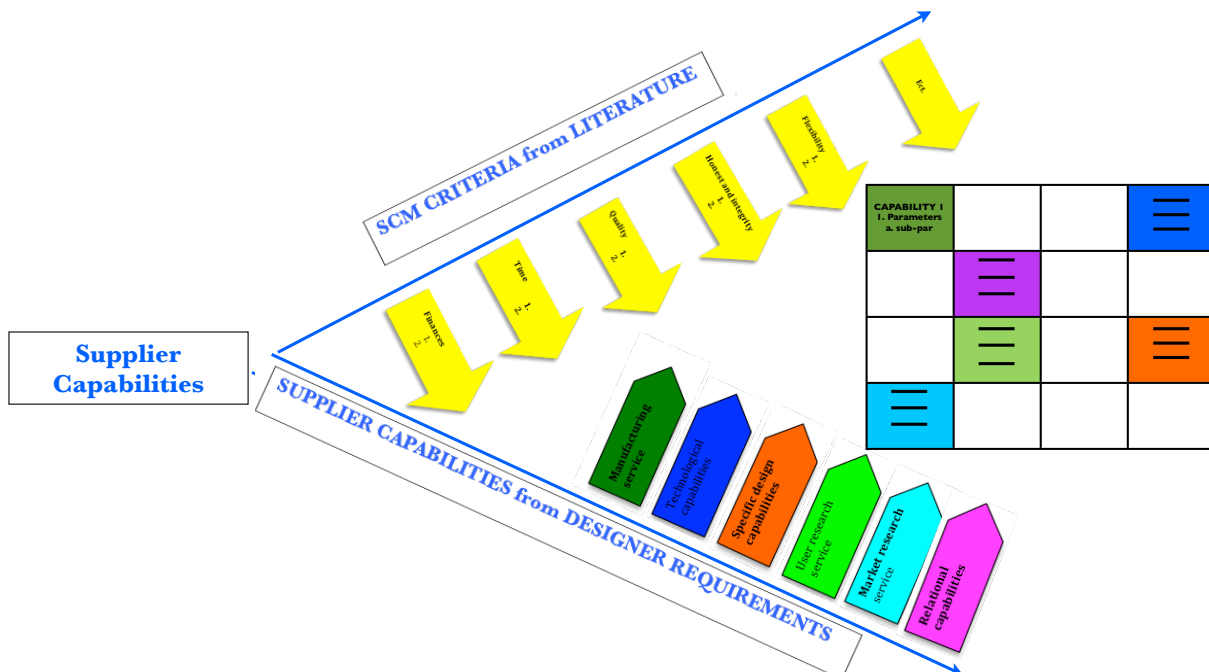
Phase 1 consists of the identification of criteria included in the literature about supply chain management. Numerous papers contain list of criteria suitable for firm managers. We analysed several articles, creating a list of SCM criteria included in the literature. Some of these criteria can be utilised by designers.

In parallel (phase 2), we conducted an insight about designer requirements in the selection process. They gave us some information that are codified in the "supplier capabilities".

The crossing between designer requirements and SCM criteria brings to the detailed report for the supplier selection process of external design consultants.

The figure below presents the methodology followed. Supplier criteria result from a crossing between criteria from the SCM literature and from designer requirements.

Figure 28 – A tool to identify supplier selection: crossing between SCM criteria and designer requirements



PART 2 - CONCLUSION

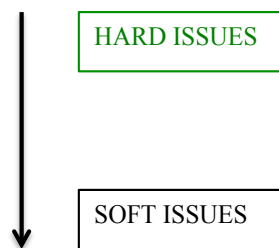
Part 2 consists of the answer to the research question from which the other research questions depend. It corresponds to the identification of the type of criteria, i.e. supplier capabilities that external design consultants require in order to select the right supplier.

The path followed to achieve our objective consists of four steps.

Two parallel steps (identification of SCM criteria and designer requirements – phase 1 and 2) are followed by the determination of a list of supplier capabilities (phase 3).

Supplier capabilities:

1. Manufacturing service
2. Technological capabilities
3. Specific design capabilities
4. User research service
5. Market research service
6. Relational capabilities



Supplier capabilities were detailed through the association with factors and parameters from SCM criteria (phase 4).

The result is the answer to *Research Questions 0*. “*What type of supplier capabilities do external designers seek for in the selection process?*” through a simple and easy-to-apply tool. (Figure 27)

PART 3 – RESEARCH QUESTIONS

Part 3 – Introduction

Part 3 consists of the identification of a tool to answer the following research questions:

RQ 1. WHAT supplier capabilities are designers looking for, in the product design and development process?

RQ 2. WHEN do designers involve supplier capabilities in the product design and development process?

RQ 3. HOW are supplier capabilities involved in the product design and development process?

RQ 4. WHY are supplier capabilities involved in the product design and development process?

The main objective consists of investigating the role of supplier capabilities in the supplier-designer relationship.

We want to determine WHAT types of supplier capabilities are important in the relationship and at which stage of the relationship they are involved (WHEN).

Moreover, we want to search the level of involvement (HOW) and the reasons for collaborating with designers (WHY). We concentrated on industrial and engineering designers, who are grouped into small design consultancies.

In order to answer the research questions, we prepared a structured questionnaire to collect quantitative data. Data analysis brings to replies to research questions.

This part consists of the description and analysis of the questionnaire about designer's practices in involving suppliers in order to deliver innovative products.

Part 3 is divided as follows:

1. BRIEF PRESENTATION OF THE EMPIRICAL RESEARCH (CHAPTER 12)
2. METHODOLOGY- A STRUCTURED QUESTIONNAIRE (CHAPTER 13)
3. ANALYSIS DISCUSSION (CHAPTER 14)
4. ANSWERS TO RESEARCH QUESTIONS (CHAPTER 15)

12. BRIEF PRESENTATION OF THE EMPIRICAL RESEARCH

After a thorough literature review, we identified trends and gaps in research (PART 1).

In last decades, firms began to involve suppliers from all over the world in order to gain competitiveness, to reduce costs and find new materials, products or infrastructures and mainly to reach differentiated innovation.

Using focus groups, academics and industrial designers interviews, we determined gaps in the literature:

1. researchers did not focus on the cases of the external design consultants;
2. there is little work about the role of supplier-designer relationship within supply chain;
3. soft criteria were not considered important in supplier selection;

We need to:

1. shift focus from firm's perspective to external design consultancy's perspective
2. determine supplier-design relationship characteristics through the analysis of supplier capabilities
3. analyse the role of soft criteria in the supplier selection process of designers

Therefore, we need to investigate the role external design consultants have within supply chain.

To do so, we decided to develop a tool to investigate how and when industrial and engineering design consultancies imply suppliers in product design and development phases.

In order to be more precise, we have to talk about supplier capabilities. Designers choose what type of suppliers they need in terms of advantages they can bring. According to Luca di Filippo, supplier capabilities "can make the difference".

Therefore, the crucial question is: "What do external designers define as (new) supplier capability?". The answer to this question has been described in the second part of the thesis.

However, the list of supplier capabilities is only the first part of our research. Academics and experts need to investigate when and how supplier capabilities are involved into the innovation process. Steps and tools to answer these questions have been described in

Methodology paragraph.

12.1. QUESTIONNAIRE FOCUS

The scientific literature doesn't deal with our topics, therefore we present a generic literature about the questionnaire focus.

Moreover the generic literature is utilized to generalize research results.

The following paragraph presents the main questionnaire focus, in agreement with literature gaps and emerging issues.

A. *engineering and industrial design:*

Industrial design is “the use of a combination of applied art and applied science to improve the aesthetics, ergonomics, and usability of a product, but it may also be used to improve the product's marketability and production.”

The International Council of Societies of Industrial Design (ICSID) in 1969 proposes the following definition of Industrial Design:

“It is a creative activity whose aim is to determine the formal qualities of objectives produced by industry. These formal qualities are not only the external features but are principally those structural and functional relationships which convert a system to a coherent unity both from the point of view of the producer and user. Industrial design extends to embrace all the aspects of human environment, which are conditioned by industrial production”.

Design Engineer is a general term that covers multiple engineering disciplines including electrical, mechanical, industrial design and civil engineering, architectural engineers in the U.S. and building engineers in the UK.

“The design engineer is distinguished from the designer/drafter by virtue of the fact that a design engineer takes care of the total system as well as inner workings/engineering of a design. While industrial designers may be responsible for the conceptual aesthetic and ergonomic aspects of a design, the design engineer usually works with a team of engineers and designers to develop the conceptual, preliminary and detail design and the most critical parts. He/she may work with industrial designers and marketing to develop the product concept and

specifications, and he/she may direct the design effort from that point. Products are usually designed with input from a number of sources such as marketing, manufacturing, purchasing, tool making and packaging engineering. In addition design engineers deal with much more complex technological and scientific systems (aircraft, spacecraft, rockets, trains, ships, dams, bridges, building structures, urban infrastructure, machinery, production systems, propulsion systems, oil, gas, and mining exploration systems, manufacturing processes, military systems, cars, electronics, computers, power generation systems - nuclear, fossil, wind, ocean, and power distribution systems). In many engineering areas, a distinction is made between the design engineer and the planning engineer in design. Planning engineers are more concerned with designing on a more systems engineering level, and overlaps onto the operational side are often necessary. Design engineers, in contrast, are more concerned with designing a particular new product or system. is important for planning engineers, while synthesis is paramount for design engineers.”

B. *external design consultants*: literature fails to cover this analysis field. Academics usually focus on design department in firms. They don't analyse how external designers cooperate to product innovation and how they interact with the supply chain. External designers are becoming more and more important and numerous in Europe.

C. *consumer goods*: goods, such as food, clothing, electronic devices, that satisfy human wants

13. METHODOLOGY – A STRUCTURED QUESTIONNAIRE

Chapter 13 presents the tool utilized to collect data in order to explain how supplier capabilities are exploited in supplier-designer relationships.

It consists of a questionnaire which was identified with a brainstorming decoded in an easy to read schema that contains the questions submitted to designers.

Those questions are consequently organized in a color-coded questionnaire.

We tested the questionnaire with 3 face-to-face semi-structured interviews that gave us feedback to determine its final version.

The questionnaire was determined through 3 steps:

- 1.brainstorming
- 2.identification of questions
- 3.questionnaire

13.1. BRAINSTORMING

Research questions have been identified through an exhaustive brainstorming about emerging issues and gaps in the literature. The brainstorming starts from the “state of the art” analysis. Firms are involving more and more suppliers to produce innovative products.

Last decades witnessed a growing trend towards globalization and localization. This brought firms to identify new suppliers and their capabilities in order to reach differentiated innovation and to be competitive all over the world.

A question drives the brainstorming: “What do designers define as new capability?”.

Before answering this question, academics and experts ought to investigate “What do designer groups look for, when involving new suppliers?” and “When do design groups involve new suppliers?”. These two questions bring to inquire “the concept of capability”. Academics and designers acknowledge the crucial thesis according to which measurable capabilities are no longer enough to reach competitive innovation. Therefore, capabilities can be divided into hard and soft issues.

13.2. QUESTION IDENTIFICATION

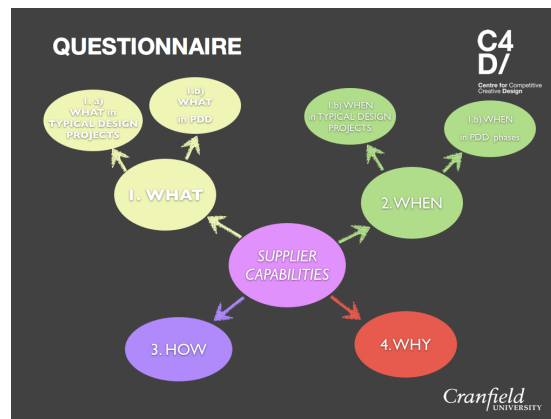
External design consultancies recognize supplier's role in enhancing competitiveness and innovation.

Therefore, they require structured practices to select and involve suppliers into product design.

Academics need to investigate how and when designers involve suppliers into the product design and development process.

Since the brainstorming is not easy to read and understand, it has been rationalized in a easy to read schema:

Figure 29 – Research questions



Four questions can be identified:

RQ1. WHAT

“What capabilities do design consultants look for when selecting suppliers?”

The research is devoted to work out the criteria design reckons as important when choosing suppliers. This question is twofold. We are interested in comprehending what capabilities /services are sought for each typical type of projects and in each of the PDD phases. RQ1a. is more general than RQ1.b.

RQ2. WHEN

“When do design consultants involve suppliers?”

This question is twofold as well. It is important to learn in which typical project designers seek for suppliers' capabilities (RQ.2a) and in which PDD phases they are specifically requested (RQ2.b).

RQ3. HOW

“To what extent do design consultants involve suppliers?”

In order to grasp the degree of involvement, we want to analyse the level of freedom designers leave to suppliers when managing a relationship.

RQ4. WHY

“Why do design consultants select suppliers?”

“Which are the motivations that push designers to interact with different realities and entities?”

13.3. QUESTIONNAIRE

In order to gather valuable input from external design consultants, a questionnaire was developed. It was supposed to be an effective instrument to statistical analysis.

The questionnaire structure has been defined as combination of literature analysis and a brain storming about how to fill in the gaps in the existing literature.

The questionnaire “Understanding how designers use their supply chain to innovate”, is divided into 3 sections:

1. introduction
2. questionnaire structure
3. questionnaire

13.3.1. Questionnaire Introduction

After an identification paragraph, the first part presents a brief explanation of the research main goal and the principal information collected from the literature review.

Before filling in the questionnaire, designers need to achieve awareness of the rationale below it. The units of analysis are either every typical design project or each of the Product Design and Development phases. This is the reason why it IS useful to explain what we mean by typical design projects and PDD phases.

PDD phases are explored through a simple table showing the stages included in each phase.

The interviewees are asked to circle which phase they are mainly dealing with. This is the first question supposed to give generic information about the interviewed designer.

To complete the introduction, a definition of supplier capabilities is reported (see description of supplier capabilities). This leads the designers towards the right definition of suppliers that, according to this research, doesn't include freelancers (i.e. marketing agencies, user research consultants etc). It deals with suppliers of materials, technologies, processes, prototypes or products.

Ulrich and Eppinger (2000) helped identifying the questionnaire.

In their "Product design and development", they recognized four project typologies according to innovation level:

a. INCREMENTAL IMPROVEMENTS TO EXISTING PRODUCTS: These projects may only involve adding or modifying some features of existing products in order to keep the product line current and competitive. A slight change to remedy minor flaws in an existing copier product would be an example of this type of project.
b. DERIVATES OF EXISTING PRODUCT PLATFORMS: These projects extend an existing product platform to better address familiar markets with one or more new products. To develop a new copier based on an existing light-lens (not digital) product platform would be an example of this type of project.
c. NEW PRODUCT PLATFORMS: this type of project involves a major development effort to create a new family of products based on a new common platform. The new product family would address familiar markets and product categories. The Xerox Lakes project, aimed at the development of a new, digital copier platform, is an example of this type of project
d. FUNDAMENTALLY NEW PRODUCTS: these projects involve radically different product or production technologies and may help to address new and unfamiliar markets. Such projects inherently involve more risk; however, the long-term success of the enterprise may depend on what is learned through these important projects. Ex. The first digital copier Xerox developed is an example of this type of project.

Investigating the PDD process, they divided it into 5 phases:

PHASES AND ACTIVITIES
0. PLANNING
a. user needs
b. product platforms and architecture
c. market observation and research market
d. technology exploration: assessing old and new technologies and needs
e. design exploration
1. CONCEPT DESIGN
a. feasibility of product concepts
b. develop selected design concepts
c. build and test prototypes
2. SYSTEM DESIGN
a. generate alternative architectures
b. define major subsystems and interfaces
c. refine industrial design
3. INDUSTRIAL DESIGN
a. define part geometry
b. choose materials
c. assign tolerances
d. complete ID documentation
4. TESTING AND IMPROVEMENT
a. reliability test
b. life testing
c. performance testing
d. regulatory approvals
e. implement design changes
5. PRODUCTION AND RAMP-UP AND LAUNCH
a. evaluate early production output

In order to create an easy and unambiguous questionnaire, we adapted their classifications according to our needs. Projects names have been changed and system design and industrial design phases have been merged into one phase.

Typical Design Projects

1. product improvement in existing line
2. new product in existing line
3. new line in existing market
4. new product/product line in new market

Phases Of Product Design And Development

1. Planning phase
2. Concept development
3. Detail design
4. Testing and design refinement
5. Production launch

Projects 1 and 2 are defined “adaptive projects” while projects 3 and 4 are “innovative projects”.

13.3.2. Questionnaire structure

The second section spells out the metrics (i.e variables) involved in this research. Quantitative data are the main objective of this research. The interviewees are asked to filled in the tables according to Likert scales (from 1 to 5 for each variable).

Three variables have been identified as main measurements.

Figure 30 – Importance, Frequency and Supplier Involvement: three main variables

the importance (1)

Metric: On a scale of 1 to 5 please select level of importance (1 being not at all important and 5 being very important)				
Not at all Important	Not very important	Neither important nor unimportant	Important	Very Important
1	2	3	4	5

the frequency (2)

Metric: On a scale of 1 to 5 please select level of frequency (1 being never and 5 being always)				
Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

the supplier involvement (3)

Metric: on a scale of 1 to 5 please select the level of involvement (1 being not involved and 5 being joint item and process development)				
Not Involved	Consulted	Co-design in item development	Co-Design in process development	Joint item and process development
1	2	3	4	5

The first variable is “*importance*”. The research aims at learning what designers consider important when dealing with suppliers who bring innovation to the project.

“Importance” is mainly a variable connected to the situation “to be”.

In order to provide supply chain actors with advantageous and reliable information, it is necessary to understand what designers are looking for in their relationship with suppliers.

Despite designers’ efforts in building a win-win situation, the actual situation is different from the theoretical framework.

To examine the practical setting, the variable “*frequency*” has been employed. It represents the metric to evaluate what capabilities designers prefer when practically selecting suppliers. It is connected to the situation “as is”.

The third variable is “*supplier involvement*”. It embodies the description of the engagement between designers and suppliers.

The variables are associated with the research questions.

The variable “importance” leads to understanding what capabilities designers look for. “Frequency” is tied-up with the WHEN question, since it is related to the moment in which supplier capabilities are involved either in the typical design projects or in the PDD phases. “Supplier involvement” is the answer to the HOW question.

In order to make it clear and simple, each variable is associated to a colour so to have a colour-coded questionnaire.

13.3.3. Questionnaire

The third section is the proper questionnaire.

The initial questions are utilized to create a general overview of the interviewee firm.

The first question (3.1) refers to the types of suppliers they utilize in each typical design project. The metric in this case is ‘frequency’, since the aim is to understanding what type of suppliers are mainly involved in each project.

The second question (3.2) is referred to what projects designers are mainly asked to handle. Frequency is the metric in this case as well.

Questions about typical PDD phases (first section - introduction), types of suppliers and frequency of typical projects are the first step to describe the context the interviewed firm is working in.

After asking general questions, the questionnaire goes deeper in assessing the supplier capabilities. The questionnaire methodology is limited because it doesn’t include the possibility to add elements that were not planned a priori (Yin, 1994). To overcome this boundary, a further question is introduced. The interviewee is asked to add other capabilities he/she considers important to select suppliers (3.3).

Afterwards, four tables associated to obtaining information in relation to supplier capabilities are presented. The first two (3.3.1.A and B) poses questions about the importance each supplier capability has in every typical design projects. The designers are forced to meditate about what capabilities they believe of importance when they need to select suppliers. The table is supposed to be read from left to right, having each typical design project as starting point. Through this tool, data about which are the most or the least important supplier capabilities are gathered.

Opposite to 3.3.1.A, table 3.3.1.B refers to the actual frequency of employment of the supplier capabilities in the innovation projects. A Likert scale from 1 to 5 (1 being never and 5 being always) is used to understand which capabilities are mainly requested for.

The comparison between the two tables is one of the principal objectives of the research. It enables managers, designers and suppliers to reflect on the differences between what they actually do and what is the best strategy to undertake.

Same structure is illustrated in tables 3.3.2.A and 3.3.2.B. They deal with obtaining information about the supplier capabilities important or frequently used in PPD phases.

Table 3.4 has “supplier involvement” as metric. It is used to understand the level of involvement of suppliers. The table has been conceived to be filled in from left to right. Designers take into account every typical design project and consider each of the phases it is composed of. The Likert scale from 1 to 5 utilized in this table comes from the literature (Spina et al.).

Finally, in tables 3.5 A and B, questions about motivations are asked. Once more, two variables (i.e. two metrics) are employed to tackle the question. “Importance” and ‘frequency’ of motivations for selecting supplier capabilities are requested.

The motivations for supplier selection are:

1. cost reduction/benefits
2. technological and market knowledge/expertise
3. technological uncertainty

4. access to new technologies/ new markets / additional
5. creation and innovation capabilities

13.4. PILOT STUDY

We decided to test the questionnaire with 3 face-to-face interviews.

Interviewed designers were chosen from the list of industrial and engineering designers, presented in the design directory website.

We conducted semi-structured interviews. Designers filled in the questionnaire while asking us suggestions on how to complete it correctly.

Feedback can be drawn from the 3 face-to-face interviews: they have been utilized to build the questionnaire definitive version.

Designers had difficulties in understanding which type of supplier we were referring to.

As a matter of fact, external design consultants work both with their own suppliers and their client's suppliers.

Identifying the final questionnaire was an iterative process. We prepared numerous versions which were tested by C4D students.

Moreover, they questioned the meaning of suppliers since some of them didn't consider marketing consultants as suppliers. That's the reason why, we decided to add a definition of supplier capabilities.

Finally, technological uncertainty is a difficult concept. It refers to the difficulties of identifying emerging technologies. When rumours about a new technology are spread, designers need suppliers who can capture information about and deal with the new technologies.

Qualitative feedback were utilized to improve the questionnaire.

We presented the questionnaire used to collect data in order to answer the research questions. We firstly determined the questions to include in the questionnaire and then we planed its architecture.

The questions coincide with the Research Questions.

It is a color-coded questionnaire in which each color corresponds to a variable. Three variables were recognized:

- level of importance
- level of frequency
- level of supplier involvement.

We can recognize the following correspondences:

WHAT → Research Questions 1. → IMPORTANCE

WHEN → Research Questions 2. → FREQUENCY

HOW → Research Questions 3. → LEVEL OF INVOLVEMENT

WHY → Research Questions 4. → IMPORTANCE and FREQUENCY

14. QUESTIONNAIRE RESULT ANALYSIS

This chapter contains the data analysis. It is divided into 3 separate analyses:

1. all designers
2. English designers
3. Italian designers

Each analysis can be univariate or bivariate.

In order to be as exhaustive as possible, we present examples of collected data and how we analyze them.

The chapter is structured as follows:

- 14.1 analysis description
- 14.2 complete analysis - All designers
- 14.3 English designers
- 14.4 Italian designers

14.1 ANALYSIS DESCRIPTION

The survey is structured as follows:

- 1) complete analysis – 13 interviewees
- 2) analysis of data from 6 English designers – English analysis
- 3) analysis of data from 7 Italian designers – Italian analysis

The analysis is carried out in two directions:

- graphic analysis about importance and frequency - univariate analysis in which average, mode, minimum and maximum values are evidenced;
- bivariate analysis - correlation analysis

We decided to present an accurate investigation of all questionnaires collected both in England and Italy.

However, in order to underline specificities of the two countries, we reported separate analyses of Italian and English designers, with respect to the complete analysis.

As graphics will show, we decided to order supplier capabilities from **the hardest** to **the softest**:

1. Manufacturing service
2. Technological capabilities
3. Specific design capabilities
4. User research service
5. Market research service
6. Relational capabilities

Other capabilities have both qualitative and quantitative characteristics so they can't be classified as either hard or soft.

