UNIVERSITÀ POLITECNICA DELLE MARCHE
FACOLTÀ DI ECONOMIA "GIORGIO FUÀ"

Dottorato di Ricerca in Management and Law

Curriculum Economia Aziendale

XXXI Ciclo

ANALYSING NEW PRODUCT DEVELOPMENT AND CO-CREATION IN INDUSTRIAL NETWORKS: PATHWAYS AND CAPABILITIES

Supervisor:

Prof. Andrea Perna

Tesi di Dottorato di:

Andrea Sabatini

Anno Accademico 2017/2018

Table of Contents

List of Figures

List of Tables

Chapter 0

INTRODUCTION

The primary aim of this work is to shed light on new product development processes deployed by firms in co-creation with their customers and users. In order to do so, this manuscript stems from the pioneering studies on industrial business interactions developed by Håkansson, Snehota and the Swedish school of Industrial Marketing that later established the Industrial Marketing and Purchasing Group (IMP Group). In order to develop a study which could use the IMP Group's perspective, and in order to analyse processes and business interactions occurred within the new product development processes, the main textbooks developed by Håkansson (1987) and Håkansson and Snehota (1995) will be taken as the theoretical stepping stone of this work. In fact, these books can be considered also the first milestones of the IMP Group theoretical background. In the journey to conceptualise the new product development co-creation process, it could be relevant to highlight the complexities of the interactions that firms should deploy in order to collaborate together with external actors for creating new products.

Regarding product innovation since the eighties with Takeuchi and Nonaka (1986), it is possible to recognise a shift in the understanding of the NPD approach, occurred and developed by scholars across the world in order to cope with different

firms' requirements, but the majority of these approaches started taking into consideration also the increasing importance of the role of the customers' involvement in the NPD process, or broadly the role of external actors (Lynch and O'Toole, 2003). The NPD is still analysed from a considerable number of scholars, and it is also possible to find several relevant researches on the effects, benefits, causes and implications of the customers' and external actors' involvement in NPD co-creation, but very few of these researches focused on the description, with a wealth of details, of the NPD co-creation process and the possible ways in which companies could manage to develop new products in collaboration with their customers or their users.

With the growing number of studies about customer involvement in NPD co-creation processes, and the consequent growing number of firms which develop products with, and according to the insights of customers and external actors, there has been a stream of literature about collaborative creation of new products which started from the initial studies of Prahalad and Ramaswamy (2000), which aimed at understanding and shedding light on the process that brings firms develop products together in order to obtain benefits related to time and costs improvement and, moreover, a product which is better suited to the users' needs and desires.

After the brief introduction of the theoretical positioning of the thesis, it is important to underline that, as suggested also by Jones and Holt (2008), the business processes phenomena that can be addressed to product creation and product development with

the support of customers and users – although the extant studies on the subject – are not clear enough. Therefore, this study has the aim to explore this phenomenon and to attempt to answer the research questions, highlighted at the end of the following chapter 1, about the different ways that can be used to develop new products with customers and how collaborative capabilities can be developed in order to be able to involve customers and users for developing new products in co-creation.

This manuscript is structured as follows: the first chapter presents a literature review with the aim of describing the theoretical background of the study by presenting the IMP theories about industrial marketing, the Industrial Network Approach and the ARA model; then it describes the new product development theories in order to create an understanding of the phenomena, and then the concept of co-creation is defined by taking into consideration the most relevant researches on the subject. The second chapter is dedicated to the description of the research methodology adopted to develop the thesis, including also the methods used to collect and analyse data. The third chapter is dedicated to the description of the company that is used as case study, the knowledge and technologies embedded in its product and the product itself; this could be helpful in order to understand the various collaborations and strategies developed by the focal firm in order to develop the product over time. The fourth chapter is dedicated to the description of the findings of the data collection of the case study; the process will be analysed in order to understand the various interactions that supported the development of the

product. The fifth chapter describes the discussion about the findings, and it tries to make a theoretical contribution via the unification of the previously analysed theory and the findings of the case described. The sixth chapter describes the conclusive remarks about the case, the process and the findings in order to make a recap of the whole case described.

Chapter 1

THEORETICAL LITERATURE BACKGROUND OF MARKETING AND NEW PRODUCT DEVELOPMENT

1.1 – The IMP Heritage

Since the first IMP based books, the purpose of researchers has been to develop knowledge and theories in order to understand and shed light on the buyer-seller relationship within industrial markets. For these reasons, the main topics of the IMP researches are often mainly focused on the relationship between different actors that are buying or selling within the business network. Soon after, IMP researchers recognised that their aim on investigating the buyer-seller business relationship required also the selection and the study of a considerable number of different empirical settings which could have different characteristics in order to take into account every possible detail, with the purpose to build a robust stream of theory on how these relationships can be conceptualised and managed.

The initial framework, which gave inspiration to all the studies that supported the development of further IMP theories, considers these different aspects (Håkansson, 1982): the interaction process (made up by episodes), the interacting parties (firms and individuals), interaction environment (market or general environment – later

described as business network) and atmosphere. It is clear, thus, that one of the main purposes of these studies was - as remarked also by (Håkansson, 1982) - to emphasise the importance of interpersonal relations and interactions between firms in overcoming initial difficulties in business relationships.

From an IMP perspective, business exchange is not understood as a set of non-embedded and independent transactions of certain types of resources. Rather, it can be conceived as a complex set of relationships between two or several actors whose aim is to create new resources through interactions (Håkansson, 1982; Håkansson and Snehota, 1995).

Later, IMP researchers discovered that there are a considerable number of issues which a firm could face while dwelling the market in order to find suitable suppliers and loyal customers. In order to succeed at surviving in this environment through time, the firm has to implement a considerable number of different activities, such as the research and evaluation of suppliers and customers, the adaptation of its needs to the products or the organisational methods of its suppliers' firms, the adaptation of machinery and technologies, also in terms of knowledge and competences, on the basis of the requests and behaviours of the suppliers and customers' firms. This could be relevant to point out that when the first studies on IMP theories were under development, several researchers started taking into account also other major theories about buyer-seller interactions between two or more organisations. To build up IMP assumptions, researchers took suggestions from other streams of

research, such as the interorganisational theory and the transaction cost theory; these two theories in particular contributed to building the framework for the IMP industrial network approach thinking (Ratajczak-Mrozek, 2017).

The IMP approach to industrial marketing can be addressed to consider firms not as isolated entities, but as entities which are interconnected with other actors in the network structure. These connections are managed through business relationships and business interactions. (Håkansson, 1982, 1987). A business relationship consists of various aspects. The main dimensions of these crucial elements in IMP theories will be discussed in the following pages of the study. Another unique aspect of IMP theory is that firms are considered interdependent with regard to other actors, and for this reason, the linking of activities and resources calls for adaptation and formation of routines between the firms (Håkansson, 2009; Landqvist, 2017). First of all, interactions are "understood as being directed towards clearly defined counterparts. Secondly, these interactions are assumed to result in different strata, affecting social, economic and technical features" (Håkansson and Waluszewski, 2002).

The IMP – Industrial network approach is then characterised by permanent links; thus, firms are not understood as isolated, but as connected and in continuous interaction. One of the main effects of these variables is the chance to reduce transaction costs in the exchange between firms, improving direct and/or indirect access to resources, and establishing non-formalised relationships amongst single

persons within firms (Ratajczak-Mrozek, 2017; Håkansson, 1982). The IMP group research tradition is often described as a reaction to the existing research tradition that was analysing individual sale-purchase transactions and individual decisions separately; furthermore, the researchers aimed to go against the assumption that companies (