Research questions are:



Research questions 1 and 2 are analysed as follows:

1. IMPORTANCE vs FREQUENCY

- RQ1.A and RQ2.A are compared in order to identify the situation to be (IMPORTANCE) and the situation as is (FREQUENCY) with respect to supplier capabilities in PROJECTS
- RQ1.B and RQ2.B are compared in order to identify the situation to be (IMPORTANCE) and the situation as is with respect to supplier capabilities in PDD phases (FREQUENCY)

2. CAPABILITIES VS PROJECTS/PHASES (complementary analyses)

- progress of all capabilities in each project/phase: information about the most important and utilized capabilities in each project/phase (tables n. 1 and 2)
- single capability in all projects/phases: capability analysis tells in which project/phase that single capability is more important or utilized (tables n.3 and 4)

Table 1 – Level of importance of all capabilities in project 1

1. PRODUCT IMPROVEMENT IN EXISTING LINE						
	1.manufacturing service	2.technological capabilities	3.specific design capabilities	4.user research service	5.market research service	6.relational capabilities
1. CAMBRIDGE INDUSTRIAL DESIGN	1	5	2	2	2	3
2. CAMERLENGO DESIGN	1	5	4	2	2	5
3. CWD	1	1	3	2	2	2
4. ANONYMOUS 1	5	5	4	1	1	4
5. FRAZER	4	3	3	1	1	3
6.	5	5	5	5	5	5
1. DGI	5	4	5	3	3	4
2. CARRETTA	5	4	3	2	3	5
3. BOZANIC	5	5	3	1	2	4
4. BONFANTI	1	4	3	1	1	2
5. GECCHELIN	1	1	1	1	1	1
6. DAMENO	3	4	2	2	3	5
7. RIFINO	3	4	5	2	1	2



RQ 1. A – WHAT in PROJECTS
All capabilities in single projects

Table 2 – Level of frequency of all capabilities in project 1

1. PRODUCT IMPROVEMENT IN EXISTING LINE						
INTERVIEWEE NUMBER	1.manufacturing service	2.technological capabilities	3.specific design capabilities	4.user research service	5.market research service	6.relational capabilities
1. CAMBRIDGE INDUSTRIAL DESIGN	1	5	3	2	2	5
2. CAMERLENGO DESIGN	1	5	3	1	1	4
3. CWD	1	5	4	4	1	3
4. ANONYMOUS 1	5	5	4	1	1	4
5. FRAZER	1	1	1	1	1	1
6.	4	4	2	1	4	5
1. DGI	3	3	3	1	1	1
2. CARRETTA	4	3	2	2	2	3
3. BOZANIC	5	5	3	1	2	4
4. BONFANTI	2	3	2	1	1	1
5. GECCHELIN	1	1	1	1	1	1
6. DAMENO	5	5	4	5	1	4
7. RIFINO	1	4	5	1	1	1



RQ 2. A – WHEN in PROJECTS
All capabilities in single projects

Table 3 – Level of importance of all projects for manufacturing service

1. manufacturing service	PROJECT 1	PROJECT 2	PROJECT 3	PROJECT 4
1. CAMBRIDGE INDUSTRIAL DESIGN	1	1	1	1
2. CAMERLENGO DESIGN	1	1	1	1
3. CWD	1	1	1	1
4. ANONYMOUS 1	5	5	5	5
5. FRAZER	4	4	4	4
6.	5	5	5	5
1. DGI	5	5	4	5
2. CARRETTA	5	4	5	4
3. BOZANIC	5	5	5	5
4. BONFANTI	1	1	1	1
5. GECCHELIN	1	1	1	1
6. DAMENO	3	3	3	3
7. RIFINO	3	1	1	1



RQ 1. A – WHAT in PROJECTS
Single capability in all projects

Table 4 – Level of frequency of all projects for manufacturing service

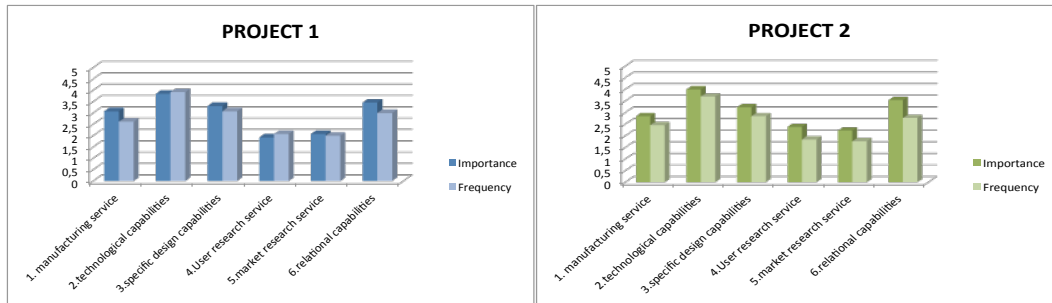
1. manufacturing service	PROJECT 1	PROJECT 2	PROJECT 3	PROJECT 4
1. CAMBRIDGE INDUSTRIAL DESIGN	1	1	1	1
2. CAMERLENGO DESIGN	1	1	1	1
3. CWD	1	1	1	1
4. ANONYMOUS 1	5	5	5	5
5. FRAZER	1	1	3	4
6.	4	4	4	4
1. DGI	3	3	3	3
2. CARRETTA	4	4	5	5
3. BOZANIC	5	5	5	5
4. BONFANTI	2	1	1	1
5. GECCHELIN	1	1	1	1
6. DAMENO	5	4	3	2
7. RIFINO	1	1	1	1



RQ 2. A – WHEN in PROJECTS
Single capability in all projects

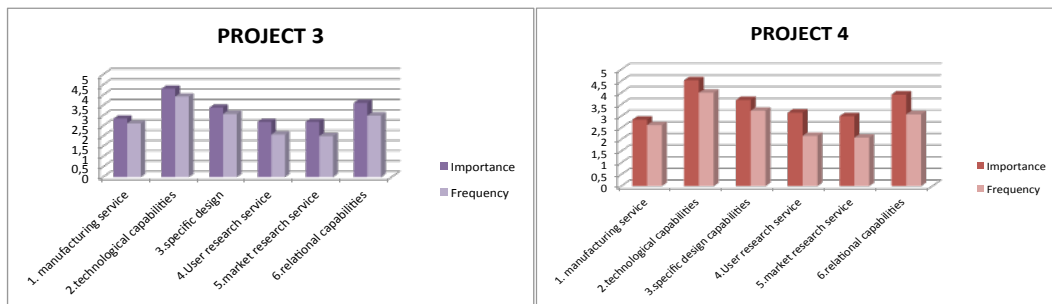
14.2 COMPLETE ANALYSIS – ALL DESIGNERS

RQ 1. A and RQ2. A – IMPORTANCE and FREQUENCY of Supplier Capabilities In Projects



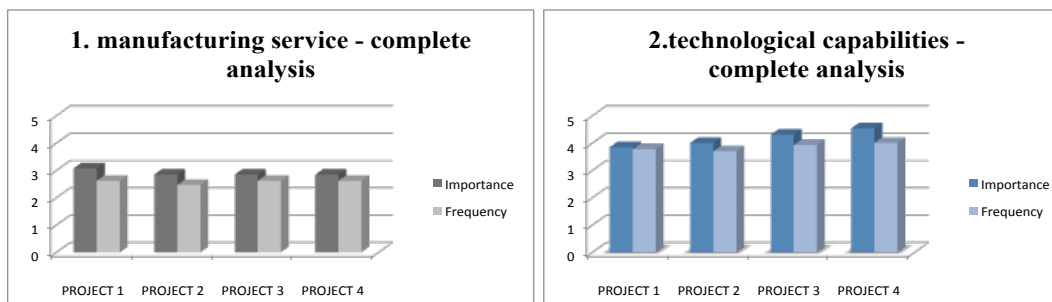
Graphic 1 - Importance vs Frequency for all capabilities in project 1 (all designers)

Graphic 2 - Importance vs Frequency for all capabilities in project 2 (all designers)



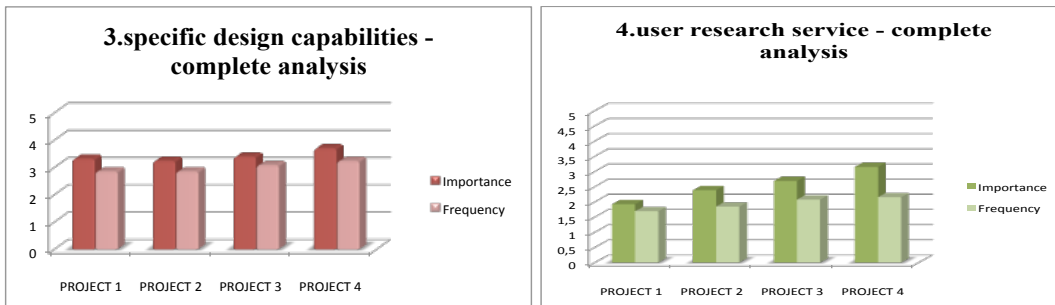
Graphic 3 - Importance vs Frequency for all capabilities in project 3 (all designers)

Graphic 4 - Importance vs Frequency for all capabilities in project 4 (all designers)



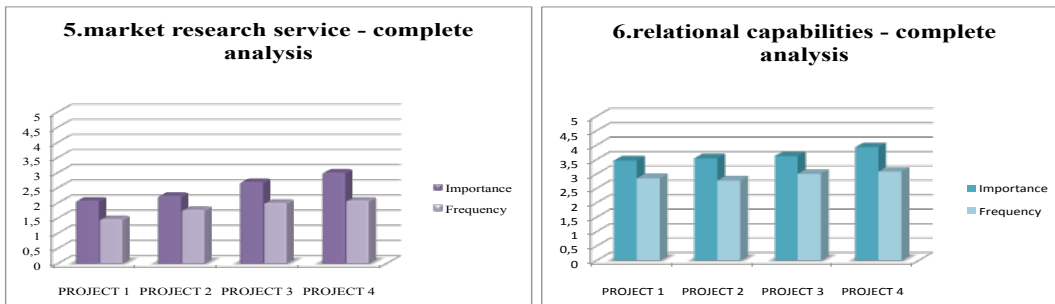
Graphic 5 - Importance vs Frequency for all projects in Manufacturing service (all designers)

Graphic 6 - Importance vs Frequency for all projects in Technological capabilities (all designers)



Graphic 7 - Importance vs Frequency for all projects in Specific design capabilities (all designers)

Graphic 8 - Importance vs Frequency for all projects in User research service (all designers)



Graphic 9 - Importance vs Frequency for all projects – Market research service (all designers)

Graphic 10 - Importance vs Frequency for all projects – Relational capabilities (all designers)

1) Progress of all capabilities in each project (graphics from 1 to 4)

Trend is the same for all the projects, despite different average values.

However, designers consider user research service more crucial than manufacturing service in radical new projects.

We can notice a high misalignment between importance and frequency, when referring to user, market services and relational capabilities. It is due to designer’s maturity in exploiting user, market and relational capabilities while involving suppliers. Designers assess the crucial role of those capabilities but some of them don’t have the experience and competences to translate it into practice.

In addition, new product/new product line in existing market (project 4) implies innovativeness and creation. It is very difficult to translate theory into practice. Despite their exploitation, user and market research services are more important in project 4 than in others.

User research and market research services are considered less important than the other services. The reason, as Jones (CID) expresses, is that user and market research services are designer's responsibility: "we do it in-house" he says.

Manufacturing service is more used in adaptive projects, as expected according to their nature. Adaptive projects are improvements to existing products or product lines: designers need suppliers who can easily and rapidly prepare prototypes to validate theoretical variations. Except for technological capabilities and user research service in product improvement, importance was given higher values than frequency.

2) Single capability in all projects (graphics from 5 to 10)

Manufacturing Service

Average of manufacturing service is similar for all projects in terms of importance and frequency (average around 3). In manufacturing service importance is aligned with frequency: its employment doesn't constitute a differentiation for projects.

Therefore, through data investigation, we assessed designer's difficulty in understanding the meaning of manufacturing service and the difference between technological capabilities and manufacturing service itself.

Opposite to what we expected, technology seems to be more crucial than manufacturing service in adaptive projects.

Technological capabilities

Technological capabilities are very important to all four projects.

Their importance increases from adaptive to innovative projects, as we expected.

As a matter of fact, technology is a driver of innovation: it becomes more and more crucial in projects where more innovation is required.

The level of frequency is slightly lower than the level of importance, except for product improvement project. Most designers do comprehend the key role of technological capabilities in projects but some of them can't put technological capabilities in practice.

Table below presents correlation analysis among projects.

We can notice that the correlation between projects is:

- very low for product improvement in existing line and new product/ new line in new market (projects 1 and 4),
- very high between innovative projects.

These findings back our thesis according to which projects 1 and 4 (adaptive project vs radical new project) are opposite in terms of innovativeness and technological requirements.

Table 5 – Bivariate analysis of technological capabilities vs projects

TECHNOLOGICAL CAPS - FREQUENCY	PROJECT 1	PROJECT 2	PROJECT 3	PROJECT 4
PROJECT 4	0,52	0,67	0,92	1

Specific design capabilities.

Importance and frequency levels have increasing trends with respect to their level of innovation. Designers seem to be aware of the role of specific design capabilities.

Analysing data, some conclusions can be drawn:

- 1) specific design capabilities are mainly important in radical new projects
- 2) standard deviation is high; min = 1 and max= 5 in all capabilities for each project

Market and user research services

User and market research services have same trends but different values. User research service has higher values than market service.

In addition, misalignments between importance and frequency are elevated.

However, user and market average values are lower than technological, specific and relational average values.

Designers are not used to outsource these services, especially in low innovation projects. Nonetheless, when working on creative projects, designers seem to perceive service importance, while they find it hard to exploit them.

According to interviewed designers, user research service is more important than utilized.

Importance average increases from adaptive to innovative projects.

The most innovative project presents 3,15 in average and its mode is 5. This means that user service is considered most significant for project 4.

However, standard deviation and confidence present to a high value: some designers consider user research service as not important at all. User research service is a soft capability: as we expected, not all designers agree about its importance in projects.

Through frequency investigation, we can claim that user research capabilities are rarely implied.

Market research service

Its graphic shows an increasing trend in importance and frequency from project 1 to 4. However, growing rate for frequency is lower than the importance one and there are great misalignments in between importance and frequency. As for user research service, designers are acknowledging market importance but they have difficulties in the practical phase.

It is worth outlining that standard deviation and confidence are lower for project 1 than for project 4. Designers agree about the market service level of importance meanwhile standard deviation for project 4 identifies the difficulties for designers to evaluate market service importance. Again, correlation analysis presents a low correlation for project 1 and 4 but a high correlation for project 3 and 4 (that are similar).

Finally, relational capabilities. As we expected, relational attitudes present high values since they are cross-functional capabilities. Their importance is assessed by designers through high marks. The level of standard deviation is high but similar for the two projects: most designers recognize the importance of relational capabilities but not all of them. Average values are similar to specific design average values, while importance-frequency misalignment is higher (high correlation values). Soft capabilities are evaluated as crucial but designers lack to involve them in supplier selection criteria (low correlation values).

3) *Correlation among capabilities in projects.*

From correlation analysis we can identify the following information:

1) User and market research correlation - There is a significant change in perspective with respect to importance and frequency. Designers recognize the importance of information from user and market research service. However, in practice, they don't use jointly information from both the disciplines.

2) technological and relational capabilities are highly correlated in frequency. This evidence, linked to the fact that technological capabilities are the most important in all projects, supports our thesis that relational capabilities are fundamental to designers and suppliers to become performing and competitive.

It is curious that designers don't recognize technological – relational relationship importance but they exploit it in practice. It seems an unconscious behaviour.

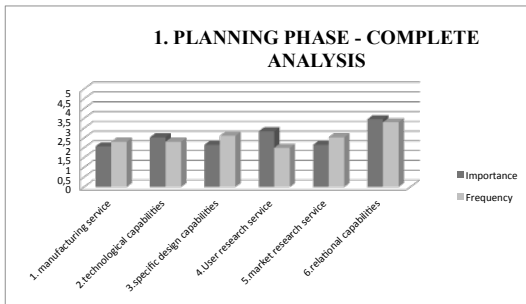
3) Market and relational capabilities. In the most innovative project (project number 4), correlation between market service and relational capabilities is high both in terms of importance and frequency. This means that designers recognize and experience the importance of good relationships with experts who have the responsibility of identifying the profitability of market reactions to new product launch.

4) Moreover, designers consider correlation between manufacturing and specific design capabilities, manufacturing and user research service, manufacturing and market service, to be less important than the other relationships when designing radical innovative products. In terms of frequency, they even consider them to be uncorrelated.

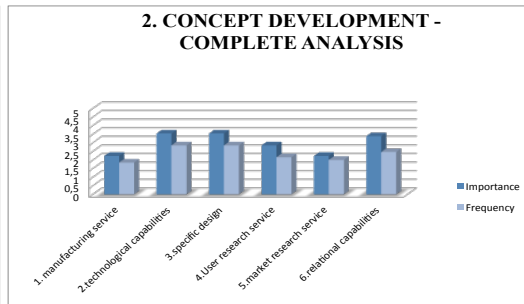
It can be explained as follows. When creating radically new products, designers are not interested in suppliers' tools and machinery to manufacture them.

After the design phase, production can be assessed with the supplier, if he is willing to collaborate (relational capabilities are more important in project 4).

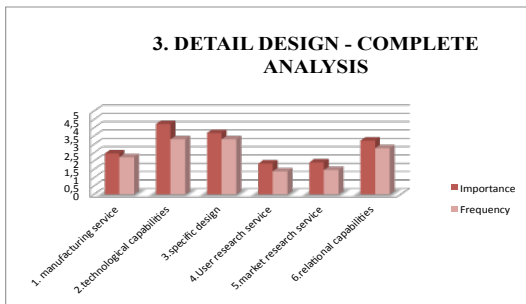
RQ 1. B and RQ2. B – IMPORTANCE and FREQUENCY of Supplier Capabilities in PDD phases



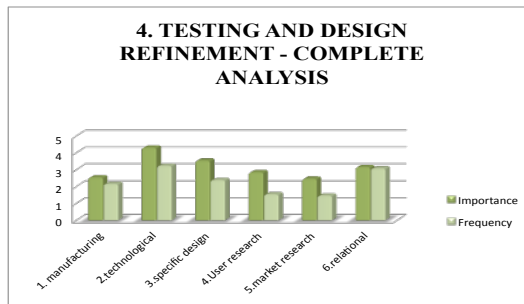
Graphic 11 - Importance vs Frequency for all capabilities in Phase 1 (all designers)



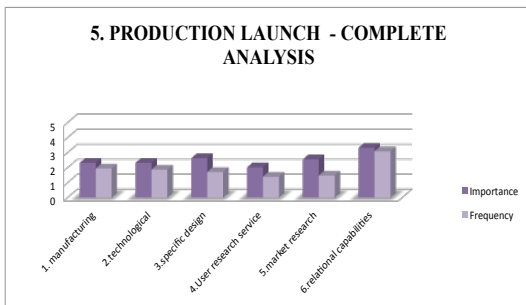
Graphic 12 - Importance vs Frequency for all capabilities in Phase 2 (all designers)



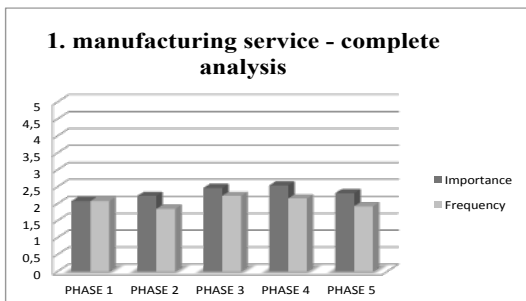
Graphic 13 - Importance vs Frequency for all capabilities in Phase 3 (all designers)



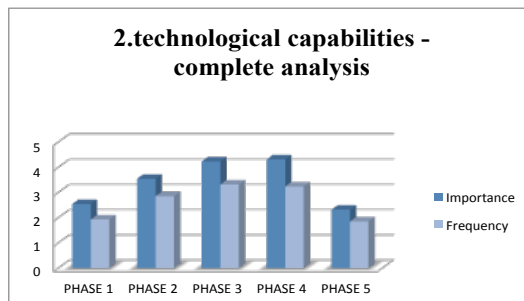
Graphic 14 - Importance vs Frequency for all capabilities in Phase 4 (all designers)



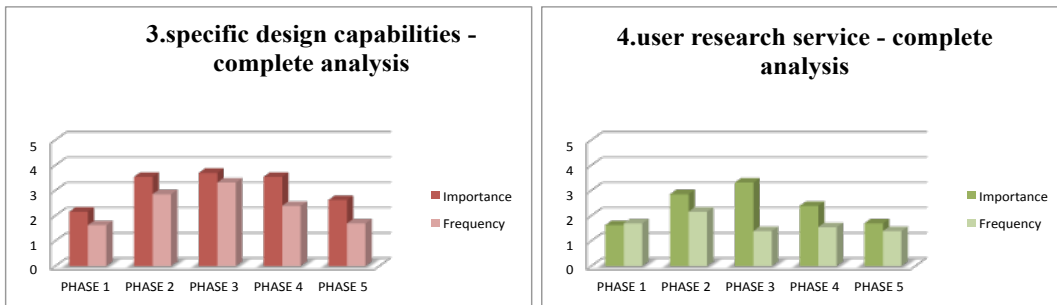
Graphic 15 - Importance vs Frequency for all capabilities in Phase 5 (all designers)



Graphic 16 - Importance vs Frequency for all Phases in Manufacturing service (all designers)

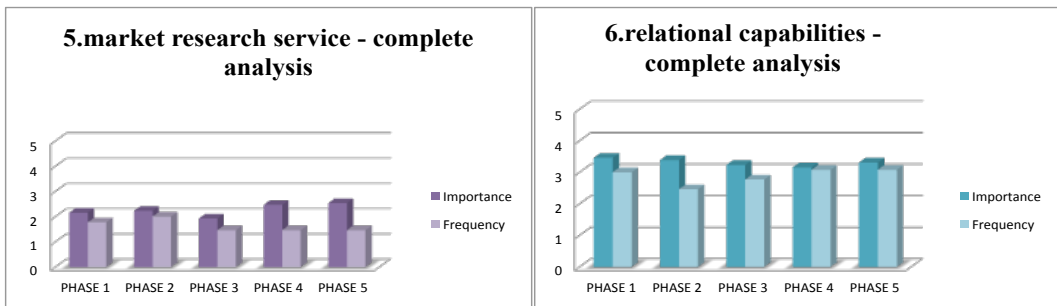


Graphic 17 - Importance vs Frequency for all Phases in Technological capabilities (all designers)



Graphic 18 - Importance vs Frequency for all Phases in Specific design capabilities (all designers)

Graphic 19 - Importance vs Frequency for all Phases in User research service (all designers)



Graphic 20 - Importance vs Frequency for all Phases in Market research service (all designers)

Graphic 21 - Importance vs Frequency for all Phases in Relational capabilities (all designers)

1) Progress of all capabilities in each phase (graphics from 11 to 15)

Phase 1 - Planning phase

Planning phase has a different trend from other phases.

Designers suggest that relational capabilities are the most critical to gain success. Their average value is the highest both in terms of importance and frequency. With respect to importance, standard deviation of relational capabilities is the lowest, since the majority of designers consider them very important (the mode is 5).

Moreover, market research service, manufacturing and specific design capabilities present a peculiarity. Frequency values are higher than importance values. Designers don't have awareness of those capability importance but they utilize them in practice. Therefore, designers have a mature approach on those capabilities in planning phase.

Designers consider relational capabilities and user research service as the most important in the planning phase. According to Ulrich and Eppinger, planning phase represents the planning

for next stages.

Standard deviation is high for all capabilities, both in terms of importance and frequency.

Analysing the mode and standard deviation values, we can claim that designers quite agree on the importance of soft skills but not on manufacturing service.

User research service presents a great misalignment between importance and frequency average values. Designers think they should utilize user research information in the first phase but they don't know how to do it.

Conducting a bivariate analysis, we registered a high correlation between user and market research service both in importance and frequency. This is consistent with our expectations since planning phase represents a preparation phase, in which user and market research influence each other.

Meanwhile, manufacturing and market research service present a low correlation in importance and frequency. Therefore, according to most designers, in the first project phase, it is not necessary to identify whether the supplier is able to produce what the market wants or not.

Technological and specific design capabilities have a high importance correlation. This backs Ulrich and Eppinger thesis, according to which technological exploration is a main activity to undergo during planning phase.

Phase 2 - Concept development phase

Designers seem to agree about the importance and exploitation of technological and specific design capabilities in this phase.

By contrast, manufacturing capabilities are not considered as important as Ulrich and Eppinger thought. According to us, this can be due to designer's difficulties in understanding the role of manufacturing service. Anyway, academics need to analyze the topic with further investigations. It is crucial to pinpoint the fact that standard deviation for capabilities in importance and frequency is high, except for technological attitude, for which designers agree on the importance.

In concept development phase, technological, specific design and relational capabilities present a great misalignment in between importance and frequency. However, average values

are high. The majority of designers do admit their importance but not all of them can exploit the opportunities given by those capabilities.

Correlation analysis

- user research and market research services are highly linked both in importance and frequency. It is what we expected.
- specific design capabilities and user research service have a low correlation in importance and frequency. In fact, this phase consists of the validation of what has been defined in the previous phase.
- Technological capabilities and user research service are negatively correlated in terms of frequency. This is opposite to what we expected: concept development phase calls for feedback and information about user needs. Technological and specific design capabilities are important in this phase. Some designers mismatch concept development with the planning phase, claiming that concept development means freedom in design.

Phase 3 - Detail design

As in concept development phase, technological and specific design capabilities are the most crucial and utilized. User research service is the last in importance and frequency.

Technological capabilities have a low standard deviation: designers agree on their role within the third phase. Technological capabilities have the highest average value (both in frequency and importance). As expected, user and market research service have the lowest average level. Standard deviation is very high in manufacturing service importance.

It is curious to underline that frequency is very different in terms of average values with respect to importance. Most designers marked the highest value to importance and frequency. However, some of them have difficulties in making them practice.

Correlation in terms of importance and frequency.

Academics should investigate the reasons why manufacturing service and technological capabilities are not correlated. Opposite to what we expected, manufacturing and specific design, manufacturing and relational capabilities are not much correlated in the third phase.

Detail design phase consists of the identification of materials, architectures, tolerances, ect. Manufacturing must be related to technological and specific design capabilities. In addition, designers prefer to collaborate with suppliers willing to share their knowledge about manufacturing service.

Moreover, it is necessary to identify the motivations of the negative correlation between manufacturing service and specific design capabilities, technological capabilities and user research service.

Phase 4 - Testing and design refinement

Once again, technological and specific design capabilities are the most important and utilized. Technological capabilities have a low standard deviation.

Both in importance and frequency, market research service average is low. Moreover, its standard deviation is low in terms of frequency.

Manufacturing, user and market research service are not assessed as important or utilized in this phase.

Correlation in terms of importance and frequency fails to represent the reality. Academics need to focus on correlations.

Phase 5 - Production launch

In product launch phase, relational capabilities are the most important, meanwhile user research service has the lowest average value. However, average values are low for all capabilities and the standard deviations are very high. Designers have difficulties in identifying what capabilities are crucial in this phase.

Apart from the high correlation between user and market research service (that are important to this phase), academics will have to explore the relationships among capabilities.

2) Single capability in all phases (graphics from 16 to 21)

According to all designers, manufacturing service has low average values in all phases. Academics should investigate the reasons why in detail design and testing and design

refinement this service is more important and utilized than in the other phases.

Technological and relational capabilities have the highest average values. Designers are aware of their importance in all phases.

Capability graphics evidence the high misalignment between importance and frequency values. Technological, specific and user have the same trend, since they are more important in phases where design and technology are implied. Designers seem not to take advantages from user research services but they recognize its importance.

Relational capabilities have high average values. Manufacturing service is more required in detail design and test and design refinement. Market research service is crucial in testing and design refinement and production launch phases.

3) Capabilities vs Phases

Concept development, detail design, testing and design refinement have the same trends, with different average values. They are structured phases, consisting of technical tools and tests. Designers exactly know what they need from suppliers. In terms of technological capabilities, phases present differences between importance and frequency. Designers recognize technology importance but some of them don't have the proper competences and practices to exploit them.

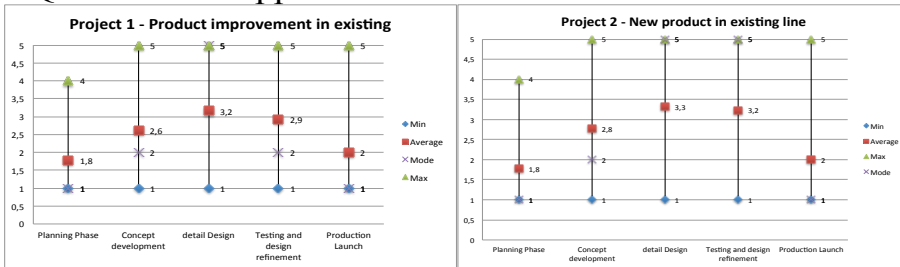
Relational capabilities have the same values in all phases. As hypothesized, they are important and put in practice in PDD stages, because of their nature. As expected, technological and specific design capabilities are critical in concept development, detail design and testing and design refinement phases.

We expected manufacturing service to be important in testing and refinement and production launch. According to Camerlengo and Jones, manufacturing service is crucial in a designer-supplier relationship. However, data analysis underlines a situation in which their importance and exploitation present low average and high standard deviation values. Researchers must investigate the role of manufacturing service in PDD projects.

User and market research services are underestimated in all phases.

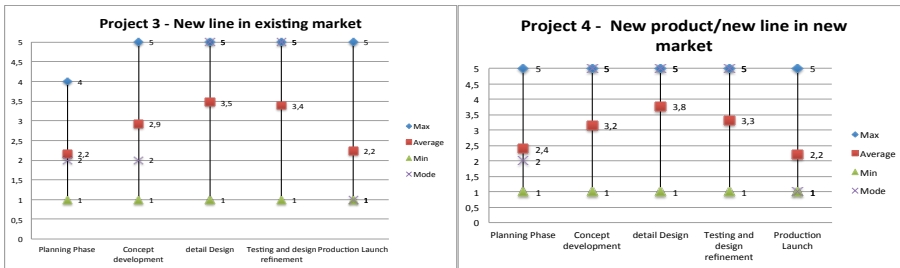
As expected, apart from some exceptions in the planning phase, importance exceeds frequency.

RQ 3. HOW - supplier involvement in PROJECTS and PHASES



Graphic 22 – Level of supplier involvement in all phases for project 1 (all designers)

Graphic 23 – Level of supplier involvement in all phases for project 2 (all designers)



Graphic 24 – Level of supplier involvement in all phases for project 3 (all designers)

Graphic 25 – Level of supplier involvement in all phases for project 4 (all designers)

Graphics above (graphics from 22 to 25) are related to the complete analysis (all designers).

Supplier involvement is the third variable. Each mark corresponds to a level of supplier involvement.

Analysis presented in the previous paragraphs is not suitable for supplier involvement.

Therefore, we exhibit graphics that show:

- * range: minimum and maximum values marked by designers
- * average value
- * mode value

Table 6 – Variable 3 – Level of supplier involvement

the supplier involvement (3)

Metric: on a scale of 1 to 5 please select the level of involvement (1 being not involved and 5 being joint item and process development)				
Not Involved	Consulted	Co-design in item development	Co-Design in process development	Joint item and process development
1	2	3	4	5

As assessed in the previous paragraph, frequency level of supplier capabilities in phases is low: all designers recognize the importance of suppliers and their capabilities in PDD process

but they are not used or not willing to translate it into practice.

This concept is evident in the following graphics. When asked about the level of supplier involvement according to which they imply their suppliers, designers don't seem to have a common idea. Range is the same for all phases in each project since designers marked from 1 to 5: some designers don't involve their suppliers while some other involve them in a joint item and process development of adaptive projects.

In innovative projects, most designers mainly marked 2: they consult suppliers about product feasibility.

Referring to planning phase of each project, graphics below show that it presents a range from 1 to 4 except for the most innovative project. Designers are not used to joint item and process development in the ideation phase. In addition, the mode value suggests that most designers don't involve suppliers.

This conclusion is opposite to what we assessed in the previous analysis: designers marked specific design and relational capabilities as the most utilized supplier capabilities in planning phase. Designers are conscious about the importance and frequency of utilization of supplier capabilities, but they can't recognize the level of involvement in each phase. Academics should focus on this discrepancy and understand the reasons why most designers marked 1 in planning phase.

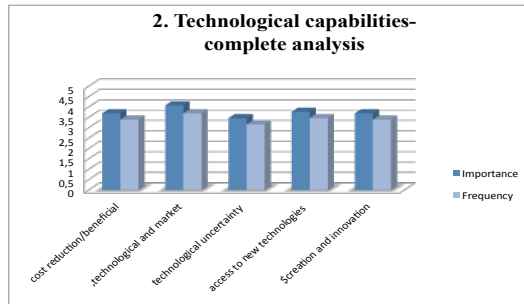
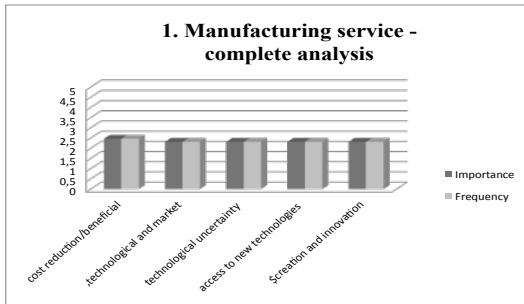
All designers present higher involvement values in production launch (phase 5) than in planning phase. They recognize the importance of co-designing with suppliers in the last PDD process phase.

For all projects:

- The concept development phase presents an average value suggesting that designers mostly consult or co-design items with their suppliers in all projects;
- The detail design phase has the highest average values: it is the most "involving" phase, where designers co-design with suppliers
- The production launch phase presents low average values (around 2)

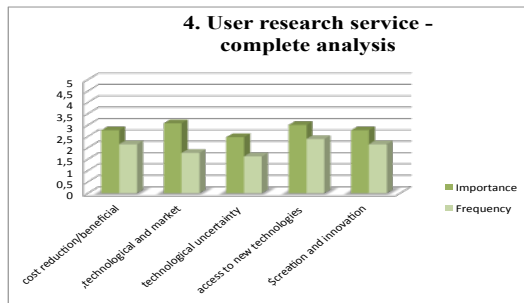
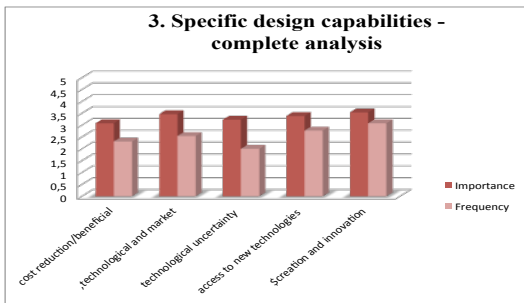
We can conclude that all designers involve suppliers mainly in detail design and testing and design refinement.

RQ 4. A and B - Motivations For Selecting Supplier Capabilities



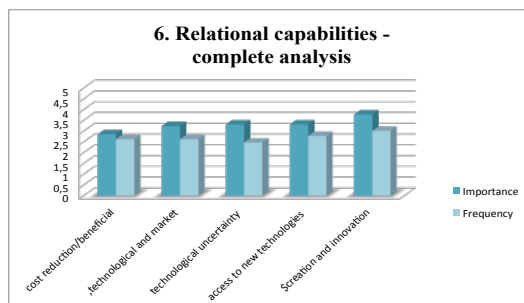
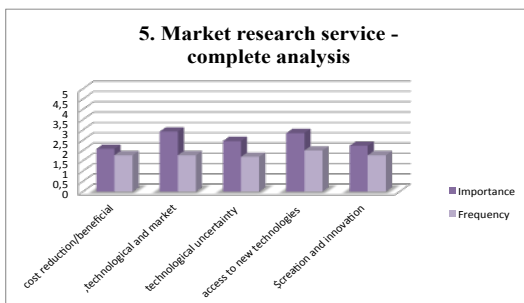
Graphic 26 - Importance vs Frequency of all motivations in Manufacturing service (all designers)

Graphic 27 - Importance vs Frequency of all motivations in technological capabilities (all designers)



Graphic 28 - Importance vs Frequency of all motivations in Specific design capabilities (all designers)

Graphic 29 - Importance vs Frequency of all motivations in User research service (all designers)



Graphic 30 - Importance vs Frequency of all motivations in Market research service (all designers)

Graphic 31 - Importance vs Frequency of all motivations in Relational capabilities (all designers)

Manufacturing service

Designers don't have a proper idea about why manufacturing service is important in supplier selection. They gave the same values to importance and frequency of all reasons.

Bivariate analysis present high correlation values among motivations in importance and frequency.

Technological capabilities

Something more precise can be said about technological capabilities. Designers give a great importance to all motivations. Suppliers with technological capabilities increase designer's competitiveness and performance. Especially, designers decide to involve suppliers in order to obtain technological and market knowledge / expertise. Standard deviation for this motivation is low, backing the fact that the majority of designers agrees on its importance.

Specific design capabilities

Specific design capabilities are important for all 5 reasons. In particular, designers look for suppliers with those capabilities in order to increase creation and innovation capabilities. It is important to underline that frequency average values are lower than the correspondent importance values, except for the last two motivations. When considering it, designers recognize the importance of specific design capabilities in cost reduction, increase of technological and market expertise and decrease of technological uncertainty. However, they seem not to involve suppliers for those reasons.

User research service

Technological and market knowledge and expertise and access to new technologies are the main reason for choosing suppliers who provide user research service. However, designers seem not to realize it (frequency average is very low). Technological uncertainty represents the last motivation for choosing user research service. As a matter of fact, understanding what users look for in products leads to technological and market knowledge, meanwhile it can't be very useful to overcome uncertainty in terms of technology and tools to utilize.

Market research service

Designers select suppliers with market research service because of technological and market expertise and access to new technologies but not because of cost reduction. Again, values are low. The reason is that market research services are often undergone in-house by designers.

Relational capabilities are chosen for all the 5 reasons, especially for creation and innovation capabilities: a good relationship with suppliers brings to working together for better and innovative products. As we can see from the graphic, frequency is lower than importance. Academics need to identify tools and activities to put in practice relational capabilities importance.

Trends of importance and frequency of motivations for choosing capabilities are similar. The difference consists of the average value misalignment. In some cases designers recognize the significance of that capability, in some others there's a need for spreading the awareness.

Correlation analysis expresses the following concepts:

In terms of importance:

- a. access to new technologies and creation and innovation capabilities are highly correlated since new technologies and tools could bring to innovative ideas and products;
- b. cost reduction/beneficial and access to new technologies; cost reduction/beneficial and creation and innovation capabilities are not much correlated: we expected negative correlation since innovation processes and new technologies are expensive

In terms of frequency:

- cost reduction and technological uncertainty are highly related since technological uncertainty brings to utilization of new and different tools: it is necessary to overcome this problem through technological abilities that lead to cost reduction
- technological uncertainty and innovation capabilities; cost reduction/beneficial and creation and innovation capabilities are not much correlated: we expected negative correlation
- technological uncertainty and access to new technologies are not much related in terms of frequency.
- In terms of importance and frequency: technological and market expertise and access to new technologies or creation and innovation capabilities are highly correlated in specific design capabilities. The reason is that specific design capabilities may lead to

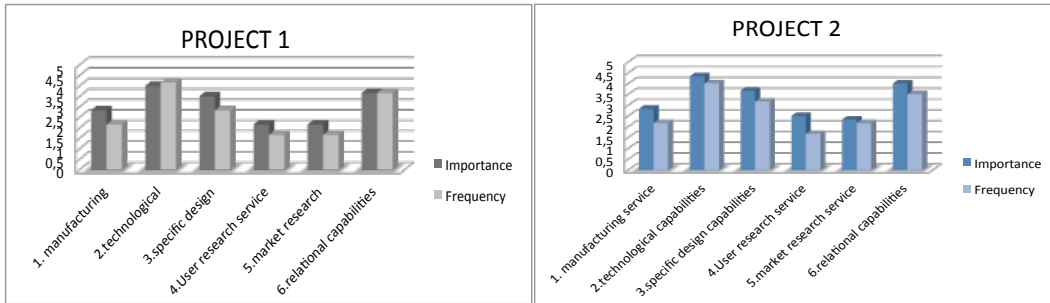
new solutions and technologies that constitute technological and market knowledge.

In terms of importance, cost reduction and creation and innovation capabilities are negatively linked when referring to user research service: it is what we expected. However, in terms of frequency, the two reasons are highly correlated: academics have to focus on this analysis.

14.3. ENGLISH DESIGNERS

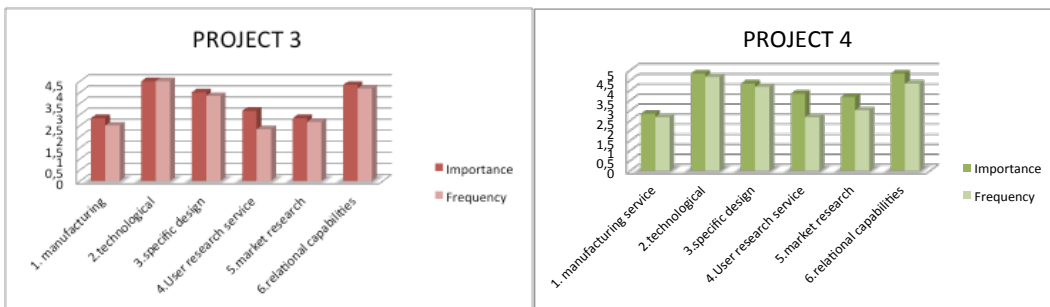
RQ 1. A and RQ2. A – IMPORTANCE and FREQUENCY of Supplier Capabilities In Projects

1) Progress of all capabilities in each project (graphics from 32 to 35)



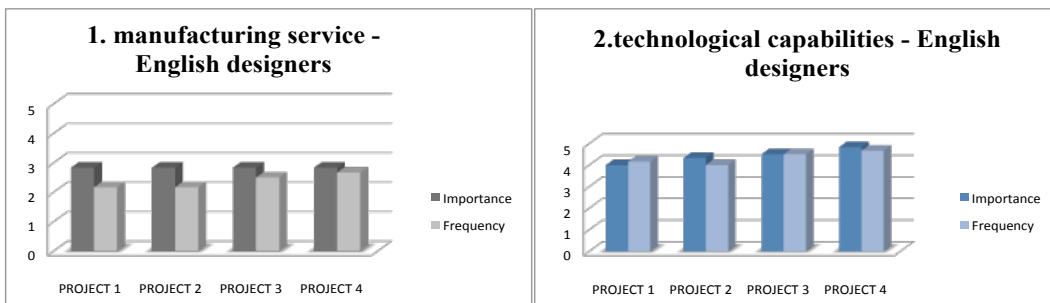
Graphic 32 - Importance vs Frequency for all capabilities in project 1 (English designers)

Graphic 33 - Importance vs Frequency for all capabilities in project 2 (English designers)



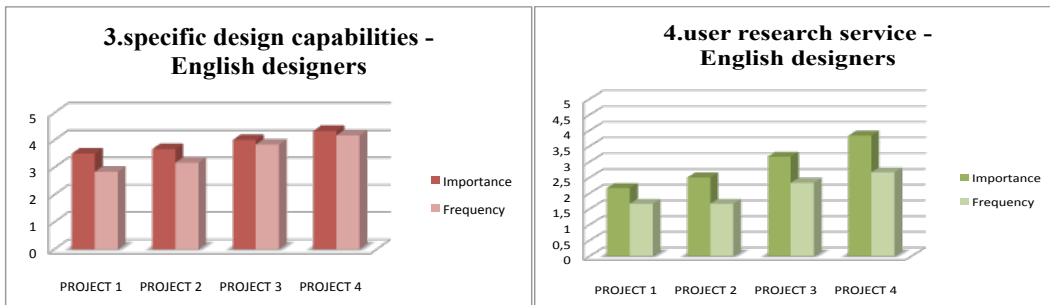
Graphic 34 - Importance vs Frequency for all capabilities in project 3 (English designers)

Graphic 35 - Importance vs Frequency for all capabilities in project 4 (English designers)



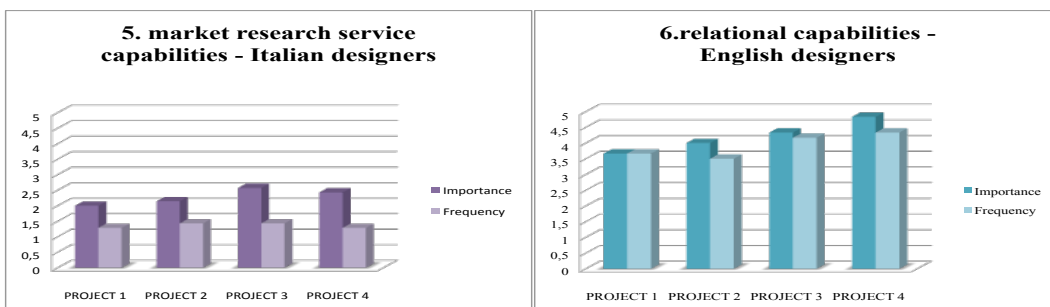
Graphic 36 - Importance vs Frequency for all projects in Manufacturing service (English designers)

Graphic 37 - Importance vs Frequency for all projects in Technological capabilities (English designers)



Graphic 38 - Importance vs Frequency for all projects in Specific design capabilities (English designers)

Graphic 39 - Importance vs Frequency for all projects in User research service (English designers)



Graphic 40 - Importance vs Frequency for all projects – Market research service (English designers)

Graphic 41 - Importance vs Frequency for all projects – Relational capabilities (English designers)

Trend is the same for all projects, despite variations in average values. However, manufacturing service is more important and utilized than user and research services, in adaptive projects. On the contrary, in innovative projects, manufacturing is less important than user and market.

Standard deviation is very high for technological capabilities in project 1. From a deep univariate analysis we can assess that the mode is 5 but one designer marked 1. The majority of English designers recognize the importance of technological capabilities in product improvement project. User research is not crucial for the first project.

The reason is that designers don't need suppliers with user and market knowledge in projects where only physical refinement and changes are required. English designers consider technological and relational capabilities as the most important and utilized in all four projects.

However, in innovative projects, English designers consider user and market services as more important than manufacturing.

Adaptive projects consider manufacturing service as more important than user and market research service. According to the project nature, designers make changes to existing products or lines. They mainly need suppliers who can provide physical changes to products.

In project 3 (new line in existing market), manufacturing is as important as market research service, while user research service is more important. This is due to the nature of the project since it is necessary to have information about what user needs in existing markets.

Bivariate analysis

In terms of importance and frequency, technological and relational capabilities are highly correlated. Collaboration with suppliers who can easily understand designer's needs is considered important and is exploited.

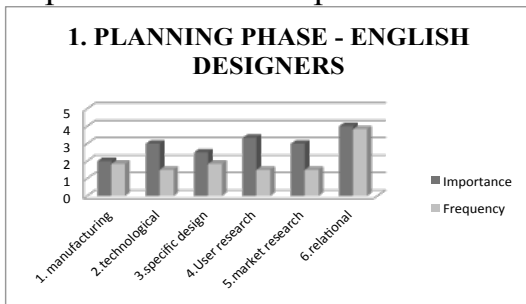
2) Single capability in all projects (graphics from 36 to 41)

English designers gave high values to importance and frequency of technological, specific design and relational capabilities. Manufacturing is given the same average value in terms of importance for all projects. However, academics need to investigate the reason why frequency levels are much lower than importance levels in adaptive projects (projects 1 and 2). Despite its importance, manufacturing is more utilized in innovative projects (projects 3 and 4) than in projects 1 and 2.

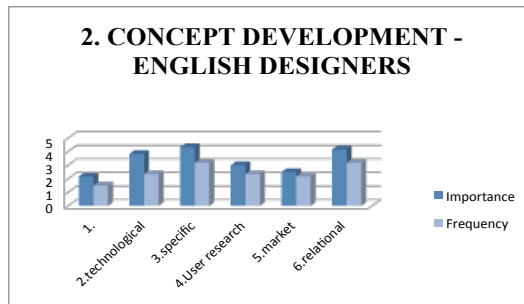
User and market research service importance and frequency increase with the growth of innovation level in projects. User research is more important than market in all phases but it is less utilized than market research service.

Designers prefer to utilize supplier's market expertise because of their close relationship with events: they are more inclined to do user research by themselves.

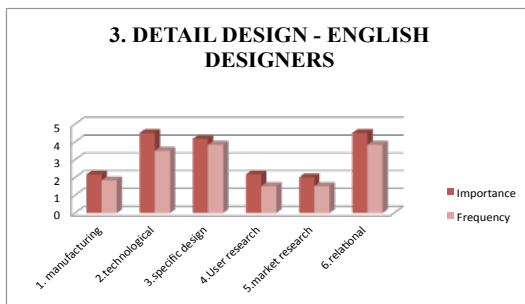
RQ 1. B and RQ2. B – IMPORTANCE and FREQUENCY of Supplier Capabilities in PDD phases



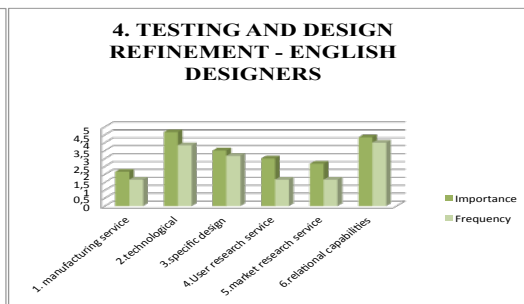
Graphic 42 - Importance vs Frequency for all capabilities in Phase 1 (English designers)



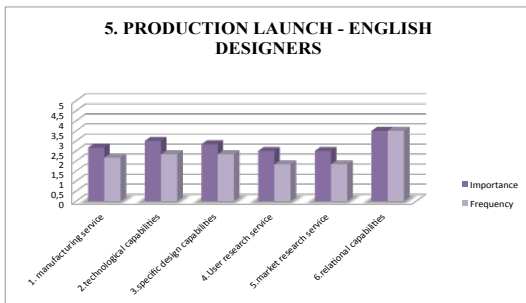
Graphic 43 - Importance vs Frequency for all capabilities in Phase 2 (English designers)



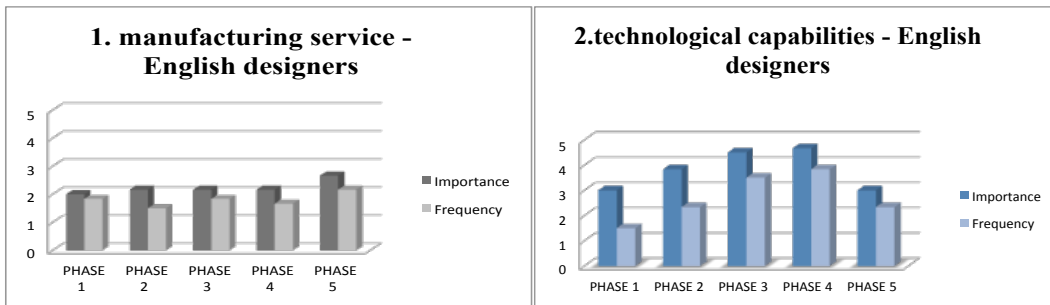
Graphic 44 - Importance vs Frequency for all capabilities in Phase 3 (English designers)



Graphic 45 - Importance vs Frequency for all capabilities in Phase 4 (English designers)

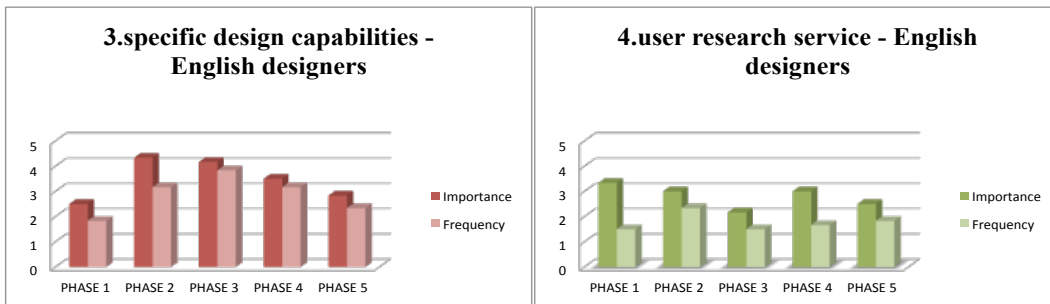


Graphic 46 - Importance vs Frequency for all capabilities in Phase 5 (English designers)



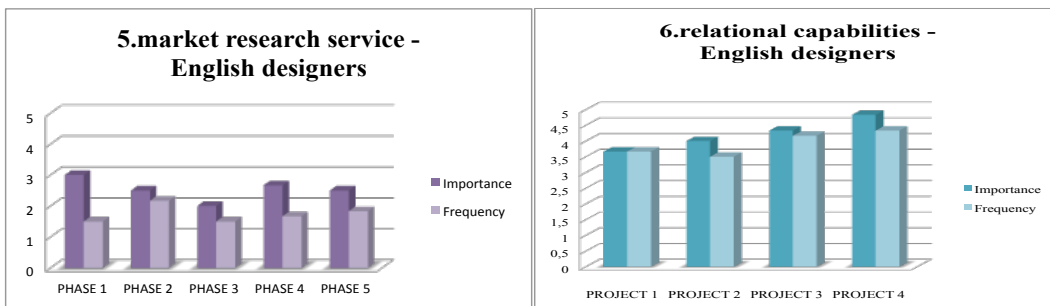
Graphic 47 - Importance vs Frequency for all Phases in Manufacturing service (English designers)

Graphic 48 - Importance vs Frequency for all Phases in Technological capabilities (English designers)



Graphic 49 - Importance vs Frequency for all Phases in Specific design capabilities (English designers)

Graphic 50 - Importance vs Frequency for all Phases in User research service (English designers)



Graphic 51 - Importance vs Frequency for all Phases in Market research service (English designers)

Graphic 52 - Importance vs Frequency for all Phases in Relational capabilities (English designers)

1) Progress of all capabilities in each phase (graphics from 42 to 46)

Planning phase

According to Camerlengo “when planning the project, relational capabilities are important

since you need to know whether the supplier is reliable, whether he is quick in replying to your questions and whether he understands the importance of relationship and collaboration”.

Camerlengo claims: *“In the planning phase you need to know if the person you’re dealing with has the technological capabilities you require (importance = 5). It is quite weird but in the planning phase you’ll have to plan the project phases with the supplier. It depends on the meaning of planning phase.”*

Planning phase. English designers consider relational capabilities as the most important. Designers need to work with suppliers who share the same objectives, ethics and who are willing to cooperate. User, market and technology capabilities are considered fundamental in the planning phase.

However, frequency values are low for all capabilities. Planning phase is difficult to manage so soft capabilities are crucial. Designers know what they should do but not all them have the maturity to put it in practice. In terms of frequency, all capabilities have the same average values, except for relational capabilities. English designers seem not to utilize the capabilities they consider important.

Concept development. As expected, technological, specific design and relational capabilities are fundamental. In particular, specific has the highest average value. However, technological, relational and specific design have lower frequency values.

Detail design: again technological, specific design and relational capabilities are the most crucial. Manufacturing, user and market do have very low values, since they are not considered important in this phase. The reason is that a detail design phase consist of detailing what has been previously determined. Services are not required.

Testing and design refinement. Technological and relational capabilities are important and utilized, while the other capabilities have lower importance. However, user and market acquire higher role than in the detail design phase.

Production launch. Apart from relational capabilities, other capabilities have the similar average values. It is curious to pinpoint that manufacturing service has not been given high values. Academies should investigate whether manufacturing service is really unimportant or

designers need to gain awareness of their role in production phase.

2) Single capability in all phases (graphics from 47 to 52)

English designers are conscious about the importance of technological, specific design and relational capabilities, as it is shown in figures below.

Technological capabilities have high average values, especially in central phases, according to what we expected because of the capability nature. They increase average values from the first to the fourth phase.

Specific design capabilities are important in central phases with decreasing average values. Obviously, specific design activities are crucial in concept development and detail design phase mainly. The testing and design refinement phase, however, needs to be supervised by experts with design knowledge.

Manufacturing service is fundamental in phase 5 but it is considered quite necessary in the other phases as well. Considering each supplier capability, we can define some remarks. Manufacturing service has:

the same importance in the first four phases but it is more important in production launch.

While English designers agree on manufacturing level of importance but frequency is not agreed.

technology, specific and relational capabilities have the highest values.

Specific design capability importance presents a decreasing trend. The trend is explained by phase nature. Concept development and detail design phases need technical abilities.

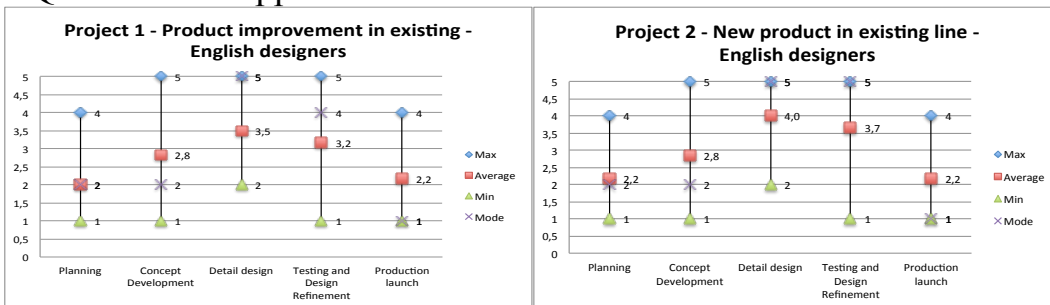
In the planning phase, user and market research service are more important then utilized. Moreover, designers gave higher values to concept development and testing and design refinement phases. The reason is than designers need user and market knowledge and expertise when developing the concept and refunding design and prototypes.

User and market research services have the same trends. However, user service has higher average values than market. Designers involve suppliers with user knowledge mostly in planning, concept development and testing and design refinement phases. Designers need information about what final users need in products, from the planning to the testing phase.

Market research service is mostly required in planning phase. However, designers consider it important in phases 2 and 4. That is opposite to what we expected according to phase definition. Academics need to verify the reasons for designers to involve suppliers with market research services.

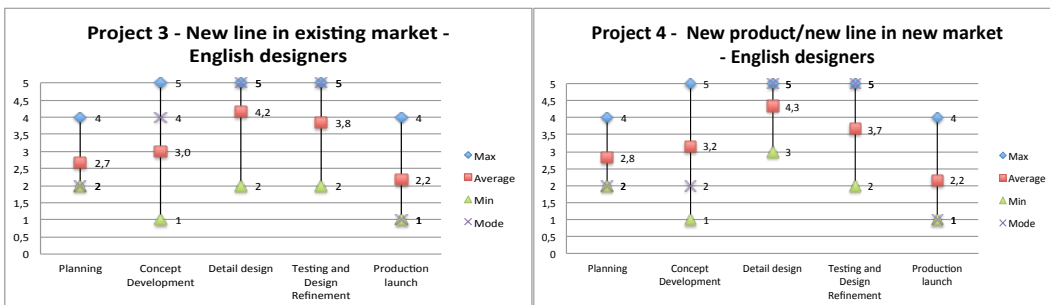
Relational capabilities have very high average values in all phases. However in phase 2 and 3 frequency values are much lower than importance levels. English designers prefer not to completely involve suppliers in order not to disclosure crucial know-how.

RQ 3. HOW - supplier involvement in PROJECTS and PHASES



Graphic 53 – Level of supplier involvement in all phases for project 1 (English designers)

Graphic 54 – Level of supplier involvement in all phases for project 2 (English designers)



Graphic 55 – Level of supplier involvement in all phases for project 3 (English designers)

Graphic 56 – Level of supplier involvement in all phases for project 4 (English designers)

The trend of average values for all projects is:

- production launch and planning phase have the lowest average values
- concept development and testing and design refinement have medium average values
- peak in detail design

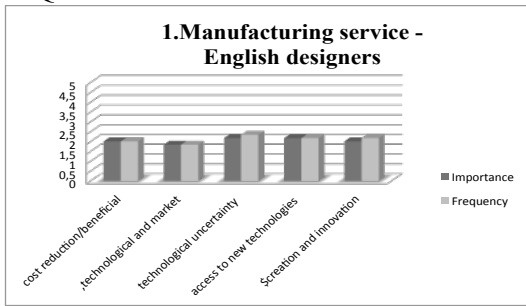
English designers present the same trend as all designers in terms of supplier involvement but different ranges and higher average values. Planning and production launch phases have reduced range of replies. English industrial designers do agree that:

- Suppliers can't be involved in product and process co-design in the production launch.
- Suppliers involvement ranges from consult to process co-design in planning phase
- most designers don't involve suppliers in product launch (the mode is 1 for all projects)
- most designers consult suppliers in planning phase (the mode is 2 for all projects)

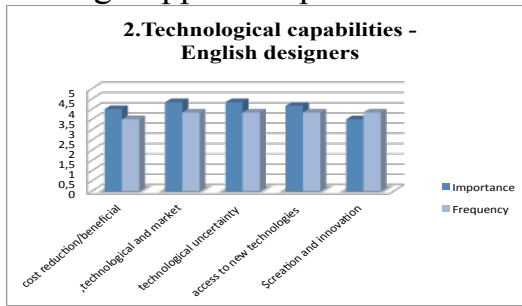
Especially in innovative projects, ranges are narrow.

As we can notice from the figures above, Innovative projects require co-design in concept development, detail design and testing and design refinement phases.

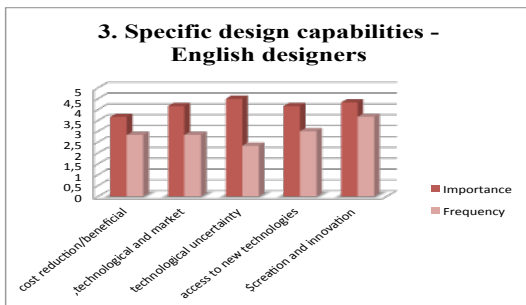
RQ 4. A and B - Motivations For Selecting Supplier Capabilities



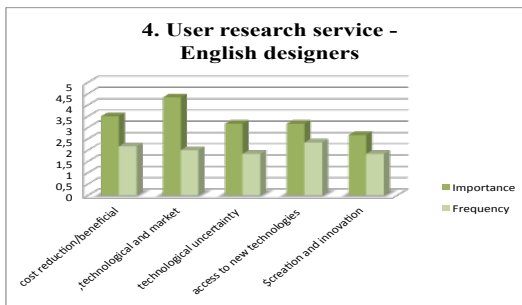
Graphic 57 - Importance vs Frequency of all motivations in Manufacturing service (English designers)



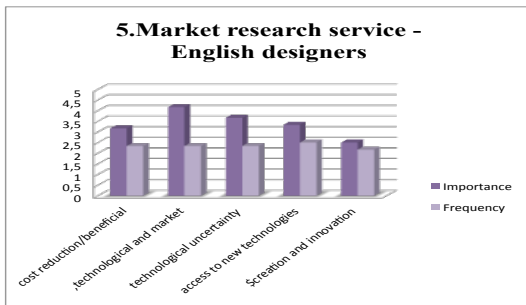
Graphic 58 - Importance vs Frequency of all motivations in technological capabilities (English designers)



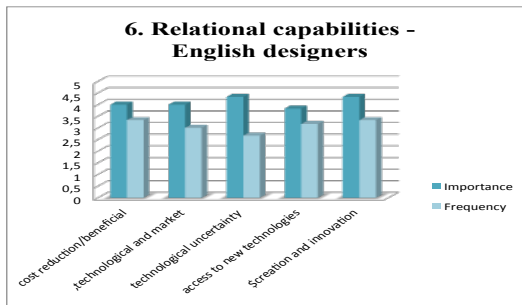
Graphic 59 - Importance vs Frequency of all motivations in Specific design capabilities (English designers)



Graphic 60 - Importance vs Frequency of all motivations in User research service (English designers)



Graphic 61 - Importance vs Frequency of all motivations in Market research service (English designers)

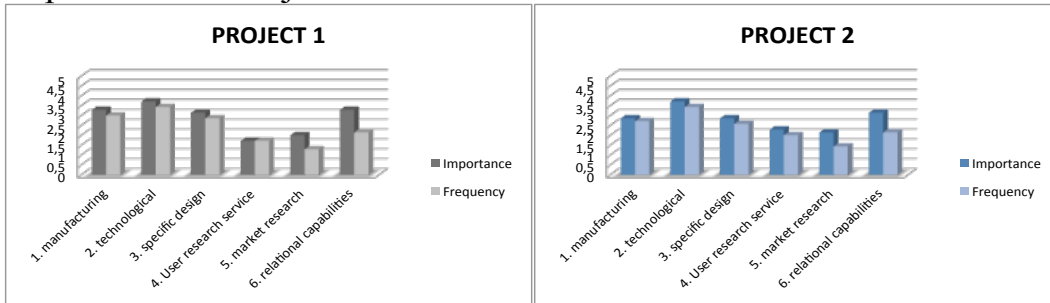


Graphic 62 - Importance vs Frequency of all motivations in Relational capabilities (English designers)

Except for manufacturing service and technological capabilities (the hardest issues), we can notice a great misalignemnet between importance and frequency in all motivations for choosing each supplier capability. Therefore, we suggest academics to go deeper in the investigation of the reasons why external designer consultants pragmatically select their suppliers and why the situation as is is so different from the situation as is.

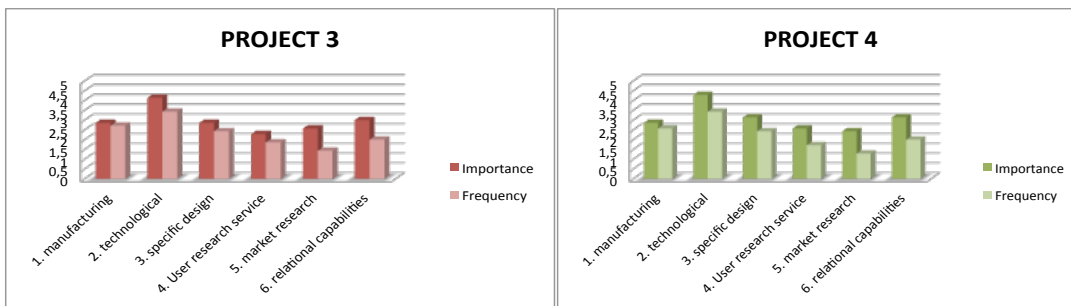
14.4 ITALIAN DESIGNERS

RQ 1. A and RQ2. A – IMPORTANCE and FREQUENCY of Supplier Capabilities In Projects



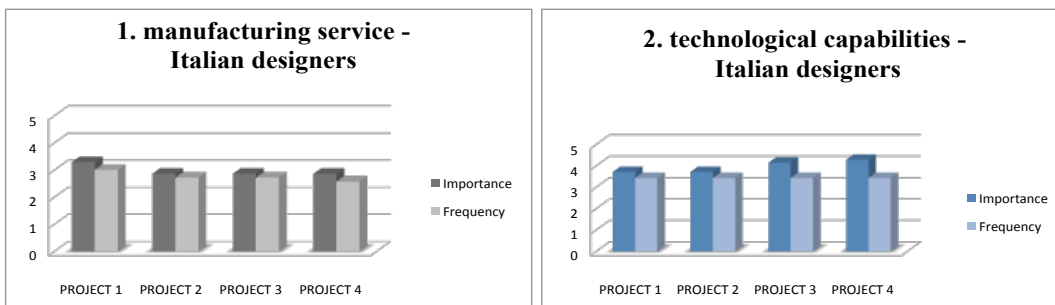
Graphic 63 - Importance vs Frequency for all capabilities in project 1 (Italian designers)

Graphic 64 - Importance vs Frequency for all capabilities in project 2 (Italian designers)



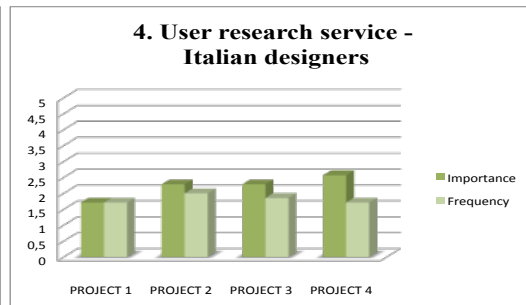
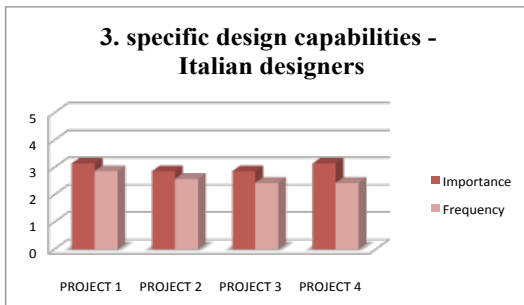
Graphic 65 - Importance vs Frequency for all capabilities in project 3 (Italian designers)

Graphic 66 - Importance vs Frequency for all capabilities in project 4 (Italian designers)



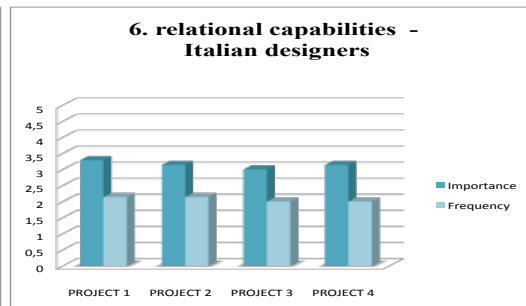
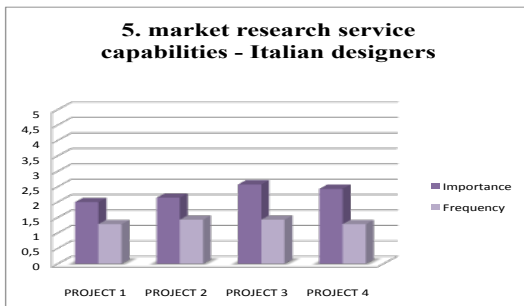
Graphic 67 - Importance vs Frequency for all projects in Manufacturing service (Italian designers)

Graphic 68 - Importance vs Frequency for all projects in Technological capabilities (Italian designers)



Graphic 69 - Importance vs Frequency for all projects in Specific design capabilities (Italian designers)

Graphic 70 - Importance vs Frequency for all projects in User research service (Italian designers)



Graphic 71 - Importance vs Frequency for all projects – Market research service (Italian designers)

Graphic 72 - Importance vs Frequency for all projects – Relational capabilities (Italian designers)

1) Progress of all capabilities in each project (graphics from 63 to 66)

Trend is the same for all projects:

- a. technological, specific design, relational capabilities and manufacturing service capabilities are crucial in terms of importance and frequency;
- b. user and market research are not considered that important

For adaptive projects, user and market standard deviation is low. In project 1 and 2, in terms of frequency, market research service has the lowest standard deviation value.

This means designers agree about their level of importance.

In innovative projects, standard deviation values are high. Designers gave varied marks to the importance and frequency of capabilities.

Bivariate analysis

According to Italian designers, there's a high correlation between manufacturing service and relational capabilities in frequency and importance, in all projects. This is due to the fact that Italian designers look for suppliers who can make physical changes to existing products.

Market and relational capabilities are highly correlated in frequency and importance of innovative projects (projects 3 and 4). They are projects with high innovative and creative contents. Designers need information about market responses to innovative products.

User research service seems to be important to projects 3 and 4 but designers don't use it in practice.

2) Single capability in all projects (graphics from 67 to 72)

Manufacturing service is more important in product improvement where physical changes are required. Frequency levels are slightly minor than importance levels as we expected. Technological values have growing importance from adaptive to innovative projects.

It corresponds to what we expected since technology is positively linked to innovativeness.

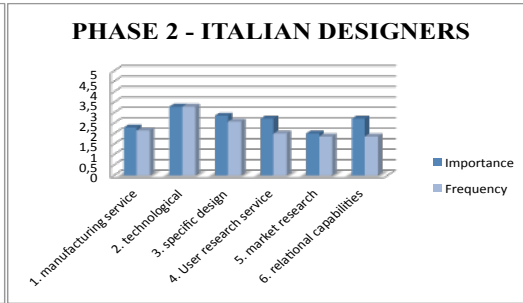
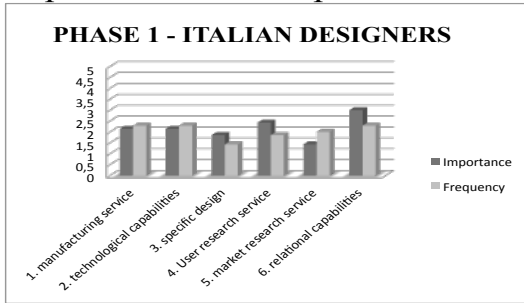
In innovative projects, misalignment between importance and frequency is great: frequency levels are the same for all projects. Therefore, we can claim that designers do understand the crucial role of technology in projects but they fail to imply them. Specific design capabilities have medium average values. They are more important in product improvement and the most innovative project despite our expectation.

User and market have similar average values, despite different trends.

Graphics on capabilities help to identify which type of capability is the most important.

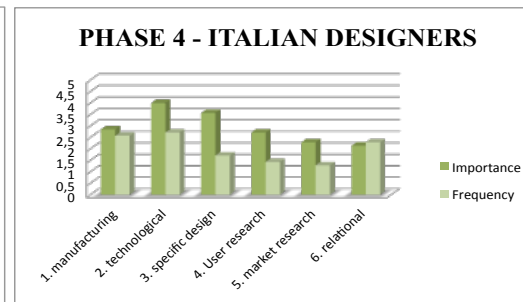
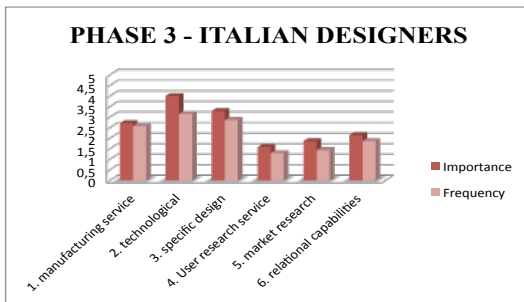
1. Technological, specific design and relational capabilities have high average values;
2. User and market research services have lower average values.

RQ 1. B and RQ2. B – IMPORTANCE and FREQUENCY of Supplier Capabilities in PDD phases



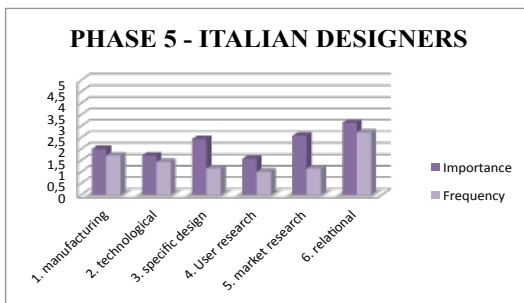
Graphic 73 - Importance vs Frequency for all capabilities in Phase 1 (Italian designers)

Graphic 74 - Importance vs Frequency for all capabilities in Phase 2 (Italian designers)

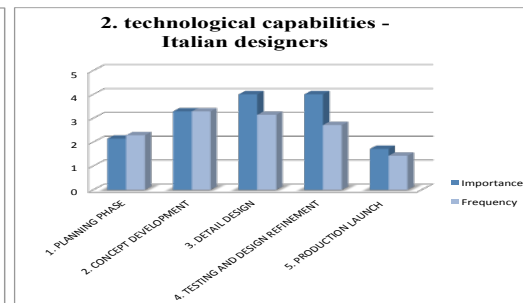
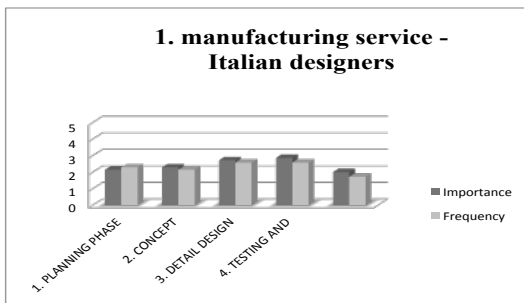


Graphic 75 - Importance vs Frequency for all capabilities in Phase 3 (Italian designers)

Graphic 76 - Importance vs Frequency for all capabilities in Phase 4 (Italian designers)

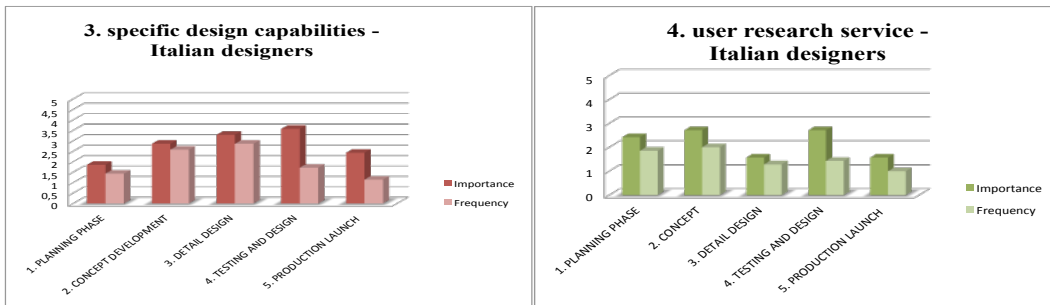


Graphic 77 - Importance vs Frequency for all capabilities in Phase 5 (Italian designers)



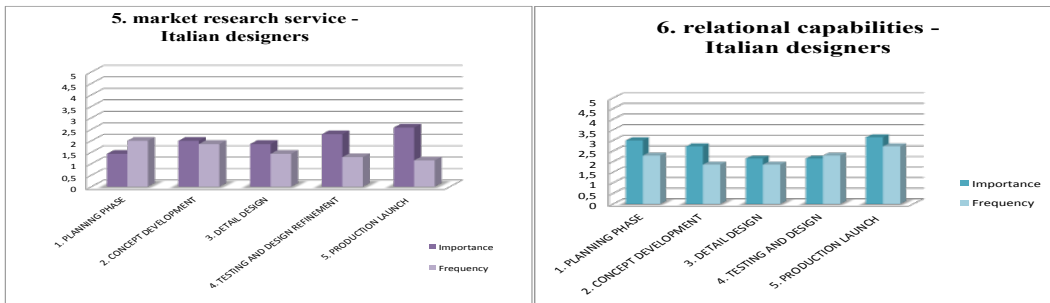
Graphic 78 - Importance vs Frequency for all Phases in Manufacturing service (Italian designers)

Graphic 79 - Importance vs Frequency for all Phases in Technological capabilities (Italian designers)



Graphic 80 - Importance vs Frequency for all Phases in Specific design capabilities (Italian designers)

Graphic 81 - Importance vs Frequency for all Phases in User research service (Italian designers)



Graphic 82 - Importance vs Frequency for all Phases in Market research service (Italian designers)

Graphic 83 - Importance vs Frequency for all Phases in Relational capabilities (Italian designers)

1) Progress of all capabilities in each phase (graphics from 73 to 77)

Designers have difficulties in identifying the most important capabilities in planning and production launch phases.

In planning phase, average values are low while standard deviation is high, stressing the fact that the theoretical phase needs to be thoroughly analyzed.

In production launch phase, relational capabilities are the most important.

Concept development phase has higher average values. As we expected, designers gave more importance to technological and specific design capabilities.

Detail design and testing and design refinement phases are very similar, since manufacturing, technological and specific design capabilities are crucial, while the other capabilities have lower averages.

Bivariate analysis

Phase 1

In terms of importance and frequency, manufacturing and technological / manufacturing and specific design capabilities have high correlation: Italian designers consider important to assess manufacturing suppliers' abilities with respect to their technical capabilities. In terms of importance, manufacturing and relational capabilities are not much correlated.

Phase 2

It is not possible to draw a parallelism between correlation importance and frequency.

In terms of importance, the following three couples have low correlation levels:

- - manufacturing and user research service
- - market and technological capabilities
- - market and specific design capabilities

The reasons are related to concept design activities. They consist of technical and prototype feasibility tests: market and user research service are not crucial with respect to technical abilities. As graphic below assesses, user research service has been utilized in planning phase.

In terms of frequency:

- * manufacturing and market service are highly correlated
- * specific and relational are negatively correlated
- * specific and user have a low correlation

Academics must analyse these correlations.

Phase 3

It is curious that specific design and market / specific design and relational capabilities have a low correlation in importance, but they are even negatively correlated in frequency. We did expect the opposite. The detail design phase requires suppliers willing to help and advice designers with specific design requirements.

Moreover, manufacturing and user research service are correlated in a phase where manufacturing is not required.

Phase 4

Opposite conclusions can be drawn from the correlation analysis. Specific design and user research service have a high correlation in importance (what we expected) but a negative correlation in frequency: academics should advice designers about the crucial role of understanding user needs when undergoing design activities. Meanwhile, designers select suppliers willing to share technological advice in this phase. However, specific design capabilities seem not to be correlated with relational capabilities.

Phase 5

Technological and market / user research service are correlated in importance but they are not utilized together. This last phase consists of physical production: academics should advice designers on the necessary to involve suppliers with technical abilities and capabilities to understand the market.

2) Single capability in all phases (graphics from 77 to 83)

Technological and specific design capabilities have the highest average values.

The other capabilities have lower average levels, included relational capabilities. Manufacturing service is more important in detail design and testing and design refinement phases, where design, preparation and testing of prototypes are fundamental.

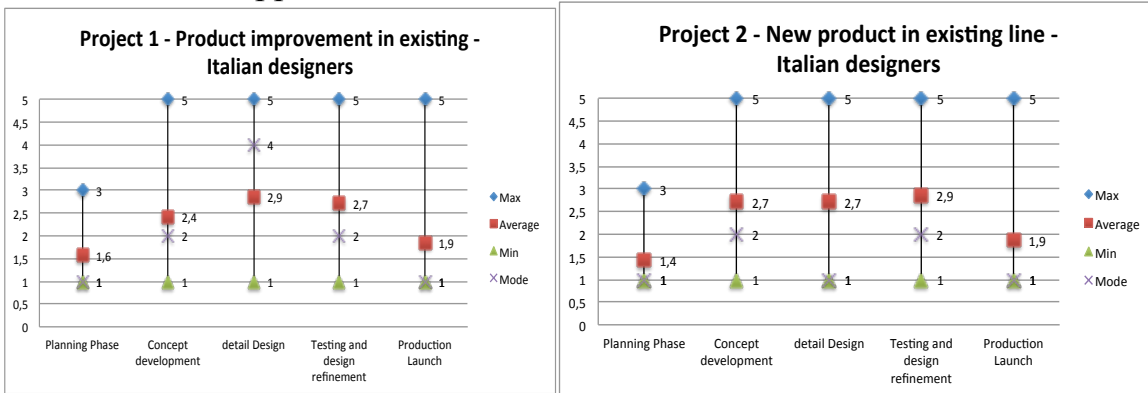
User research service seems to be more important in concept and testing and design refinement where user's remarks are necessary to validate what has been designed.

Specific design capabilities are important in the central project phases.

Relational capabilities, opposite to what we expected, are important in phase 1 and 5.

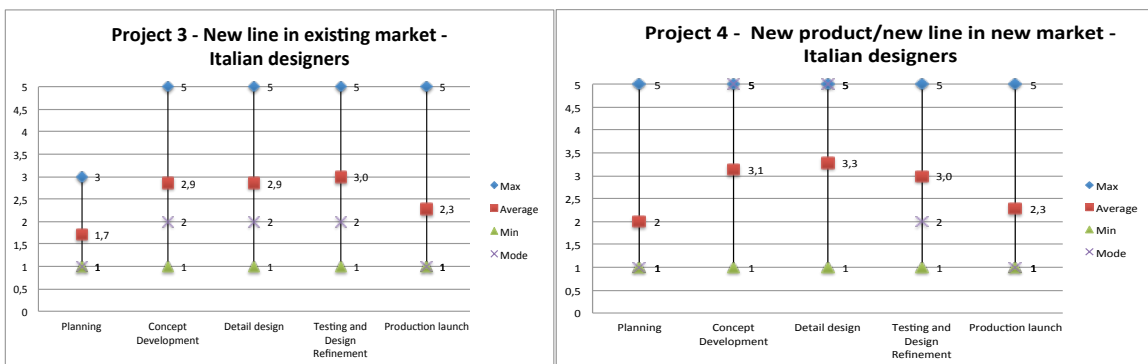
Opposite to expectations, market research service is important in testing and design refinement and production launch phases.

RQ 3. HOW - supplier involvement in PROJECTS and PHASES



Graphic 84 – Level of supplier involvement in all phases for project 1 (Italian designers)

Graphic 85 – Level of supplier involvement in all phases for project 2 (Italian designers)

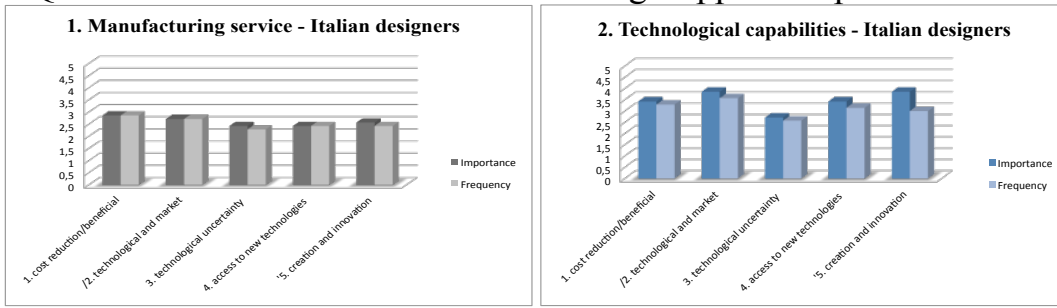


Graphic 86 – Level of supplier involvement in all phases for project 3 (Italian designers)

Graphic 87 – Level of supplier involvement in all phases for project 4 (Italian designers)

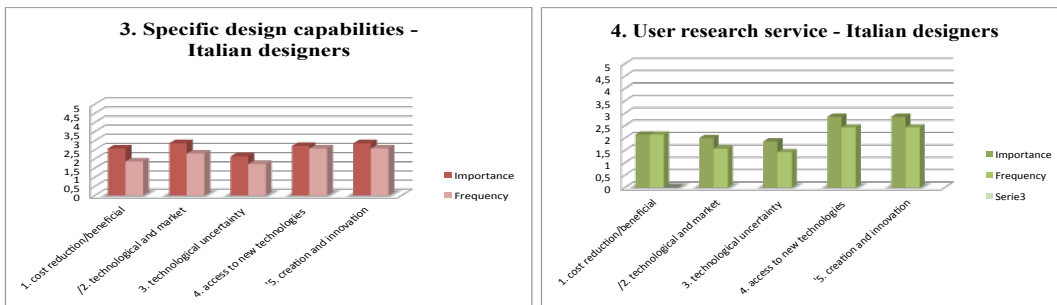
As we can notice from suppliers, Italian designers mainly don't involve suppliers in planning phase, except for the most innovative project (project 4). Ranges go from 1 to 3, the mode is 1 and average values are low.

RQ 4. A and B - Motivations For Selecting Supplier Capabilities



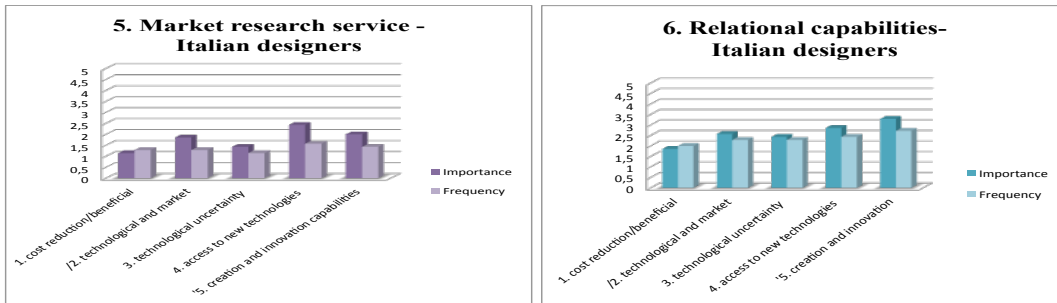
Graphic 88 - Importance vs Frequency of all motivations in Manufacturing service (Italian designers)

Graphic 89 - Importance vs Frequency of all motivations in technological capabilities (Italian designers)



Graphic 90 - Importance vs Frequency of all motivations in Specific design capabilities (Italian designers)

Graphic 91- Importance vs Frequency of all motivations in User research service (Italian designers)



Graphic 92 - Importance vs Frequency of all motivations in Market research service (Italian designers)

Graphic 93 - Importance vs Frequency of all motivations in Relational capabilities (Italian designers)

Graphics above represent the reasons for choosing manufacturing service. According to us, Italian designers do not have a proper idea about the motivations for selecting suppliers with manufacturing service, since all the reasons have similar average values.

Moreover, market research service motivations have lower average values than manufacturing.

Designers don't realize the role of market research services.

However, Italian designers are conscious about the primary reasons for deciding to involve suppliers with technological capabilities and relational capabilities.

Specific design capabilities are mainly involved because of creation and innovation capabilities and technological and market research expertise.

User research services are primary important because of access to new technologies and creation and innovation capabilities. User research service makes designers and suppliers look for new and emerging technologies.

Chapter 14 presented an exhaustive univariate and bivariate analysis of collected data. We conducted three separate analyses:

- all designers
- English designers
- Italian designers

The analysis was presented with graphics that show:

- the alignment (or disalignment) between importance and frequency of capabilities in each project
- the alignment (or disalignment) between importance and frequency of all projects for each capability
- the alignment (or disalignment) between importance and frequency of capabilities in each phase
- the alignment (or disalignment) between importance and frequency of all phases for each capability
- the level of supplier involvement in all phases of all projects
- the alignment (or disalignment) between importance and frequency in each capability for all motivations

We explained the graphics for all analyses, in order to identify the characteristics to associate to each analysis.

The table below presents the main results of data analysis.

	ENGLISH DESIGNERS	ITALIAN DESIGNERS
RQ 1 and RQ 2	<p>a. Trend is the same for all projects, despite different average values: technological, relational and specific design capabilities are the most important and utilized (alignment between importance and frequency)</p> <p>b. Great misalignment between importance and frequency for specific design capabilities (in adaptive projects) and user research service in all projects</p> <p>c. Increasing value of all capabilities with respect to innovation level (except for manufacturing)</p> <p>d. Great misalignment between importance and frequency of capabilities in phases</p> <p>e. Relational capabilities are fundamental in planning and production launch</p> <p>f. Technological, specific design and relational capabilities are fundamental in concept development, detail design and testing and design refinement</p>	<p>a. Trend is the same for all projects: - technological, specific design, relational capabilities and manufacturing service are crucial in terms of importance and frequency; - user and market research are not considered that important</p> <p>b. Manufacturing service is more important in projects where physical changes are required</p> <p>c. Great misalignment between importance and frequency in technological and relational capabilities</p> <p>d. Designers have difficulties in identifying the most important capabilities in planning and production launch phases.</p> <p>e. Manufacturing, technological and specific design capabilities are crucial in detail design and testing and design refinement</p>
RQ 3	<p>a. Ranges of involvement level are narrow for all projects: English designers recognize the differences in supplier involvement according to the different phases of each project</p> <p>b. Innovative projects have narrower ranges: English designers have proper ideas about the importance of supplier involvement in projects where many information and specific competences are required</p>	<p>a. Italian designers don't agree about the level of supplier involvement in phases of project: they ranked each phase from 1 to 5</p> <p>b. Italian designers recognize the supplier role in planning phase of each project: they ranked from 1 to 3, showing that at most they co-design items with suppliers but they don't involve them in process co-design or in joint co-design</p>
RQ4	<p>a. A great misalignment between importance and frequency in all motivations for choosing each supplier capability</p> <p>b. Technological capabilities are chosen for all reasons</p> <p>c. Specific design capabilities are important for all the reasons but designer pragmatically select them for their creation and innovation characteristics</p>	<p>a. Great alignment between frequency and importance in motivations for choosing manufacturing service</p> <p>b. Technological and relational capabilities are mainly chosen because of creation and innovation needs</p>

15. RESEARCH QUESTIONS: DISCUSSION

It consists of a comparison among all, English and Italian designers, following the same analysis structure shown in chapter 13. The chapter aim is to identify similarities and differences among designers.

The chapter is organized according to the Research Questions:

- 15. 1 RQ1. A and RQ2.A – IMPORTANCE and FREQUENCY of Supplier Capabilities in Projects
- 15. 2 RQ1. B and RQ2.B – IMPORTANCE and FREQUENCY of Supplier Capabilities in PDD phases
- 15. 3 RQ 3. HOW - supplier involvement in PROJECTS and PHASES
- 15. 4 RQ 4. A and B – IMPORTANCE and FREQUENCY of Supplier Capabilities in Projects

Each paragraph contains comparisons among designers with respect to the correspondent research question.

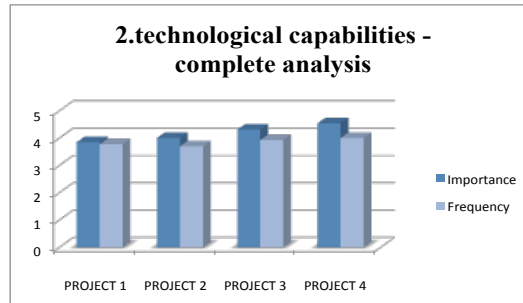
15.1 RQ 1. A and RQ2. A – IMPORTANCE and FREQUENCY of Supplier Capabilities In Projects

In general, industrial designers consider technological, specific design and relational capabilities as the most important in all projects.

It is curious to underline that two of the hardest capabilities (technological and specific design) and the softest capability (relational) cooperate together to product performance.

Designers claim that suppliers willing to collaborate can make the difference when involved in product design development. They help to reduce project time and they give suggestions to designers.

In general, an industrial designer should present a graphic like the following in terms of technological importance and frequency. Technological capabilities have the highest average values, which increase according to the level of project innovation. The difference between importance and frequency are due to designer maturity.



Graphic 94 – Importance vs Frequency of all projects in technological capabilities (all designers)

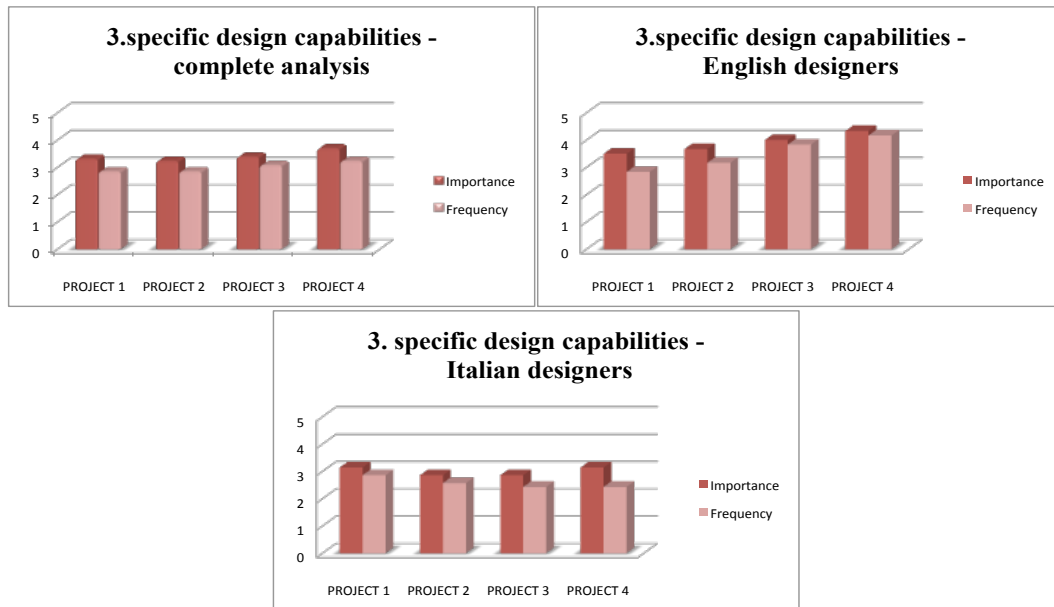
English designers give greater marks to technological capabilities, with respect to the complete analysis. This is linked to their project nature.

Italian designers marked lower values to technology importance. Moreover, they gave lower values to frequency. The reason is contained in Italian industrial design characteristics: they undergo very different types of projects, with various technological contents. Their marks are an average of the divergent projects they are asked to follow.

Analysis of data collected from English designers shows the same trends as the complete analysis in capabilities vs projects. However, average values about technological, specific design and relational capabilities are higher than in the complete analysis.

The reason is that English designers recognize the importance of hard and soft issues in projects. English industrial designers deal with electronic, biomedical and mechanical devices. They mostly cope with similar types of projects, where technology expertise and specific design abilities are the major requirements.

As we can notice from graphics below, specific design capabilities have different trends with respect to the design nationality.



Graphic 95 – Importance vs Frequency of all projects in specific design capabilities (all designers)

Graphic 96 – Importance vs Frequency of all projects in specific design capabilities (English designers)

Graphic 97 – Importance vs Frequency of all projects in specific design capabilities (Italian designers)

The complete analysis suggests a growing average value from adaptive to innovative projects. The innovation level influences designer's need for specific design capabilities. This is especially true for English designers. Their projects require CAD and graphic designs, mold flow, etc. Specific design capabilities are very important to them. English designers, who take over innovative projects, have the maturity to exploit specific design capabilities (frequency and importance values are very similar).

On the contrary, Italian designers don't acknowledge the specific design importance in projects. Italian designers consider specific design capabilities as their core-competences: they are not willing to collaborate with other actors. However, frequency levels have similar values, while importance values show that Italian designers consider product improvement and new product/new line in new market projects as more in need of specific design capabilities.

Academics ought to investigate the reasons for specific design capabilities being more important in product improvement.

Moreover, user and market research services maintain a secondary importance with respect to manufacturing service in all projects.

Referring to user and market research services, industrial English and Italian designers gave them low values in adaptive projects (product improvement and new products in existing line). The reason is that interviewed designers had difficulties in understanding user and market research service meaning and role in projects since they can't be defined as hard or soft, having qualitative and quantitative aspects concurrently.

However, despite their inability to exploit those capabilities, designers seem to recognize user and market research potentialities in highly innovative projects (new line in existing markets and new product/line in new market).

With respect to all, English and Italian analyses, user research service becomes more and more important and utilized according to the level of innovation. Nonetheless, in spite of importance high values, frequency is low. The reason is that despite designers are willing to select suppliers with user expertise, they are currently doing user research in-house or outsourcing it to research agencies. English trend is similar to the complete analysis trend, with different values. English designers are experiencing user research in suppliers. They recognize user research service importance but they have difficulties in putting it into practice.

Italian graphic shows the difficulties of understanding user research service in suppliers. They are used to manufacturing suppliers.

As for the complete analysis, English graphics show that user and market research services are more important and utilized in innovative projects, where the level of innovation is high and designers need information about what users look for and what the market is calling for.

Referring to the hardest capability (manufacturing service), we can notice that in the complete analysis, they present low importance and frequency values. Manufacturing service presents low importance and frequency values in all projects for complete, Italian and English analyses. According to English designers, manufacturing service has the same importance in all projects (average value is the same as in the complete analysis). Nevertheless, utilization frequency increases from adaptive to innovative projects. The higher the innovation level is, the more English designers exploit manufacturing service.

Italian designers show the same level of importance and frequency in all projects, except for

product improvement project (project 1), whose importance and frequency are slightly higher than the others. As a matter of fact, according to Italian designers physical changes are more necessary in product improvement.

In all projects, we identified misalignment between importance and frequency: they are due to designer maturity. A mature designer has expertise, competence and structured practices. He is able to put advanced tools in practice and to exploit capabilities whose nature is both quantitative and qualitative. This concept is backed by data: great misalignments between importance and frequency are noticed in user and market research services.

For Italian designers, misalignments in relational capabilities are consequences to negative experience. All designers do perceive relationship importance, meanwhile they have sometimes experienced suppliers unable to relationships.

Italian designers fail to involve soft capabilities in a supplier-designer relationship. The reason is that most of the interviewed designers collaborate with their client's suppliers but they don't select suppliers by themselves. They are not responsible for supplier selection: they can't include soft issues in supplier criteria. In addition, they consider suppliers as mainly manufacturers.

English designers claim that relational capabilities constitute a driver for performing products. Jones and Camerlengo hold: "relational capabilities are always important. Human compatibility is fundamental." And "If I don't have a good relation with a supplier, my client will not act a good product, a good design." "Quality of relation leads to quality of product/project means. Quality of relations is related to the better final quality and better quality price ratio.

A quality product needs so many entangled bricks. These bricks are results to good relationships along the supply chain (designers, shareholders, stylists, suppliers, etc)".

Analysis of data collected in Italy, reveals different conclusions. Technological and relational capabilities are still the most important but their values are lower.

Italian designers don't utilize structured procedures when dealing with suppliers in PDD projects. By contrast, English designers gave very high and very low marks, suggesting that they have a consolidated practice for supplier involvement. Italian and English designers were contacted because of their membership of national design directory websites. Both groups

consist of industrial and engineering designers. However, some differences can be drawn. English interviewees mainly deal with technological and engineering devices. In reverse, Italian industrial designers cope with a wide range of projects. (See Cambridge Industrial design vs Dameno in appendix to identify the difference).

In order to produce a visual differentiation we can draw the following ranks. It means that in practical terms, Italian and English designers have different needs.

English analysis in each project, in terms of frequency:

- technological capabilities
- relational capabilities
- specific design capabilities
- manufacturing service
- user and market research services

Italian analysis, in each project, in terms of frequency:

1. technological
2. manufacturing – specific design capabilities
3. relational capabilities – user research service
4. market research service

15.2 RQ 1.B and RQ2.B – IMPORTANCE and FREQUENCY of Supplier Capabilities in PDD phases

Key points:

- * In planning phase for complete, English and Italian graphics – user and relational capabilities are the most important. It is the ideation phase, where designers need to have create a relationship with suppliers, they have to start working together and understanding each other. In addition, they need information about what changes/new product types are required by users.
- * Technological, specific and relational capabilities are the most important and utilized in

detail design phase of all designers. As we expected, hard and soft capabilities coexist to create innovative and competitive products.

- * All designers agree that in production launch, relational capabilities are the most important. Designers and suppliers run together to produce in time and in quality innovative products. They must have a good relationship.

Michele Camerlengo claims that relational capabilities are chosen to get benefits such as communication celerity, communication clearness and communication reliability: they lead to cost reduction.

In all phases, despite designers recognize hard capability importance, frequency levels are low. They are not used to jointly design and develop products with suppliers. They can call for advice, ask for feasibility, but they are not used to make suppliers part of the process. We can notice it also in English and Italian graphics.

In the complete analysis, technological and specific design capabilities show the same importance and frequency:

- trend medium average values in planning phase and production launch phase which are respectively the preparatory and final phases. The former consists of ideation and identification of which capabilities are required while the latter consists mainly of production.

In those phases, technology and specific design capabilities are less necessary.

- * high values in central phases: concept development means technological feasibility; detail design needs 3D, CAD and other specific design capabilities; testing and design refinement require accuracy. Those phases are mainly in need of hard capabilities that give form to products.

Complete, English and Italian designers analyses agree on technological capability trends in terms of importance. Hard capabilities are considered the most important.

In planning and concept development phases for English designers, technological importance values are much higher than frequency. English designers prefer to involve suppliers in the following phases, holding that planning phase and concept development phase are designer's responsibility. This is linked to the fact that in concept development phase relational

capabilities are considered important but not much utilized.

Despite frequency trends are the same for all designers, specific design capabilities have different importance trends in English and Italian graphics, compared to the complete analysis. While English designers consider specific design as a preliminary requirement, Italian designers involve it mainly in the last phases, holding it as refinement activity.

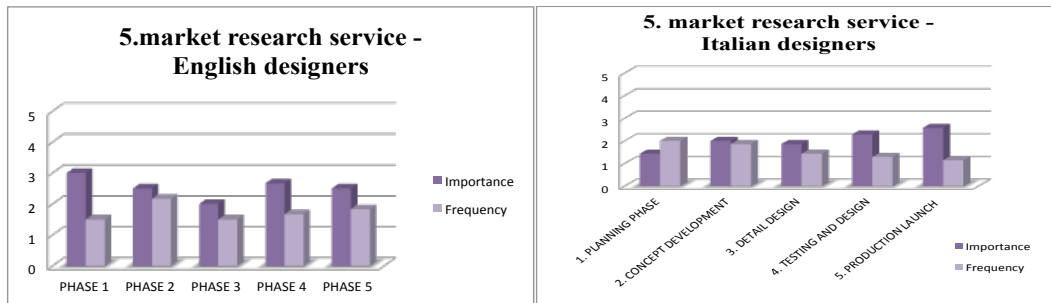
When mentioning manufacturing service, English designers hold it is more important in production launch, where product manufacturing is necessary.

Italian designers present the same trend as the complete analysis. Moreover, manufacturing service is not considered important or utilized in production launch phase. We can claim that Italian designers didn't understand the real value of these capabilities in PDD phases.

User and market research service graphics confirm that designers are not used to joint design and development . Jones claim “user and market research are designer’s responsibility ”. Therefore, importance trend is different from frequency trend. User research service has the highest importance value and the lowest frequency value in detail design phase. Detail design phase would benefit from supplier’s user expertise and research capabilities but designers are not willing to let them in. Academics should spread the awareness and necessity for involving suppliers in the user research.

Frequency values are shared by all designers, since user research service is more utilized in:

- * concept development: user information can help define what is necessary
- * planning phase
- * refinement
- * detail design
- * production launch



Graphic 98 – Importance vs Frequency of all phases in market research service (English designers)

Graphic 99 – Importance vs Frequency of all phases in market research service (Italian designers)

English market research graphic shows a greater importance in testing and design refinement and production launch. While it is true that market information are necessary in production launch, where designers need to be conscious of market requirements and trends, it is not the same for phase 4.

Frequency levels in testing and design refinement and production launch (phases 4 and 5) back different thesis: market research service is low in frequency values since it is not fundamental in phase 4; it is low in phase 5 since designers think the phase doesn't need supplier market service.

However, Italian designers present a different trend. Market research service is considered less important and is less utilized (low average values). Moreover, market research service is more important in testing and production launch while it is more utilized in phase 1 and 2. Academics should investigate the reasons for this divergence.

In general, soft capabilities have similar high importance and frequency values. Planning phase requires more relational attitude (importance value is the highest). Frequency values are similar, except for concept development phase. Some designers misunderstood this phase meaning. They didn't refer it to feasibility but to ideation and creation. Therefore, they thought it was self-made phase.

However, the concept development phase requires supplier advice not to waste time and prototypes in the following process phases.

According to Italian and English designers, relational capabilities have different trends.

Despite relational graphic shows high values, English designers hold relational capabilities are

more important in detail design phase. English designers give more importance to this phase, according to their project nature. By contrast, Italian designers give more importance and utilize more relational capabilities in phases 1 and 5. It is what we expected since phase 1 and 5 are the beginning and the conclusion phases so they call for more cooperation and collaboration by both parts.

As shown in the complete analysis, both English and Italian designers misunderstood the concept development meaning.

15.3 RQ 3. HOW - supplier involvement in PROJECTS and PHASES

Average values follow the same trend:

- low supplier involvement in planning and production launch phases
- peak in detail design phase

Academics ought to increase studies in this direction: they should analyse the reasons why external industrial designers have difficulties in making suppliers part of the supply chain.

Italian graphics show ranges from 1 to 5 and have the same trend as the complete analysis, with lower average values.

15.4 RQ 4. A and B - Motivations For Selecting Supplier Capabilities

Questions in table 3.5 of the questionnaire are created to investigate reasons for choosing each capability in suppliers.

Except for Italian designers who gave higher marks to cost reduction and technological and market expertise, we can claim that designers don't know exactly why they choose suppliers

with manufacturing service.

Italian designers are used to collaborate with manufacturing suppliers in order to obtain cost reduction with technological refinements and changes.

Complete, English and Italian analyses show the same average values with respect to importance and frequency. Academics should help designers in putting more attention about the reason for choosing suppliers in order to gain competitiveness.

Italian and English designers chose technological capabilities for different reasons. English designers want to minimize delays or errors due to new or forthcoming technologies, whose characteristics are not known. Suppliers with technological expertise can minimize technological uncertainty.

Italian designers are more focused on creation and innovation capabilities and technological and market expertise. This is due to Italian project nature. Italian designers are always looking for appealing ideas that can bring innovation on the market.

While English designers select suppliers with a strong relational attitude for all the reasons, Italian designers select them for accessing new technologies and creation and innovation capabilities.

16. RESEARCH QUESTIONS: CONCLUSIONS

Chapter 16 summarizes Part 3. It describes the methodology and steps to answer the research questions and presents the main results obtained through data analysis.

Part 3 presents the questionnaire and how to investigate it.

This part is focused on external design consultancies and their necessity to identify structured practices to involve suppliers in delivering innovation to clients.

“The purpose of this research is to understand how UK and Italian design consultants utilise supplier capabilities to enhance their product design and development activities in order to deliver differentiated innovation to their clients. Our objective is to develop tools that designers can adopt to improve the use of supplier capabilities in their key Product Design and Development activities.” (questionnaire, Appendix 2)

Designers and suppliers are linked by supplier capabilities, therefore suppliers can be described according to their abilities and competences.

We identified a tool to investigate the characteristics of supplier-designer relationship: a questionnaire with qualitative and quantitative questions about supplier capabilities. Ulrich and Eppinger claim that designer’s work is divided into projects and each project is constituted of phases. Therefore, we need to examine supplier capability importance and utilization in different projects and different phases of the design and development process.

Supplier capabilities have been identified in the second part of the thesis. Literature review, forum, group and individual interviews brought to a list of capabilities that designers consider necessary when selecting suppliers. Most designers hold soft capabilities must be considered as crucial as hard issues when selecting and evaluating suppliers. Therefore, we decided to identify a capability classification according to the degree of measurability:

1. Manufacturing service (the hardest)
2. Technological capabilities
3. Specific design capabilities

4. User research service
5. Market research service
6. Relational capabilities (the softest)

However, the list is simply a theoretical exercise: supplier capabilities deserve to be validated by external design consultants through a semi-quantitative questionnaire. In particular, this research wants to assess soft capability significance in supplier selection and supplier involvement.

“What do external design consultants seek for when selecting suppliers? When do they involve suppliers? Why do they involve supplier capabilities?”: the questionnaire objectives are manifold.

The first objective is to determine what supplier capabilities are considered important in the different types of projects (categorized according to the innovation level) and PDD phases. This is crucial to identify the best practices, as to say, the situation “to be” which is often divergent from the “state of the art”. The situation “as is” is recognized through a variable called “frequency”, while the situation “to be” is related to “importance”. Designers have to mark supplier capability utilization and importance on a scale from 1 to 5.

In order to identify the “best practice”, we analysed the alignment between importance and frequency.

A parenthesis about data collection is necessary. Data have been accumulated both from English and Italian designers, listed in the national design directory website.

To be exhaustive in the investigation, our analysis is twofold. Firstly, we analysed individually complete, Italian and English data. Secondly, we made comparisons among complete and national analyses.

After identifying what type of capabilities are important and frequently utilized in each project and phase, we need to comprehend what is the reason for designers to selecting and involving suppliers in their product design and development process. Again, questions are twofold in order to individuate the situation “as is” and the situation “to be”.

Finally, academics and experts are calling for information about supplier involvement. They

want to point out the level of involvement according to which designers imply suppliers in the different phases of each project.

The questionnaire was completed by 13 practitioners: 6 English and 7 Italian designers.

Seven questionnaires were followed by semi-structured interviews.

Quantitative data were used to improve the questionnaire or to have information about designer practices. You can find transcripts of the interviews in the appendix.

Qualitative data were investigated through univariate and bivariate analyses, whose discussion have been reported in this part of the thesis.

Therefore, some important conclusions can be drawn.

In general, industrial designers consider technological, specific design and relational capabilities as the most important in all projects. However, a difference can be established. English and Italian external designers follow different project typologies: Italian designers undergo projects with various technological contents while English designers mainly undertake technological and mechanical projects. Therefore, English designers give greater values to technological capabilities, with respect to Italian designers. Italian designers follow different typologies of projects with various technological contents. Meanwhile, English industrial designers are focused on a narrow range of projects with high technological contents.

English trend is the same as the one for the complete analysis, despite importance-frequency misalignments are lower.

English and Italian analyses bring to the same conclusions with respect to *Research Question 1. WHAT supplier capabilities are designers looking for, in the product design and development process?* and *Research Question 2. WHEN do designers involve supplier capabilities in the product design and development process?*

- 1) External designers look for technological, specific design and relational capabilities in all projects.
- 2) User, market and manufacturing services have different importance and frequency according to project nature. Manufacturing is more important than user and market in all projects, except for new product/new line in new market, where designers need

information about market and user responses with respect to the launch of radically new products.

- 3) User is more important than market research service in all projects.
- 4) As Jones and Camerlengo claim, relational capabilities are cross- functional attitudes, crucial to the success of products. This is the reason why relational capabilities are in the front-end in terms of importance and frequency.
- 5) In planning phase, client, designer and supplier need to agree strategies for the project: they need to share the same objectives and vision. Opposite to expectations, designers use manufacturing, specific design and market research service, without realizing their importance. This observation is important to the goal of identifying suggestions for external designers. Academics' responsibility is to increase the awareness of capabilities importance in phases.

Graphics utilized for Research Questions 1, 2 and 4 are not suitable for Research Question 3 that refers to supplier involvement. Since each mark corresponds to a specific level of involvement, graphics show ranges, average values and modes which give crucial information about the how English and Italian designers involve suppliers in each phase of the PDD process.

The main results with respect to Research Question 4 are:

- English designers don't recognize the reasons for choosing supplier with manufacturing service (average values are the same for all reasons)
- Misalignment between importance and frequency for English and Italian designers since they don't have properly in mind the reasons for choosing supplier capabilities. Academics should help industrial designers in achieving awareness of the motivations for involving suppliers
- Italian and English designers choose technological capabilities for different reasons: English designers want to minimize delays and errors while Italian designers are mainly focused on creation and innovation capabilities

Misalignment between importance and frequency is due to designer maturity. Designers with a high maturity level present alignment between frequency and importance values.

They possess experience and competences in order to put in practice what they considers crucial to competitiveness.

Feedback form qualitative and quantitative analyses are crucial to identify designer best practices and to give designers suggestions about how to select and involve suppliers within their supply chain.

Our quantitative analysis is a first attempt to investigate designer-supplier relationships in order to describe innovation drivers.

Chapter 16 presents a summary of Part 3. It reportes the methodology utilized to identify the six supplier capabilities (manufacturing service, technological capabilities, specific design capabilities, user research service, market research service and relational capabilities). Moreover, it reassumes the main results of data analysis, outlining that technological and relational capabilities are important and utilized in all projects and phases by both Italian and English designers. It also offers an explanation about the reasons why research question 4 is shown with different graphics. Finally, it provides information about the motivations for industrial designers to select suppliers.

Some important conclusions are:

- all industrial designers consider technological and relational capabilities as the most important in all projects and phases
- English and Italian industrial designers carry out projects that are different in nature: English designers mainly follow technological projects while Italian designers take over different various projects with different technology contents
- Italian designers fail to involve soft capabilities in a supplier-designer relationship
- Italian desigenrs don't utilize structured procedures, when dealing with suppliers

FINAL CONCLUSIONS

Final conclusions present a summary of the thesis contents. It explains the reasons for choosing the thesis topic, the main goals and methodologies to achieve them.

Moreover, it offers an overview on the research contributions and main limitations of this thesis.

The final conclusions consist of 3 chapters:

Chapter 17. Discussion and Conclusion

Chapter 18. Research Contribution

Chapter 19. Applicability and Generalization

Chapter 20. Limitations

17. DISCUSSION AND CONCLUSION

Chapter 17 sums up introduction, Part 1, Part 2 and Part 3 of the thesis.

This thesis project is titled “Understanding the role of design within the supply-chain.”

The existing literature isn’t interested in the strategic role of design in industry.

Designer’s point of view is not taken into account. Despite this fact, design has a key role for British companies, as Sir George Cox underlines. How is design value delivered to the companies, manufacturers and managers?

According to Luca Di Filippo (an Italian designer who worked for Foster and Partners; he actually lives in London), “the chain of competence can make the difference”. Suppliers and designers working together to reach a common goal are the winning strategy. How can they create a successful team? What are the characteristics suppliers and designers need to enhance innovation?

This research starts from the interest in understanding how design can manage its relationships with clients and suppliers to deliver highly innovative products.

Design is a key activity that could be conducted directly in house from companies or, according to the concept of ‘open innovation’ (Chesborough), could be brought to firms through external sources. Design consultants are a main source of design ideas. Chris Woodward (CWD agency, London) believes firms are strongly focused on their internal process so to be nearly narrow-minded. External design consultants are crucial to enhance innovation.

Studying the role of design within the supply chain is necessary to understand the reasons for the strategic position of design.

Innovation is the key word to this analysis. This research takes into account the external consultancy point of view and goes deeper into discovering the relations between designers and suppliers.

The research is focusing on external design consultants that deliver innovation to the supply chain. They use their activities, proficiencies and capabilities to innovate products. In particular, the analysis focus is on industrial and engineering designers.

The objective of this thesis is to identify the characteristics of supplier-designer relationships. The research questions originate from a logic and structured literature review. Ulrich and Eppinger offer a complete overview about the Product Design and Development process that designers undertake.

Some are the gaps identified in the existing scientific literature. From the gaps we can draw up key issues that are worth investigating.

The first key issue is related to the criteria external design consultants apply to appoint their suppliers. In most cases, design consultancies are focused on some specific core competences so they need suppliers to provide capabilities, services or goods. While the literature deals with plenty of criteria implemented by focus company in selecting and assessing suppliers, very little has been written on how a key actor of supply chain (design consultancy) take part in the process by naming its suppliers. The analysis splits up into two directions. The first stream of study is related to the typical design projects designers follow. It is of great interest to work out whether a casual relation exists between supplier capabilities sought for and projects handled. The second stream faces a deeper evaluation of practices, focusing on the phases of product design and development process.

Secondly, in order to create a framework, it is essential to investigate the point of the process where designers let suppliers in. According to the different stages of PDD process they are following, designers might decide to adopt different strategies when involving suppliers. This should be true according to the different projects as well.

The third issue is: what kind of collaboration suppliers offer to designers?

Finally, the advantages brought by involving suppliers in the design process are multiple.

A hypothesis of this research is the following: the motivations for selecting suppliers can be consequent to the typology of suppliers that designers are willing to contact.

Considering a supply chain perspective, the objective is recognizing the linkages between external designers and suppliers. The level of involvement represents either the weak or strong relations between the two entities.

The aim of this research is to provide managerial tools that can be used to create supplier selection strategies and to enhance the innovative power of a synergy between designers and suppliers.

Key issues are translated into research questions.

The basis of research questions consists of the concept of “supplier capabilities”.

They represent the criteria utilized by external design consultants during the supplier selection process. Supplier capabilities are identified through the crossing between designer requirements and criteria utilized by SC managers in the supplier selection.

The nature of supplier capabilities corresponds to the first clustering method. Therefore, they are classified from the hardest to the softest: manufacturing service, technological capabilities, specific design capabilities, user research service, market research service and relational capabilities.

The list of capabilities is just the first objective of our research project. We want to determine the supplier-designer relationship characteristics.

Therefore, we built a questionnaire addressed to external design consultants. Designers answered questions about the situation “as is” and the situation “to be” with respect to the supplier capabilities involved in the PDD phases of each project.

Phases and projects derive from Ulrich and Eppinger contribution. In addition, external designers were asked about the motivations for choosing supplier capabilities and the level of supplier involvement.

Collected data were analyzed and resulted in self-explanatory color-coded graphics.

The most important conclusion consists of the difference between Italian and English designers in terms of project and attitudes can be assessed. Italian industrial designers follow different types of projects with various technological contents while English industrial designers are mainly related to technological issues. Therefore, Italian designers look for aesthetical, creative innovation while English designers seek for technological discoveries.

Chapter 17 retraces the theoretical and empirical paths followed in this thesis. It summarizes the reasons for choosing external design consultants as thesis topic, the motivations for focusing on the difference between soft and hard capabilities and the research questions. Moreover, it goes deeper into the methodology and explains how we got to answer the research questions.

18. RESEARCH CONTRIBUTIONS

Chapter 18 describes the main contributions our thesis provides to the research.

Our research is aimed at filling in the gaps identified in the scientific literature with respect to design involvement in the supply chain. In particular, researchers failed to consider design consultant requirements and needs in terms of supplier selection.

The literature contains numerous papers about the criteria utilized by managers.

However, it lacks in developing the topic with respect to designers. Therefore, our first contribution to the research is the focus change. We paid attention on external design consultants, organizing interviews, forum and focus groups in order to determine their requirements and needs when selecting suppliers.

External designers work both with their client's suppliers or with their own suppliers.

When selecting their own suppliers, external designers look for "supplier capabilities". The recurring necessity for all interviewed designers is the relational capability. Designers decide to collaborate with suppliers willing to cooperate or co-design, sharing knowledge and information and the same vision.

Michele Camerlengo talks about "human compatibility". Therefore, we classified capabilities according to their measurability. They can be divided into soft and hard issues. This is our second contribution to the research.

Firm managers refer to "soft capabilities" but they didn't cluster supplier capabilities according to their measurability nature.

Our goal was to determine a list of criteria, i.e. capabilities easy to recognize and apply to the supplier selection process. Our third contribution corresponds to the list of supplier capabilities.

Our contribution to the research has a twofold nature.

The first is a theoretical contribution that corresponds to the determination of the concept of supplier capability and the identification of a record of supplier capabilities.

The second contribution is of empirical nature. In order to evaluate the supplier capabilities identified, we conducted an empirical investigation. It is the first attempt to describe the process of supplier selection and involvement followed by external design consultants.

We gave a questionnaire to external designers that resulted in important conclusions with respect to the capabilities utilized in each project or phase of the PDD process.

Chapter 18 presents this thesis contribution to research:

1. shift of focus in favour of external design consultants
2. identification of the difference between hard and soft selection criteria
3. list of supplier capabilities as criteria to be utilized by external design consultants in supplier selection

19. APPLICABILITY AND GENERALIZATION

Chapter 19 presents how the research results can be generalized and when they can be applied.

As presented in the questionnaire, our goal is to develop tools that designers can adopt to improve the use of supplier capabilities in their key Product Design and Development activities.

We classify external design consultants in three groups:

- a) UNAWARE DESIGNERS: designers who are not aware of supplier role within SC
- b) AWARE DESIGNERS: they are aware of the crucial role suppliers carry out in the PDD process but they are able to exploit only the “hard” capabilities
- c) MATURE DESIGNERS: they are aware and can involve and exploit supplier capabilities according to their levels of importance

Each category can be given suggestions that were identified through our research.

- a) UNAWARE DESIGNERS: our research results represent guidelines to self-evaluate and enhance designer’s relationship with suppliers, in order to enhance the design process itself. They have to become aware of the importance of supplier capability involvement and then they should exploit their supplier relationships.
- b) AWARE DESIGNERS: they need to imply our research results as guidelines to correctly adopt supplier capabilities.
- c) MATURE DESIGNERS: they are aware of supplier responsibilities and they adopt supplier capabilities. Therefore they can use our suggestions to elaborate best practices.

We decided to review a comprehensive literature about selection criteria, in order to generalize the results to all designer categories.

The list of supplier capabilities can be applied to all design fields, with different weights.

In addition, our selection criteria can be applied to service consultancies. For example, they can be used to choose marketing consultancies or distribution agencies.

Chapter 19 shows that our research results can be utilized as guidelines for designers.

20. LIMITATIONS

The main limitations of our analysis can be described as follows:

- number of interviews: despite our phone calls and mail questionnaires, the number of respondents is low. External design consultants are not used to be interviewed by researchers so they are sometimes distrustful.
- clustering in four types of projects is resulted to be excessive since external designers marked similar frequency and importance levels for projects 1 and 2, and for projects 3 and 4. The differentiation between adaptive and innovative projects could have been enough
- some designers lamented that the questionnaire is “too academic”
- the questionnaire is too structured to allow designers to suggest new or missing supplier capabilities.

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APPENDIX 1 – SCRIPTS OF DESIGNER INTERVIEWS

CAMBRIDGE INDUSTRIAL DESIGN

GENERAL INFORMATION

<http://www.cambridge-industrialdesign.com/>

Mr Alex Jones

<http://www.linkedin.com/in/alexanderkjones>

Company is made up of 2 people: Mr Jones and his assistant.

Questionnaire length: from 13:57 to 14:35 (considering also the interruptions for explanations).

B. INTERVIEW

C. = Carolina; A. = Alex

C.: “I’m a MSc student from Politecnico of Milan, who is conducting a research about how and why external design groups select their supplier and what capabilities they are looking for. There’s little in the literature about how designers select and involve suppliers since it mainly focuses on the buyer’s point of view. I’ve prepared a questionnaire which I would like you to validate. Your feedback will be very valuable.”

A.: With supplier you mean ‘any company that we use during the whole course of the project’?”

6) “Yes, I do. As you can see, I’ve listed the set of supplier capabilities that are supposed to be important. Each capability has a brief explanation of its meaning.” [*page 1, supplier capabilities*]

A.: “For example in the first case (*product improvement in existing line*), if I was to say that I sometimes use long-term suppliers, can I also say that I occasionally use new suppliers?”

C.: “Yes, you can.”

A.: “So, if I was to say that I use new suppliers and existing suppliers 50% and 50%, should I put 3 as rating?”

C.: “Yes, you should.”

A.: “I can use 4 for new suppliers and 4 for existing suppliers...”

C.: “If you think it more useful to mark percentages, please use them.”

A.: “Yes, it might be easier.” “So, these are the capabilities you’re referring to” [*page 1, description of supplier capabilities*]

C.: “Do you think this set of supplier capabilities is complete?”

A.: “Yes, I can’t think of anything. If something else comes to me, I’ll tell you.”

A.: “What is relational capability? Is that a company that...graphic designer, a moulder or someone else...”

C.: “Relational capability could cross every type of capabilities, it is related to how they interact with you, their openness to contacts, trust, compatibility between you and the person in the company.”

After a while, table 3.3.D, relational capabilities

A.: “So, here I’m saying how frequently do I use a company who has these capabilities”

C.: “Exactly”.

A.: “But all of these companies have relational skills in-built.”

C.: “Maybe to someone relational capabilities are more important than to others. You can feel it when having contacts with them, that someone is more likely to give information or to disclosure their information.”

A.: “So, that is if ‘quality of relation’ is important?”

C.: “And frequency of relations.”

A.: “Whenever I use a supplier, for example if a use a market research company, I expect that importance and frequency are not separate.”

C.: “I know what you mean, maybe the relational capability is more related to importance of the capability than to frequency of using it.”

A.: “So, I’m going to change the rating” [table 3.3.D]

C.: “Ok, so how is relational capability important to you when you select suppliers?”

A.: “These things (trust, loyalty, reliability, etc) are very important and those make up one of the main reasons for using a supplier so I can’t really separate that out.”

C.: “These two table were supposed to ask 1) ideally, the importance of supplier capabilities and 2) actually, what you do. Since for you the relational capability is very important and it is one of the main reasons, we can merge the two columns. Relational capability can be a cross-skill.”

A.: “Because in terms of frequency it would be very frequently, every phone call, every meeting.”

A.: “Is this the same as that one?” [*referring to 3.3.B and 3.3.D*]

C.: “No, they aren’t. One is related to PDD phase and the other one to the typical design projects.”

A.: “Ok, sorry. I can spot it.”

A.: “If I do not have a good relationship with a supplier, my customer will not get a good product, a good design.”

C.: “What is your definition of relational capabilities?”

A.: “I would think it as...If I have a supplier that makes metal boxes, they can make very good metal boxes and they can deliver them on time, and quality is excellent. If there’s a problem, I’ll ring them up and they say, sorry, we will correct it, we will sort it out. The other company that makes metal boxes, will supply something no good and I ring up, no one is there and I leave a message, they don’t get back for a week and then when they do correct

the problem, perhaps there's some other problem. It is the supplier's attitude that affects whether I use the supplier or not. They can provide lots of capabilities, but if they don't respond to my calls than all of this is useless."

C.: "This is very important to our research because the literature deals with hard issues. The relational capabilities are not that common but I think they are very important to establish a long-term relationship."

A.: "For designer, I think you have to be very good at building relationships because we are the centre of the customer and the suppliers and we have to manage both. The supplier doesn't really have the same issues and some of them don't really care, there are plenty of other people, other customers, so it is a kind of 'if you don't like me, you go...', so suppliers don't view relational capability as a service that they supply and a good service to make people come back. Since we have to deal with both sides, customer and suppliers, we have to learn to be supportive and responsive otherwise no one will come back. I think most designers are very good at it, most suppliers are not very good at personal skills."

C.: "In our research we want to make Supply Chain (SC) aware of the importance of design and make design a strategic issue inside SC. We know external designers are seen as something external and not as inner skills. We would like SC managers to understand that with appropriate design the profitability will increase."

A.: "Our suppliers are aware of the advantages because we supply work for them. If a customer wants a chair design, we are going to find a supplier to make that chair. So the supplier is aware that we are a good source of work for them. "

C.: "You are the contact to the other world."

A.: "I think so. If suppliers look after us, the customer holds to them and they can have a better relationship together and we can step out."

C.: "So, you have a very important role in the SC, because the process is divided in 2 phases. Like you said, you make contacts and then you make them contact themselves directly."

A.: "Yes."

Section 3.5 - Motivations for selecting supplier capabilities

A.: "For many of my customers our motivating factor for selecting suppliers and indeed changing suppliers, is quality. So if they are making something and they have quality problems or the quality degrades all the times, they are going after change. I suppose you can call them practical reasons. If maybe the supplier has changed personnel and so that relationship is no longer there or they don't have the capability to check quality, problems build up and they decide to move quickly."

C.: "So, you mean performance and quality of relationships."

3) : "Yes."

He did carefully go through each part of the questionnaire again to fill in what he was not sure about. He decided to change the rating of table 3.1 in order to reply with percentages.

At the end of the questionnaire

C.: "What do you think about the questionnaire?"

A.: “Like I said, I think the relationship thing is a difficult one to include, I feel because it is outside of the normal criteria of selecting suppliers that are quality, cost, technical abilities. Those are good things, but personally, I find it difficult to select a supplier if I don’t like him... because I have a choice!”

C.: “Even if it has a very good quality and performance?”

A.: “That is true but I have experience of this sort of company and after a while the inability to talk to me or to the customer gets in the way. We had a supplier that makes the front panels of hi-wi, very very good quality but the problem was that he was so fixated with quality that he used to reject a large percentage of the panels. For customer, that’s not good news because the customer is looking and saying, ok, 5% of those panels are no good. This supplier will look at the panels and say no, 40% are not good. It’s the customer’s money he is throwing away. So after a while, the customer is going somewhere else because he can’t work with someone who does that. If I or my customer are not getting a good service and the person is difficult to talk to, even if we did start use it, after a while we will stop using them.”

C.: “Is it a matter of compatibility between the persons or the top managements as well? Ethical, strategical issues...”

A.: “Yes, I mean sometimes a customer can ask me to work closely to a supplier I don’t personally get on too well but the supplier has a good relationship to the customer so I’m happy with what they want to do and it doesn’t matter if I don’t like them. In the case my customer say use ‘this supplier’ with whom I have a good relationship, I’ll work within that since their relation is probably more important than my relationships to them. However, obviously, here we are talking about the personal ability of the supplier to create the right relationship and atmosphere...”

It is difficult to see how it will influence the relationship during a product development phase. If a relationship is ok but not great, you can’t see the impact on the output of that project so relation capability is difficult; the other capabilities are obvious because you read the brochure and you say they can do whatever. Relational capability is a specific time related because you have to experience supplier’s response before you can understand if it is the right supplier.”

C.: “From what you said, I can guess that relational capability is at a different level compared to the other capabilities. Is it a cross- boundary capability?”

A.: “Yes, it is. Because the graphic designer or a market research company have to have this. This is part of the other capabilities.”

C.: “If you had to say a percentage, how important is the relational capability on the others?”

A.: “I think, when you first come across a supplier, the technical capability outweighs the personal relationship because you have to go on. So you select the person because of his great work. really have that as a big percentage at the beginning since you can’t verify it initially. But later on, when you have done a project, then you think: ‘Should I use this again? Should I recommend this person to other customer? Are they people that get on well?’ ”

C.: “You mean also trustworthy people?”

A.: “Yes.”

Questionnaire

C.: “What do you think about the structure of the questionnaire?”

A.: “Purely on the practical base, as you saw, I found this [3.1] difficult and I couldn’t use this [metric 2] to do that. Here [from 3.3] the other problem was which of these [metrics] to use”.

C.: “Would it be easier to have a reminder in each page?”

A.: “Yes but maybe if each metric were of different colors, color-coded.”

C.: “Do you think it is too long or too complicate?”

A.: “I don’t think it is too long, I think that’s fine. Have you talked to many?”

C.: “No, you’re the first one.”

A.: “That’s why you’re asking me about the structure.”

C.: “I will talk to 5 to 10 pilot companies to validate the questionnaire.”

A.: “There are a few big companies in Cambridge that you might find helpful.”

C.: “Which one? I found the addresses on the design directory website.”

I showed him the address database.

A.: “Think Product design...Tim is a friend of mine.”

C.: “Can I tell him that I’ve been here?”

A.: “Yes, you can. If you wanted to come back to this area, there is Cambridge Consultants. In Cambridge we have multi-disciplinary consultancies. They employ product designers and chemists, they develop the whole process. So, Cambridge Consultants, the Technology Partnership, PA consulting. At the top of this road there’s the village of Harston, so just there is a company called Sagentia So they make industrial tools for medical consumers. They are all big companies that employ hundreds of people, you might get a lot of feedback since there are lots of people. I recommend you go on LinkedIn and if you do some research on there, you should be able to find someone who could be interested. There’s also 42 technologies that do Industrial design and team consultancies. A lot of these consultancies will be like us so 1, 2 or 3 people. We’re working with a company that does heater, they came over last January and one of the reasons why they wanted to work with us is that we’re quite small, it means that you’re very flexible, if they want something you can quickly do it and there’s not a lot of papers.”

A.: “Is it an MSc?”

C.: “Yes, it is. We hope to collect some statistically relevant data.”

A.: “I’m always interested in these kind of results.”

C.: “If you want I can send the results to you.”

A.: “Is there a goal just behind the numbers?”

C.: “The entire goal is related to the role of design inside supply chain. How design is seen at front and rear end and how to make design a strategic device for supply chain managers. If I can’t collect numerous data, I think I will create case studies in order to compare data maybe dividing the research by industrial sectors or by the size of interviewed companies. It depends on the number of replies.”

C.: “Just another question, I’m interested in the Motive Pro suit that you made in partnership with Skalene Technologies”

A.: “The partnership was very good. They specialized in electronics for bluetooth and wi-fi and that sort of things. There are a sort of consultancy but they have their own project which is ultrafast inject printing using nanotechnology (it is their main work) but they do consultancies to pay their project. They’re very helpful. What happened was that a guy from Birmingham university had an idea to try and design a motion capture suit at a low price. Film capture motion suits are between 50 and 100 thousands euros and are very accurate (the suit that you wear is connected to a data collector in the room). The aim was to make something for 2 thousand euros. Since it is cheaper, it means many more uses. Medical response, how people move a racket, boxing as well, music and dance (a pianist who has nodes on his hands and as he played the device would track his position and would trigger back some other piece of music). There’s a lot of potential. We designed the junctures with straps and the physical stuff and Skalene did the electronics for nodes. We built 2 suits for him, he is kind of doing research about what area is this suit useful. He is trying to find out you would be interested in producing it this autumn.”

C. CAROLINA'S REMARKS:

Table 3.1:

Alex found it difficult to fill in this table that was supposed to be the easiest. He wanted to change the metric in percentage since he would rather think in terms of the all projects and not in terms of frequency.

3.3 SUPPLIER CAPABILITIES:

He filled it in vertical and not in horizontal so he focused on the capabilities and in which project or phase he used it.

He thinks about the importance of each capability in the different projects or phases --> WHEN are the capability INVOLVED?

So the table 3.3.A can be read in two ways:

- from top to bottom crossing projects --> WHEN question (Alex's way)
- from left to right crossing capabilities --> WHAT question (Carolina's way)

Since he is an engineering designer, he rated technological capabilities "very important".

He did it carefully going back to each metric.

3.5 MOTIVATIONS:

He filled it in vertical (focus again on capabilities).

d) ANALYSIS OF TRANSCRIPT

Page 3_ Designer's attitude to relational capabilities is very important.

Relations complete the service.

Sector: industrial design, small company (flexibility is important)

A.: "I think, when you first come across a supplier, the technical capability outweighs the personal relationship because you have to go on. So you select the person because of his great work. really have that as a big percentage at the beginning since you can't verify it initially. But later on, when you have done a project, then you think: 'Should I use this again? Should I recommend this person to other customer? Are they people that get on well?'"

Definition of Relational Capabilities =

3.any company that we use during the whole course of the project

4.relational capabilities are built-in

5.quality of relation

6."relationship thing is a difficult one to include, I feel because it is outside of the normal criteria of selecting suppliers that are quality, cost, technical abilities. Those are good things, but personally, I find it difficult to select a supplier if I don't like him... because I have a choice!"

7.relational capabilities complete the service offered to the client

8.specific time related

9.cross-boundary capability

10. every supplier has to have relational skills

11. relational capabilities make the difference in a relation

Motivation for selecting suppliers = **quality of relation and performance quality.**

Designer's role in SC = designer is the centre of the relation and enabler of contact, contact for the two worlds.

CHRIS WOODWARD

Looking at the title

CH.: "What do you mean by supply chain?"

CA.: "It is the set of organizations and individuals involved in the upstream and downstream flows of products, services and information from a source to a customer. We are trying to understand how designers deal with both the rear and front end (customer and supplier)."

CH.: "What about supplier capabilities?"

CA.: "We've selected those types of capabilities but perhaps you could think about something else."

CH.: "They are quite general. If you want I can talk about my experience here and my past experience in other agencies. I mean, the level we get involved with as a designer when I used to work for larger organization, a big electronic company. We did the design and consultancies and they basically have massive back ends to deal with this stuff. Now we do more independent stuff to more independent clients and we convert consultant to action. Sometimes they really understand, otherwise do not involve a level ...of what customer wants and how you can influence suppliers to get better design and not only in look but the materials purchase is supplied. We used to do a project and it looked like a standard grey but we moved it into a black actually. They were doing a customer make of that raw materials. We contacted people who did plastic as raw materials and we looked at their portfolio and standard ranges of black. From a designer point of view we got involved in all aspects... Design used to be a design chain with all the areas here, marketing, research. It still works now but the communication has changed. All these decisions here, this person has to make it (market person), this person has to make it (researcher) because they channel back through design, so we have designers as a core piece now so marketing, research, engineering, manufacturing, all channel through as and it is good for us since we get much more integrative, we are much more empowered."

CA.: "So design is the base for all these fields"

CH.: "From a technology point of view we had to stand a new key pad for "

CA.: "So you're dealing with the supplier they have."

CH.: "... what we're doing now is influencing people from manufacturers or people in the suppliers on how their parts look and feel"

CA.: "How do you influence them?"

CH.: "We do it from a supplier perspective...I just basically discuss with them,..."

CA.: "It is our goal to describe SC in this way, making companies aware that design is core competence and they have to make it internal, an inner skill so that they can improve their profitability."

CH.: "It doesn't necessary have to be internal is related to the dimensions of the company, big company do it internal. We do those, if you have a consultancy visit... We have a big network of people and people I use have similar experience, we form our education in London, we actually have more experience than most in London, we actually work as a cooptative, outside resource."

CA. "You have multidisciplinary teams according to different projects."

When you go internal, you get very blinkered in the way you are watching the world, they have done that for ages. We're coming from an agency point of view and we ask them 'Have you thought about doing this or that?'. But we have so much info about different areas, we're having research, looking at trends, we have quite special team with people from different areas. I think from a structure point of view it is easier to have it internal, but they pay us to enter and do unique things like this. When you're internal you go on doing what you've previously done and you don't think you can change it. We can stand and have an argument or a debate."

CA.: "Is it what you called 'lead by example?'"

CH.: “It could be lead by example... You have more perspective coming in. If you did it in-house, it is fine for the first couple of years but you’re not in the real world and it could be quite hard to keep the path. It depends on the type of products you do, most the stuff we’re doing here is dealing with fast moving in electronics. design ”
 “Why?”

5 - 10 years ago people did realize the importance of design and that design was a key element or main the main element in process. Design on the product cycle has changed as well, design intuition is always a big element. I came from a design area before we settle this and research so I use intuition...

Questionnaire (CWD 15thApril from 30’)

If you’re dealing with Chinese people...materials, cost of materials, cost of tooling, cost of parts, delivery.

You need them to disclosure their records.

CH.: What’s the difference between the type of projects? What’s the difference between pdt improvement and new product in existing line? Aren’t they the same?

C.: They are not the same. For example, if you think about a new pan in an existing line of pan or you can design a new line of pans for a brand and for a specific market. The fourth project is radical innovation.

CH.: They are academic categorizations.

Phases

C.: Are they fine?

CH.: Yes, they are. I mean, in general terms it is fine.

C.: We’re looking for general information in order to create a framework but we know that every project is different.

CH.: When dealing with product design you have different products, some phases are really heavy, some other are really light. When designing medical tools/ products, it’s again a different situation.

C.: Who are the clients for the Chinese stuff?

CH.: Many clients. I have NDA but I can say there are many clients. Most of the stuff we do here is related to electronics, TV ...

How did you get in touch with the Chinese suppliers?

C.: Always through my clients, I’ve never contacted them directly.

CH.: product life cycle affects the duration of the relationship with suppliers.

3.3. Supplier capabilities

Other: development in the area (R&D)

CH.: I have to mark a number...

If he’s an existing supplier working on an existing line I would like to select

C.: From what you said your suppliers are knowledge suppliers.

CH.: It’s not so easy for me. If it is an existing line generally the tech is the same, we don’t change...

C: You select new suppliers or you use the ones you’ve used for a long time.

CH.:

C.: When you involve new people, did you meet them before or it is just a matter of contacts?

CH.: It is a matter of contacts...

How do you choose them?

Maybe it is a product I've seen before or I've got an idea and I

I prefer to work with English people. It is easier for language, time..

C.: And culture

Yes. When you deal with Chinese people you get in touch with their representatives who live in the I and speak English. Time is money.

So you look for relational skills, you look people with whom you can get in touch frequently and quickly.

New pdt in existing line: I don't do it anymore but previously I was in charge of the department in the company where we had to find new markets for new products. If you think about what I'm doing now, this is 2. It is related to ho many people who have since new products in new market is a huge project.

It's always nice to work with a supplier...

CH.: What do you mean my specific design capabilities?

C.: 3D graphics, CAD, etc

CH.: The rates should be the same for every single product. It is the way it should be but it isn't.

C.: Frequency changes.

Yes, it does.

CH.: You have to understand the market. We don't need market research because we know the market. Market research is very much bigger than user research. User research is more important for design. We do it in-house or we use agencies (quicker).

Because market research and user research are quite different.

Are you thinking about a particular project or generally?

CH.: I'm thinking in general terms. Technology in new market, you need to have other information because the tech has changed. The are so may questions in that project because it could be this or that, you need to get new knowledge. You need to justify to your client what you designed.

C.: Since it is a new market.

CH.: When we look at the cost of proper design...

It depend if the supplier is giving it to us and we have to do the concept or we are planning.

C.: You're planning.

CH.: So rel cap will be more imp. If it is just given to us we don't care but if we set it up the planning phase, this will be the opposite (it will be the highest) because we need to get the people we want. Especially when we're building the team, we want the people to like working with us.

If you understand the tech whatever it is, you can exploit it and the design...so that we can get the best.

It is more like a Bible..

FRAZER DESIGN

J.: We do all of the activities of PDD, cause we do quite a lot of product development here. From the concept to assisting our clients with sampling (when they have the first sample back) and adjustment from running changes in the production, it depends on the clients. In the consumer area the manufacturer is doing the supplying, we don't get involved in the engineering process but only in the industrial design.

And you work with their suppliers.

We have to work with their suppliers.

You are only doing the policing role to make sure the supplier is implement the design as we wanted it. We received the sample and make sure it matches the requirements. The suppliers also have their constraints that sometimes are not obvious because we are separate companies both supplying the same client, they don't necessarily tell us all the issues they are dealing with. It is not usually intentional, they don't usually share everything.

It could be that they don't want to share everything with everybody.

We have some clients who are making B2B products, they have marketing and electronics as core competencies but they need us to design it (they use our competencies in technologies), specify it, find a supplier in China, manage the process and check it. It is a much more involved role. We don't actually source products as a design company even if it could do.

Typically we deal with clients' suppliers. We can also tell the client: 'we want to do this product, you'd better use multiple sourcing and they will adopt them or not'. We prefer they make the last decision because they are manufacturing the product, they are in charge.

C.: What do you think about the description of PDD reported in the questionnaire? Does it correspond to the reality?

J.: yeah, I mean in general, because you can't generalize completely because every pdt, design and challenge is different and industrial design has always different issues. For example, we worked for Philips: we developed the process for some products but it is not a typical case. The one issue with the questionnaire is that you generalize too much. The questions are too general. You'd better pick up 3 projects quite different and then characterize the types of projects and work with the scores. Consumer and capital good are at the opposite of the scale: 2 different types of approach, one is more engineering and the other more conceptual (aesthetic design).

C.: You think we should have divided the questionnaire in specific areas

J.: Yes, I think so. Broadly speaking: industrial design and packaging and branding (Semourpowell).

C.: We know that is a big issue to try to generalize but since we're dealing with supply chain language and design language with want to create a typical framework that could be used by designers and managers so they can understand how the designers work and which is their role in the SC. We also wanted to make the questionnaire quite short.

The 'typical' was a concern at the beginning, we know that every project is different from the other so it was a big challenge to decide the questions.

J.: The importance of this things is yes, they all get high scores. The mktg research is sth that we don't commission, we're rarely part of it. User research yes but it is definitely in the packaging area that mktg research is done, because you have to deal with the psychology. It is not that important with technological pdt because you are buying it for the functionality. User research and user trial: you may ask people to use the product to understand

the priority in that particular area and when you have the prototype you want to see if it matches the requirements. We did a lot of user trial in the past and we've been involved in commissioning it. But you don't expect your customers to innovate the products. User needs is good to understand their conditions and behaviour. But asking what they want is not worth doing.

C.:As a designer, do you think that suppliers could help you in delivering innovative products?

J.:> Yes, The issue always is uncertainty. If you try to innovate, since innovation is a scale from a very small innovation (new to company even if every one outside is doing it) to radical innovation, In this situation you need a big support from your suppliers because it has never been done before and the question is: 'why do I have to put a lot of effort and it is not going to fruition?'. If you want to use a new process in a small scale you'll find a lot of difficulties. When an innovation succeeds, everyone wants to do it. In UK the manufacturers can't expect high volumes, a lot of customer with a few bits is the strategy.

If you want big volumes you go to China and there the SC is a different issue.

And it is managed differently.

J.: Yes. Do you the Alloy? They are one of the big companies that control SC for their clients (BT). they are optimizing the SC in China and selling pdt in the UK. It is not typical of design companies to deal with SC issues but they do a good design and SC is very important to them.

C.:What kind of support do you ask for to suppliers?

J.: It depends on the supplier. Normally it has to do with materials and processes. You know you can source it here, but how do you source in China, how do you get the support from the supplier here, they became very wary of telling you the stuff they are using, the transfer becomes difficult and they are wary that the designers are only looking for knowledge.

C.: Did you think about other supplier capabilities? What are the criteria you use to select suppliers?

J.: Initially, you'd like to have sb who talks to you about some issues. It is all about quality of service now. We don't forget companies that are putting a huge effort in our work even if they know that they're not getting a lot in the short period. It is very important. Service is in trust, loyalty, etc. Commitment is an important word. Most of the time you talk to tech sales, in this level you expect to get a good service from, because you need to find out and you need to have a good commitment. Ultimately their commitment is just sales, if it starts to get further and further away, usually their interest drops rapidly and you don't get the support that you need. Especially, if you're innovating there are a small numbers of companies and suppliers for that innovation. It is one of the frustration. Only car industries can get the attention of a supplier easily because a great figure of money is involved.

C.: Do you prefer to change the supplier when you're at high level of innovation?

J.: When you do know already that they're not suitable, you tend to be looking for new suppliers. I'm trying to get an example. We're having some problems at the moment with a supplier because it was difficult to get the sample, the Chinese are doing sth on their own thinking their helpful, maybe they are, maybe they aren't.

What are you doing with the supplier in this case?

It is a case of existing process. They did the process with us 10 years ago, last year we specified the same process and now we put it in house, we're trying to do sth specific in moulding decoration (plastic). They had the ability to do it but it was difficult to get materials from UK, ink from Germany and top put them all together. That's what we're doing.

C.: What do you think about the role of designer in relationship between client and suppliers?

J.: They are very imp. It goes back 20 years when suppliers didn't see the designers as a potential source of business and then they kind of realize that designers had a powerful specification role and if they specify a particular material, you can't just do sth similar. One is arguing opposition to the client so to give us enough influence and control to get what we want. You try to persuade the clients to give you responsibility over the suppliers to assure quality and requirements.

Good products come up from a very very good relation between clients and designers.

What is the role of supplier in that relation?

It has to do with making money, if they can't get money their interest drops. Commitment and involvement must be huge if you have to produce high volumes. You can get it to happen if you're Apple but you can't get it to happen if you're smaller. If the supplier can't make money out of that, it won't be interested in co-designing, unless it is a reward.

Do you happen to work with the supplier to provide the clients with new technologies?

How did you involve the suppliers?

By selecting a new tech means that you have got a certain number of suppliers who can supply that and that pushes the client in a particular direction. They go themselves to select the suppliers of that tech. The client indirectly go and find the supplier.

What info can you give the suppliers? technical specification.

Do you happen to involve suppliers in the concept phase or only in the later phases (prototypes and detail engineering)?

I'm thinking about an example in which we've done that.

The suppliers do need to be involved but usually the Asian suppliers are so enthusiastic to try and solve the problems but partnership is a strong way, designers say what they want and they try to achieve it. They can make a suggestion for adjust pdt for their own processes.

What do you think about the role of design inside the SC? Is it difficult to designers to understand the terminology of SC?

It depends on what type of design you are. We're at a conceptual end it is difficult but if you're an industrial designer who have to understand it otherwise you're in a weak position. You need to make it down and you're supposed to know how it works. If you don't have a way to showing them a route to achieve it as a designer, you're in a very weak position and that's why you have to understand the language of SC and the next step is to understand the supplier because you need to answer the question: 'who is gonna make it?'. We have to find the supplier who can provide whatever the key element is and make that design different. It is important in industrial design. Even if you're making simple plastic products, if you want to do sth innovative, you have to understand the process of manufacturing plastics and the potential of changes.

J.: We envy people like Apple who can use aluminium. It'll spread out, leading suppliers will understand how to do this, other will copy that and Chinese people will do it with competitive service.

C.: Do you consider that a framework to select suppliers for designers and managers would be useful?

yes. I think, one of the classical examples (plastic material suppliers), if they came up with a interesting material in their lab and said 'here we are designers, we can do this'. Or if they said to designers: 'what would you like?' 'WE would like plastic to do this' and suppliers went back to their lab and ask themselves 'how can we do it'. It is always a big question from the suppliers' point of view. Is it best for them to develop and offering or is it best for them to go and ask the designers 'what do you want'?.

J.: What about you? What would you reply?

C.: Both, they've got to be proactive. It tends to be very technical and more about the quality of material and engineering rather than aesthetics. It has changed.

J.: In the car industries, it has changed completely, they wait for the suppliers to come up with new ideas and there's more flexibility. For example, car seats are a so tech issue that car industries can't design them so suppliers provide them with those. Car industry is a great example for showing where suppliers are offering innovation. The supplier has the control of that. Speciality suppliers for all the components have an enormous amount of responsibility in controlling innovation.

Do you think that suppliers could help you also in the aesthetical features?

They would have been designer...Probably in aesthitics not much.

You mainly involve them for tech features and for production.

Yes. Very often we're doing combinations of things together.

Could you think about other reasons to select suppliers?

I suppose sustainability in packaging.

We research suppliers here, we find sb who is really good at it: we look at the sample, at the process and then we pass it on to people to China. It is taking knowledge and passing it to sb else. It means that suppliers have to offer services where things have been made. Some companies do that, they can supply Chinese manufacturers with knowledge and know-how.

What are your in-house capabilities?

User research, tech capabilities (housing of things), specific design (specialities in some areas where we've a lot of experience).

We subcontract prototyping. We offer the project of prototyping but we don't do it. We had subcontracted hardware design and sw and circuit design, usually to show the clients the sample and then they go wherever they want.

C.: Relational capabilities?

Companies we deal with regularly are prototyping companies and we have good relationships with them. We're trying to give them all our work and unless they can't do it, or for some reasons they're particularly expensive, we'll always use them. By using these guys we know we're gonna get a really good job. Sth we have to sell our best suppliers to the clients because they want sb cheaper: we have to tell them the reasons for which we're

working with them (they are in the UK, experience in a particular area, they are very good). Loyalty works in both ways.

LUCA DI FILIPPO

INTRODUCTION

L.: The working situation in Italy is very different from that in England. Italians are very proud and don't want to integrate other persons in the process. English people have a different approach to team working. You can sense the difference just analyzing the word that is a unique word. English people don't encourage eclecticism but specialization. When people are specialized are more confident in developing and accepting team working and a win-win situation.

C.: Because you're well-disposed to accept other views and other knowledges.

L.: Consultancy here is a big issue.

....

L.: I think your research could be very valuable from different points of view: sociological and psychological as well. You could go deeper in each field and try to understand the inner motivations for the difference between Italian and English structure in the relationships with suppliers and in the whole supply chain. In Italy the relationship with suppliers is very difficult due to narrow-mindedness that prevent from revealing weaknesses. Relating to your experience with the designers, how much freedom is left to designers to select their suppliers?

C.: I can't make a statistical output since I've interviewed only 3 people since now. 2 out of 3 work with their clients' suppliers. The first person I've interviewed has his own suppliers: maybe it is related to the nature of the project itself (Motive Pro suit for example).

....

L.: You should distinguish between interior and industrial design. In addition, you have to think about Terrain (Braun's most famous designer) or Antonio Citterio (architecture, interior and product design / I worked with him in Italy). Experimental design in which the designer has to deal with suppliers, is an atypical reality.

C.: Another issue is related to the role of good team relationship on the quality of finished goods or delivered project. The supplier is part of the team so his role has to be analyzed in order to understand whether his involvement is beneficial to the delivered quality or not.

L.: Let's talk about L'Arca - il peso della committenza illuminata (I don't remember which number was it in). The client is the keystone for final quality. Danese and B&B are examples of friendship relations between the designers and the client, it was a relation linked to the same passion. I've worked both as interior and product designer. The difference consists of the relationship between the client and the designer. Trust is the key element since only in this situation the client is well-disposed in following the designer's suggestions. I've been asked about programs or special suppliers in relationships of mutual trust. In this situation, the designer becomes part of the company even if he is not an internal resource. We are talking about industrial design, we're not talking about fashion design or Philippe Stark.

4) Is it so difficult to identify Philippe Stark?

L.: He began as industrial designer, he thought cost and function were very important for the final product.

Giovanoni, Grosvenor, Zaha Hadid. I have a friend that works for Zaha Hadid.

Another field is related to designers who sell their brand to empower another company's brand. In this case, the company has to deal with the production but the designer doesn't interfere: the designers makes only the system design. This is design marketing.

L.: The title of the research is very interesting: “to innovate”. What do you innovate? Cost - performance, cost-function relations?

35’: Design Ethics; SC and designers different aims. What makes higher profits? Cost reduction or brand importance (competitive advantage). Product and industrial design with different levels of quality and different requests from the clients. Industrial designers have a social role. But design doesn’t mean style, it is not your style put into new things. Munari ‘the role of designer’ (book): the designer can listen to other people, can mediate, etc...La caffettiera del masochista (Normann - book). Definition of industrial design? An industrial designer has to mediate: client-user; aesthetical or functional approach. Things come from logic consequences and not on a whim’. You have different tasks to manage (aesthetical and functional, etc): you can make a decision only when you have compared the different levels.

‘Il design è un pipistrello, mezzo topo e mezzo uccello - Koenig’

QUESTIONNAIRE

C.: We can innovate the product, the process or the relations.

Product improvements, new products in existing lines, ...

L.: “Now we have to face the structure of the questionnaire...Shall I consider clients then, not think about my self”

C.: What do you do? Do you have your own suppliers or do you work with client’s suppliers?

L.: It depends...

C.: on average

L.: So I will think about clients in Italy...

C.: What about here?

L.: At the moment I’m working on photography but I had experience here and it was completely different from the previous one.

C.: Maybe it is better to consider the English structure.

L.: For the English market I was always working as an employee so I didn’t have a direct client...It was quite different from Italian experience. I would prefer talking about an Italian experience... New suppliers are the most common situation. It is a little obvious since you bring new tech to a client so you are forced to find new suppliers.

C.: Always new suppliers?

L.: It could happen. If you have, let’s say, 20 consolidated technologies, but only 1 new, that’s where the process change. Should we use a case study?

C.: It’s up to you. What is the case study you’re talking about?

L.: To be honest, every time is a different story.

- That’s why I asked you for an average. Even if I know that every project is different from the others.

- I’m quite sure. If you have new pdt or consolidated pdt (pdt improvement) also from an entrepreneurship point of view. If I’m an entrepreneur and I call you as a designer because I need to improved a product in my existing line, 99% of the times, your instinct will see a lot of things that could be changed and you advise the client for a radical change.

User abilities and needs, technologies, everything changes so fast: the designer asks for radical change but the client doesn’t have money (when you don’t have money you want only pdt improvement and long term suppliers as much as possible). I would say 5, 3, 1 and in a mathematical order I’ll do the reverse for radical innovation.

[table 3.1]

C.: Because of the nature of the project itself.

L.: And because of the nature of the business. The main issue is what is the final aim of the client and his mind frame. If a client asks you for new pdt in new market you have no boundaries, you are looking at the future.

C.: Don't you need long term suppliers, established relationships when you have a completely new projects in your hands?

L.: This is sth related to business strategy rather than design strategy. So it can happen that you have to deal with new pdt in new mkt reverting the order of the frequency (1,3,5). It is quite interesting because of the nature of the question.

C.: The previous person I've interviewed told me that they use long-term suppliers in radical innovation because they know they are reliable.

L.: Ok, just use a key study. A traditional lamp post (cast iron). This is an historical element, they called me and said 'why don't we use glass instead?'. The fact is that to approach new mkt you need some innovation so you have to move forward'. The other lamp (slightly incremental innovation) was related to the same supplier, same materials, just a matter of shape but it is 1 out of 10 pdt (DonDay). It is difficult and maybe not so logical to cluster projects like this.

C.: It makes sense since we are dealing with the supply chain...managers, engineers need some frameworks to work on. And it uses academic clustering because of its nature so that everyone can decode it in each project.

L.: I would use this formula for 3.1 because of logics.

C.: Are you thinking about a particular project?

L.: I'm thinking about different project and different clients but it is very difficult to create an average. I'm trying to distill my experience on common logic. So what I can say is, what happens if a client asks you for new pdt, new line in new mkt? It is most common to face a new challenge in my work.

7) So you look for new suppliers in new challenges

L.: Definitely. Probably 80% of the pdt would be done with existing tech but the 20% is new and you need new suppliers and more effort to control them, to integrate into their consolidated way to produce the object so it is not a matter of quantity but of randomness. Usually, in my experience, if sb asks for tiny improvements of pdt in existing line it means that they don't have money, they don't have research and development at all and you as a designer have to go in their warehouse and ask them for what they do and have and just think about clever changing of sth giving a plus to the project but from a pure design point of view, not materials or tech, just a smart idea. Like bending a pipe in different ways: this is not new tech, the supplier of the previous item was a Chinese guy who had only to change the bending pipe (the same tech used to develop a pdt that was launch before, so no difficulties at all). This is why I told you it is an interesting case study.

For instance, before launching the entire line (this is the case of new pdt/ line in new market because it didn't exist a lamp post that could be used in urban historical elements; it is new also because you have a particular type of basement that could be used in UK and Australia where they have particular std). In this case we applied 5,3,1 because the plastic was completely a new production. We looked for new suppliers also for bending pipes and for laser cut.

C.: You needed sb who has different tech skills from the others.

L.: You start and think about what is missing in the market so why don't design sth that could hang on from bars that we have in Italy? Great idea!

C.: It is related to the nature of the project.

L.: In addition, when you have to design sth like this you have to think about market needs, how to sale the pdts at a fair price. You have to minimize costs. If the cost is low you can have an higher profit margin or much more volumes sold. For example 'die casting in aluminium', it is not always necessary so we can switch to other tech (polyurethane) that costs much less since the amortization is at 3 pieces. Every element is part of the final goal that is profitability. This case study is very valuable because we have same line of products but different projects. Moreover, what is newness? Is it related to the market or to the company. Donday is cost-less because of a big mistake they ordered 10 thousands of an element for another job so they had a huge warehouse: we did a lego system 'let's see what we can do with your existing pieces'. It is quite difficult to find an average cause you can have the most innovative design for a company (the market has never had a kind of iron piece like this) or you can have low tech design (Donday) with pretty anything new. We didn't need new suppliers because we were

using the one we has previously and the other parts were in the warehouse.

I'm really interested in your research because you're going to understand how designers work.

C.: We have to divide them in relation to the project they are fulfilling without generalizing that much.

4) How many case studies do you need? Lots.

C.: For each question I could give you thousands of replies. But I would prefer to focus on only one company otherwise it is too difficult for me.

L.: 3.1 e 3.2 are simple. Rarely they don't call me for pdt improvement (they don't want to spend money on it) since they prefer to do it in-house or with only a consult of a designer (give us an idea).

Other supplier capabilities:

To have an R&D department.

C.: Isn't it technological capability?

L.: Not only, if you have tech skills it means that you're able to produce anything with a standard and not to help me finding a new way to solve a problem.

C.: So development tries to produce sth new.

L.: Exactly. It is what I always ask for. If a supplier has a R&D unit

C.: R&D goes towards the future instead tech use consolidated tech.

L.: For the aluminium element we used a supplier from milan that had a very very good R&D department. That makes the difference in selecting the supplier. You can be expensive but it is you I want. With development they can help me. Pdt improvement in existing line plays around what you have, when you do project 4 you push the boundaries forward so R&D is everything, on the higher level. In project 1 the most important thing is how suppliers are well connected to the company and the client. The value is not related only to relational capabilities but it is the overall feeling.

Relational skills are quite important (the rank is 5) but 5 have to be also on the reliability of client on a supplier.

C.: The client is in touch with the supplier.

L.: I should call it 'overall complicity' with the client. There's another element that is not easy to evaluate: cost. When you're dealing with money, if the client has a really good supplier, he can ask 'would you like to try with me' that means...

C.: Risk sharing?

L.: Exactly. No one cares about user and market research cap because you have checked them before. Market is not important at all when the supplier is existing. If you share risks with the suppliers who provides let's say, prototypes, no one cares about the problems they have because it is risk sharing in partnership with the supplier. Market in project 2 and 3 is not very imp (2). If a client knows the supplier I'm talking about the attention the client has on that supplier, and they don't care about other suppliers because they have tested the existing ones. Relational capabilities have to be 5 always (project). The attention to the supplier is really high when you have a new supplier for a radical project (so relational cap are very imp = 5). Even if the supplier has to work on a tiny little piece, it is very important to do it properly. It changes dramatically the approach because it is the main piece.

L.: Do you care about the average of the products as well?

C.: No, I don't.

Table with frequency (3.3.1.B)

L.: It is exactly the same...

C.: No, it's related to frequency. The other one is related to importance.

L.: Yes, you're right. The importance was quite easy. The frequency is more difficult, only God knows.

C.: I thought it was vice versa. Because you related the ranking to what you're actually doing.

L.: Sth important is related to your aims, frequency is related to what you have to face. Coming back to case

studies, we have opposite approach in projects 1 and 4. Of course, the aim is to gain the maximum profit having the best pdt. If the aim is reducing cost you don't use new tech unless they are really necessary. I can't answer to this question considering an average. For every single element I can give you different ratings.

In Prj 4 it was quite common to ask for user and mkt research. But it is never a big issue, tech is always 5.

C.: What you look for is different from what you find!

L.: You are trying to distill in 1 questions projects that should be divided in at least 3 different areas (design, production and selling).

C.: We have distinguished the phases from planning to production launch.

L.: It means that you're ready to sell the pdt. Before the launch you already have the stuff positioned. There's a supplier that helps you to produce the object and a supplier that does the exhibit design.

C.: We're looking for pdt supplier.

L.: User and market relational cap of a supplier, why do I have to look for suppliers that do user and mkt research?

C.: Don't you consider important to have a supplier that can provide you with information about users' needs and market trends?

L.: Not at this level. Maybe Nike's suppliers but not medium and small suppliers. I provide myself user insights or I call for sb who can do it because it is part of my job. You have to distinguish between research to produce and research to sell. In the real life you don't ask the supplier to provide you with research about mkt and user. It works like that if you're playing top level, championship. For example you (Nike) call Dupont even if you have a mkt research unit, just to make sure that D is doing a research on a new plastic. To be honest, this is only for the 2% of designers but in the real life when a supplier just does its job. Maybe you can tell them that you know that Dupont is doing research on that field and if you need sth more specific you call D as a supplier of the supplier. Don't underestimate this process.

C.: Isn't the first tier supplier in charge of its second tier supplier?

L.: No, it isn't. Lets' do an example. Press industry. I have to do a brochure and I call suppliers that print brochure. They have 2 or 3 paper suppliers as well (for example Federigoni, harrow and other brand) but they don't have a clue of the innovation you have in mind. If you want improvement in design you (designer) call Federigoni and ask for help in the first tier supplier (Federigoni called me back and sent me samples of new papers but F didn't send the samples to the supplier). It is quite tricky. That's why I think what you're doing is a fabulous work. When we working on lamp they had a supplier for glass but they hadn't a clue about what they had to do to satisfy us so I asked Saint Gobain for help.

The main brand came and we had the meeting with Saint Gobain and the supplier. The real supplier was a small factory in Italy buying the glass from Saint Gobain.

C.: S was a second tier suppliers. The company is in charge of the second tier suppliers (Saint Gobain).

L.: User and mkt research capabilities in real life are not looked for within supplier companies. I have to give myself the supplier these information about materials because maybe it is a niche mkt that only a designer knows or perhaps they know about its existence but they believe it costs a fortune or don't know how it works.

C.: Since like you said, supplier is never aware of what happens in the world, would you like the supplier to be aware of that kind of info?

L.: I'd loved to, and that's why I love your work and your research. If you do a good job, you can do a clever job and publish it, it will help people to understand what they have to do and why they have to read about the world rather than just thinking about cash. That's exactly the point. Here, in England, it is exactly what you would like it to be because 90% of the times english supplier knows what you're talking about or can say much more and detailed and they are really very informed. Honestly, even when I was in Dubai working for huge projects, I didn't have suppliers that provided the user and ... I provided it myself. If I'm a designer that does also brand consultancies (it happens frequently in England), I'm selling that kind of research, it's part of my job. Maybe in the automotive industry when you've big and complex structure and many pieces, you can find suppliers that

have this info (also Brown asks for it or b press in Romagna have Zanussi or Cimbali, big suppliers) but for a single designer and a small firm, it doesn't happen like this frequently. It is always that leads in small reality. Designers are brand as well and they are selling consultancies. User and market research cap are very different. If you ask a supplier for user research it is reasonable but about market I can't think about no examples.

Structure of Questionnaire

L.: I can't think about the whole project without separating it in at least 3 phases. I'm very interested in learning about your research. I think the questionnaire is misleading for the structure since when you refer to small/medium realities (this questionnaire seems to be well structured for big companies) things are more aleatory. I think that some elements are missing. You should divide every project in 3 areas/situations (planning phase, project phase, production and launch). 5 phases are more than what is necessary.

L.: Average could be done at the end for each project that has been divided in 3 phases. Since if you asked me about average in each phase it could be very easy for me, but if you ask me about average in every project, it becomes more difficult.

PROJECT 1		capabilities
	PHASE 1	scale of importance
	PHASE 2	
	PHASE 3	
	PHASE 4	
	PHASE 5	

C.: So tables with phases, projects and involvement are better structured.

L.:If you divide the questionnaire in this structure: what happens in the planning phase? And you can ask me all the questions related to planning phase...maybe it is better.
I can't know what happens in each project.

C.: But you know what you would like it to be. We are looking for the difference between what it is and what it should be. During planning phase for example, market and user research are not important at all.

In particular, according to my experience that is linked to branding, when you think about new pdt/line in new market, a lot of elements take shape: brand strategy. For example brand Union (for them planning is 50% brand strategy), design bridge. In these big realities the relationship designer-supplier is very different from small realities. Interviewing them could generate another point of view. Randomness has to be consider in the structure. If the supplier is only in the production it is simpler.

C.: No, he is involved in the whole innovation process. We want to understand how designers involve them to innovate.

L.: This is extremely important. It could be your future work.

The cool thing is: where the supplier could be join the process in order to innovate?

You have to distinguish the difference between suppliers. Ex. supplier di polyurethane could enhance innovation if the he had a different approach. Now he can't improve innovation because of the nature of the process since he is not interested in enhancing innovation: he knows his work but he is not interested in providing (free) technological support. Ex. Saint Gobain pays an engineer to explain the supplier how to make the glass but the supplier isn't interested in providing a new tech in glass, Saint Gobain leverages the supplier thanks to his

competitive brand and know-how advantage.

The difference between product and interior design could be another interesting issue in order to fulfill the research.

Nature of supplier.

‘Nuove strade del design in Giappone.’

Further questions to Luca [see questionnaire, red circles]

C.: "In new product in existing line, you put 2 to the importance of tech skills and 3 to the frequency. Does it mean that even though it is not that important, designers actually look for that capability when selecting suppliers?"

L.: Exactly. In 3.3.B I claimed the desperate research the designer has to undertake in order to understand how to utilise technological expertise in the concept phase.

I don't have great experience with English suppliers. When I used to work in Foster and Partners I realized that the chain of competences makes the difference: how suppliers and designers work together to reach a common goal. Quality is always a must.

IL DOPPIO SEGNO

<http://www.ildoppiosegno.org/>

Like the average of Italian designers, Monica and Carlo design different types of products, from lamps to bins, from chairs to bottles. Carlo and Monica are researchers.

Carlo talks about the crisis in the last 10 years. Nowadays, suppliers are conducting a revolution since they don't want to be squeezed by firms; suppliers decided to create a "consorzio" in order to gain power vs companies and to produce their own products. An example is CTM, a supplier district near Rome. Suppliers (who possess the know-how about the whole project) gave birth to the partnership in order to access new opportunities. Collaboration means will to find an agreement.

Two types of projects: 1. two-piece lamp: Carlo had the idea to design a new and simple type of lamp. He decided to create the lamp using a new material: the CORIAN. This material makes him enter the company and begin the project since the companies are always appealed by innovations. In this case the supplier helps Carlo in reducing costs and producing the object in the correct way. Another example of the first type of project consists of a coin with heart and head. Carlo created it and a producer is producing it free. Both Carlo and the supplier are working to get interested customers/ clients.

2. Second project: a big can for red dog from Bayer. In this case the company approached the designer giving him the concept, the deadline and final price. Developing the concept was a quick task; the longest task was to contact suppliers to produce the different parts of the can.

Carlo's remark: suppliers are not proactive in general. Sometimes they offer a new material: it is an innovation. Carlo talks about a famous invention: a spring for spectacles created by technician in a company who decided to link this innovation to a famous designer's name without whom the spring would not have been sold.

Monica talks about her project with Jimmy Choo. She had to produce a plastic bag from a sketch by the company. She had to collaborate with suppliers in order to get the correct mix of plastics to obtain a resistant material: she went to the supplier's and made a trial and error process. It was a joint co-design with technical department (it was not a proper R&D).

Good supplier- designer relationship = same language, trust.

The choice of suppliers depends on the experience in the field. They have a network of suppliers for a stated area of products but they have to look for new suppliers if they face new projects/products. They switch from lamps to cans.

They say the following names correspond to 3 different realities:

DESIGN GROUP ITALIA = research in a big company with structured design process

DAMENO = small reality with 2 people

GIOVANNONI = famous designer

Sadler invented a gel for motorbike suit.

Taplast is an example of industrial design begun by the supplier. The top manager invented the plastic spring for dispensers.

QUESTIONNAIRE

Project 3 begins with the research phase but it does not have a conclusion. For examples, Samsung proposes the project to designers all over Europe in order to get knowledge and trends but it doesn't produce the product.

Projects 1 and 2 are related.

The designer does user research for the first 3 projects.

Specific design capabilities are designers' because every actor has his own competences.

In the planning phase the technological capacity is required.

Product launch – the supplier is not involved unless he is the owner of the process.

Innovation is a risk for the actors. When the supplier understands the innovation can become differentiation, he pushes the innovation.

3.3.2.A – marketing becomes important from the 4th phase (testing).

3.4 – 4th project = since it is a completely new project, the designer looks for involvement in all the areas.

3.5 is more difficult to understand and fill in.

APPENDIX 2 - QUESTIONNAIRE

UNDERSTANDING HOW DESIGNERS USE THEIR SUPPLY CHAIN TO INNOVATE



1. INTRODUCTION

1.1 FEATURES OF THE COMPANY

COMPANY NAME:

INTERVIEWEE NAME:

ROLE IN THE COMPANY:

ORGANISATION STRUCTURE (could you please send us a copy of the organisational structure?)

1.2 PURPOSE OF RESEARCH

The purpose of this research is to understand how UK design consultants utilise supplier capabilities to enhance their product design and development activities in order to deliver **differentiated innovation** to their clients.

Our objective is to develop tools that designers can adopt to improve the use of supplier capabilities in their key Product Design and Development activities.

We will provide all participants with a survey report and recommendation from our project.

1.3 SUPPLIER CAPABILITIES

Supplier capabilities are the external skills and resources (investments, information, knowledge, ideas, ...) that suppliers provide, the tasks they carry out and the responsibilities they assume regarding the development of a part, process or service for the benefit of a buyer's current or future product development projects.

Your help is valuable in pinpointing the capabilities external designer groups look for when selecting their suppliers.

In this research we are interested in:

- **User and market research service** (ability to interpret market trends, client commitment and ability to understand their needs, etc)
- **Technological capabilities** (materials, process capabilities, technological expertise,..)
- **Specific design capabilities** (brand, graphics, product, ect)
- **Relational capabilities** (soft skills: trust, commitment to the relationships, loyalty, top management compatibility, etc)
- **Manufacturing service**

1. 4 TYPICAL DESIGN PROJECTS

Four different design projects can be distinguished:

1. **product improvement in existing line**
2. **new product in existing line**
3. **new line in existing market**
4. **new product/ product line in new market**

1.5 PHASES OF PRODUCT DESIGN AND DEVELOPMENT

		ACTIVITIES						
PHASES OF PDD	PLANNING	a. identify opportunities	b. evaluate and prioritize projects	c. allocate resources and plan timing	d. complete pre-projects planning	e. reflect on the results and the process		
	CONCEPT DEVELOPMENT	a. identifying customer needs	b. establishing target specifications	c. concept generation	d. concept selection	e. concept testing	f. setting final specifications	g. project planning
	DETAIL DESIGN	a. part drawings	b. DFM	c. prototype/mock-up drawings				
	TESTING AND DESIGN REFINEMENT	a. reliability test	b. life testing	c. performance testing	d. regulatory approvals	e. implement design changes		
	PRODUCTION LAUNCH							

According to Ulrich and Eppinger , the PDD can be divided into five phases.
QUESTION: Which stages of every phase are you usually involved in?

2. QUESTIONNAIRE STRUCTURE

In this research we are asking you to answer questions about three variables:

the importance (1)

Metric: On a scale of 1 to 5 please select level of importance (1 being not at all important and 5 being very important)				
Not at all Important	Not very important	Neither important nor unimportant	Important	Very Important
1	2	3	4	5

the frequency (2)

Metric: On a scale of 1 to 5 please select level of frequency (1 being never and 5 being always)				
Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

the supplier involvement (3)

Metric: on a scale of 1 to 5 please select the level of involvement (1 being not involved and 5 being joint item and process development)				
Not Involved	Consulted	Co-design in item development	Co-Design in process development	Joint item and process development
1	2	3	4	5

in PDD phases and design projects in order to enhance innovation.

3. QUESTIONNAIRE

3.1 TYPOLOGIES OF SUPPLIERS

3.1 : In the following **typical design projects**, how **frequently** do you select each type of suppliers?

Metric: On a scale of 1 to 5 please select level of **frequency** (1 being never and 5 being always)

		TYPES OF SUPPLIERS		
		NEW SUPPLIERS	EXISTING SUPPLIERS	LONG-TERM SUPPLIERS (more than 5 years)
TYPICAL DESIGN PROJECTS	1. product improvement in existing line			
	2. new product in existing line			
	3. new line in existing market			
	4. new product/new line in new market			

3.2 FREQUENCY OF TYPICAL DESIGN PROJECTS

3.2: How **frequently** is your company involved in the **typical design projects**?

Metric: On a scale of 1 to 5 please select level of **frequency** (1 being never and 5 being always)

		FREQUENCY
TYPICAL DESIGN PROJECTS	1. product improvement in existing line	
	2. new product in existing line	
	3. new line in existing market	
	4. new product/ product line in new market	

3.3 SUPPLIER CAPABILITIES

3.3 : Are there any **other supplier capabilities** you look for when selecting or involving suppliers in your projects? (If yes, please specify)

Other:

3.3.1 SUPPLIER CAPABILITIES IN TYPICAL DESIGN PROJECTS

3.3.1. A: In the following **typical design projects**, how **important** are each of the following **supplier capabilities** on enhancing innovation?

Metric: On a scale of 1 to 5 please select level of **importance**

		CAPABILITIES (IMPORTANCE)						
		User research service	Market research service	Technological capabilities	Specific design capabilities	Relational capabilities (soft skills)	Manufacturing service	Other
TYPICAL DESIGN PROJECTS	Product improvement in existing line							
	New product in existing line							
	New line in existing market							
	New product/ product line in new market							

3.3.1. B: In the following **typical design projects**, how **frequently** do you utilise the following **supplier capabilities** in order to enhance innovation?

Metric: On a scale of 1 to 5 please select level of *frequency*

		CAPABILITIES (FREQUENCY)						
		User research service	Market research service	Technological capabilities	Specific design capabilities	Relational capabilities (soft skills)	Manufacturing service	Other
TYPICAL DESIGN PROJECTS	Product improvement in existing line							
	New product in existing line							
	New line in existing market							
	New product/product line in new market							

3.3.2 SUPPLIER CAPABILITIES IN PDD PHASES

3.3.2.A: In the following **PDD phases**, how **important** are each of the following **supplier capabilities** on enhancing innovation?

Metric: On a scale of 1 to 5 please select level of *importance*

		CAPABILITIES (IMPORTANCE)						
		User research service	Market research service	Technological capabilities	Specific design capabilities	Relational capabilities (soft skills)	Manufacturing service	Other
PHASES OF PDD	Planning							
	Concept development							
	Detail design							
	Testing and Design Refinement							
	Product Launch							

3.3.2.B: In the following **PDD phases**, how **frequently** do you utilise the following **supplier capabilities** in order to enhance innovation?

Metric: On a scale of 1 to 5 please select level of *frequency*

		CAPABILITIES (FREQUENCY)						
		User research service	Market research service	Technological capabilities	Specific design capabilities	Relational capabilities (soft skills)	Manufacturing service	Other
PHASES OF PDD	Planning							
	Concept development							
	Detail design							
	Testing and Design Refinement							
	Product Launch							

Metric: On a scale of 1 to 5 please select level of *frequency* (1 being never and 5 being always)

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

Metric: On a scale of 1 to 5 please select level of *importance* (1 being not at all important and 5 being very important)

Not at all Important	Not very important	Neither important nor unimportant	Important	Very Important
1	2	3	4	5

3.4 SUPPLIER INVOLVEMENT

3.4: To what extent do you **involve** suppliers in each phase of the typical design projects?

Metric: on a scale of 1 to 5 please select the level of **involvement** (1 being not involved and 5 being joint item and process development)

		PHASES OF PDD				
		Planning	Concept development	Detail design	Testing and Design Refinement	Product Launch
TYPICAL DESIGN PROJECTS	Product Improvement in existing line					
	New product in existing line					
	New line in existing market					
	New product / new line in new market					

Metric: on a scale of 1 to 5 please select the level of **involvement** (1 being not involved and 5 being joint item and process development)

Not involved	Consulted	Co-design in item development	Co-Design in process development	Joint item and process development
1	2	3	4	5

3.5 MOTIVATIONS FOR SELECTING SUPPLIER CAPABILITIES

The **motivations** for selecting suppliers are the following:

- cost reduction / benefits
- technological and market knowledge / expertise
- technological uncertainty
- access to new technologies/ new markets / additional
- creation and innovation capabilities

3.5. A: In the following **supplier capabilities**, how **important** are each of the following **motivations** in **supplier selection**?

Metric: On a scale of 1 to 5 please select level of **importance**

		MOTIVATIONS FOR SUPPLIER SELECTION (IMPORTANCE)					
		cost reduction / benefits	technological and market knowledge/ expertise	technological uncertainty	access to new technologies/ new markets / additional	creation and innovation capabilities	other
CAPABILITIES	User research service						
	Market research service						
	Technological capabilities						
	Specific design capabilities						
	Relational capabilities (soft skills)						
	Manufacturing service						
	Other						

Metric: On a scale of 1 to 5 please select level of **importance** (1 being not at all important and 5 being very important)

Not at all important	Not very important	Neither important nor unimportant	Important	Very Important
1	2	3	4	5

3.5. B: In the following **supplier capabilities**, how **frequently** do you select suppliers for the following **motivations** in **supplier selection**?

Metric: On a scale of 1 to 5 please select level of frequency

		MOTIVATIONS FOR SUPPLIER SELECTION (FREQUENCY)					
		cost reduction / benefits	technological and market knowledge/ expertise	technological uncertainty	access to new technologies/ new markets / additional	creation and innovation capabilities	other
CAPABILITIES	User research service						
	Market research service						
	Technological capabilities						
	Specific design capabilities						
	Relational capabilities (soft skills)						
	Manufacturing service						
	Other						

Metric: On a scale of 1 to 5 please select level of frequency (1 being never and 5 being always)

Never	Rarely	Sometimes	Often	Always
1	2	3	4	5

Would you be interested in taking part in a further discussion?	YES	NO
If yes, please add your SKYPE DETAIL		

THANK YOU FOR COMPLETING THE QUESTIONNAIRE.
If you have any questions, please send an email to c.magistrone@cranfield.ac.uk.

APPENDIX 3 - QUALITATIVE FEEDBACK FOR QUESTIONNAIRE

- relational capabilities include also trust and reliability or we have to distinguish them?
- framework = what leads to differentiated innovation? [literature on differentiated innovation]
- ESI is worth doing also in designer-supplier relationship?
- please note that we are working on a designer’s point of view

STRUCTURE of ANALYSIS and QUESTIONS to Simon	
1. SIZE of the company	
2. SINGLE or AVERAGE project	
3. OWN supplier vs CLIENT’S supplier	How much freedom is left to designers in selecting their own suppliers?
4. concept of NEWNESS (to market or company)	
5. points of involvement of the supplier	In which phase of the project a supplier can support the designer in his innovation process?
6. correspondence between frequency and importance	can we identify a correspondence between frequency and importance ratings? My usual question is: ‘you put 5 in importance and 4 in frequency, does it mean that it is important but you don’t always do it?’
7. supplier-designer-client	What is the role of designer? The strategy is due to client of designer?
8. how to analyze data?	qualitative or quantitative analysis --> articles to read
9. position within SC	

CHANGES TO QUESTIONNAIRE	
1. definition of SUPPLIER	<ul style="list-style-type: none"> - Do we consider marketing consultants as supplier? - do we have to include the definition of supplier?
2. what about preparing a box in which they explain whether they are referring to single project or an average of projects? Or is it better to state a standard for us?	
3. user vs market research capabilities	They are not the same, is it better to divide them?

	(LdF+CWD)
4. reminder of description of planning phase?	
5. what about adding a motivation list?	
6. technological uncertainty is quite difficult to understand	
7. % or Likert scale	Isn't it better to fill in table 3.1 and 3.2 with percentage? I think it is easier.
8. what about including the description of the projects from Ulrich and Eppinger?	<p>NEW PRODUCT PLATFORMS: This type of project involves a major development effort to create a new family of products based on a new common platform. The new product family would address familiar markets and product categories. The Xerox Lakes project, aimed at the development of a new, digital copier platform, is an example of this type of project.</p> <p>DERIVATES OF EXISTING PRODUCT PLATFORMS: These projects extend an existing product platform to better address familiar markets with one or more new products. To develop a new copier based on an existing light-lens (not digital) product platform would be an example of this type of project.</p>
9. Ulrich and Eppinger	system design

DESIGNER	TABLE	FEEDBACKS
LdF	Table 3.1	He does it in horizontal, he thinks about logical concepts: new pdt in new mkt needs new supplier because of the nature of the project
LdF		The questionnaire is well structured for big companies but it doesn't involve ALEATORY that is a great issue in small and medium realities
LdF	suggestion for questionnaire	<p>PJT CAPABILITIES</p> <p>PHASE 1</p> <p>PHASE 2</p>

Cambri dge Industri al Design	3,1	He uses percentages to fill in the table
MC	3,1	He thinks % could be easier.
Cambri dge Industri al Design	3.3.	He fills the table in vertical. The focus in on CAPABILITIES. Alex asks himself WHEN are the capabilities INVOLVED? The tables can be read in 2 ways: 1. WHEN: from top to bottom crossing projects (Alex's way) 2. WHAT: from left to right crossing capabilities (Caro's)
Cambri dge Industri al Design	frequency vs importance	"When selecting suppliers I expect that importance and frequency are NOT separated"
Cambri dge Industri al Design	3,5	Vertical filling: focus on capabilities.
MC	3.3.1.B,C,D	he compares the same cell along the different projects (frequency of user and mkt research capabilities in 1.B, 1.C and 1.D) / mind that he fills the questionnaire in vertical, thinking about the frequency
MC		difficulties in understanding the level of involvement.

DESIGNER	INFORMATION FROM INTERVIEWS
LdF	projects 3 and 4 need new suppliers because of the nature of the projects
Cambridge Industrial Design	Def of Suppliers = any company that we use during the whole course of the project
MC	Def of Suppliers = “you don’t usually rely on suppliers for user and mkt research capabilities unless you consider a mktg agency as a supplier”
Cambridge Industrial Design	<p>Definition of Relational Capabilities =</p> <ul style="list-style-type: none"> - relational capabilities are built-in - quality of relation - “relationship thing is a difficult one to include, I feel because it is <u>outside of the normal criteria of selecting suppliers that are quality, cost, technical abilities.</u> Those are good things, but personally, I find it difficult to select a supplier if I don’t like him... because I have a choice!” - relational capabilities complete the service offered to the client - specific time related - cross-boundary capability - every supplier has to have relational skills - relational capabilities make the difference in a relation - comes from a designer attitude <p>“For designer, <u>I think you have to be very good at building relationships because we are the centre of the customer and the suppliers and we have to manage both.</u> The supplier doesn’t really have the same issues and some of them don’t really care, there are plenty of other people, other customers, so it is a kind of ‘if you don’t like me, you go...’, so suppliers don’t view relational capability as a service that they supply and a good service to make people come back. Since we have to deal with both sides, customer and suppliers, we have to learn to be <u>supportive and responsive</u> otherwise no one will come back. <u>I think most designers are very good at it, most suppliers are not very good at personal skills.</u>”</p> <p>Rel Cap is a cross-boundaries capability = it is very important, everyone needs it above other cap --> it can’t be compare to the other capabilities.</p>
MC	Specific design capabilities of suppliers = they can do sth that other suppliers can’t.
MC	<p>Relational caps are always important. Human compatibility is fundamental.</p> <p>Tech cap are essential.</p>
Cambridge Industrial Design	<p>Quality of relation leads to quality of pdt/project</p> <p>NB “If I don’t have a good relation with a supplier, my client will not act a good pdt,</p>

	<p>a good design.”</p> <p>It is difficult to measure how quality of relation impacts on quality of finished pdt/ projects.</p>
MC	<p>Quality of relation leads to quality of pdt/project =</p> <p>It is related to the better final quality and better quality price ratio.</p> <p>A quality product needs so many entangled bricks. These bricks are results to good relationships along the supply chain (designers, shareholders, stylists, suppliers, etc)</p>
Cambridge Industrial Design	<p>Designer’s role in SC =</p> <p>designer is the centre of the relation and enabler of contact, contact for the two worlds.</p>
MC	<p>Designer’s role =</p> <ul style="list-style-type: none"> - creative problem solving + comprehension of customer needs - it is to solve a problem through an idea (whether radically innovative or not) and test prototypes.
MC	<p>Product improvement project and new pdt in existing line project are related to existing and long term suppliers.</p> <p>New suppliers are a huge investment.</p> <p>Designers prefer working with established and long-term suppliers. The set of existing supplier is the starting point in selection.</p>
MC	<p>Relational capabilities are chosen to get benefits such as communication celerity, communication clearness and communication reliability: they lead to cost reduction.</p>
MC	<p>The questionnaire was quite difficult because I have never thorough about these questions myself, even through I’m now realizing their importance. <u>Very often you don’t have time to plan how to select suppliers, you just do it automatically since you don’t have time.</u></p>

DESIGNER	OTHER CAPABILITIES
LdF and CWD	R&D department in-house
LdF	overall complicity with client (it is more than relational capabilities) --> designer becomes part of the internal team even if he is an external consultant
LdF	reliability
LdF	risk sharing between supplier and designer
LdF	process awareness
LdF	He worked for Foster and Partners. He understood that the <u>chain of competences</u> can make

	the difference.
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MOTIVATIONS for SELECTING SUPPLIERS

DESIGNER	MOTIVATIONS for SELECTING SUPPLIERS
* loyalty, reliability, trust	MAIN MOTIVATIONS to select suppliers
* quality of relation	
* quality of performance	

PHASES OF THE PDD	Michele Camerlengo'S REMARKS
Planning Phase	assessment of supplier capabilities “In the planning phase you need to know if the person you’re dealing with has the technological capabilities you require (importance = 5). It is quite weird but in the planning phase you’ll have to plan the project phases with the supplier...I need to know the facilities of suppliers from the beginning.”
Concept development	The concept doesn’t need to be feasible or realistic. The concept development is an initial brainstorming phase for the designer. My rule is ‘no boundaries’ in this phase expect for some info about user and market research cap. Firstly, many ideas come from the concept development phase. Secondly, only the feasible ones are chosen.
Detail design	Beginning of interaction between designer and supplier.
Testing	continuous relationship among designers, suppliers and clients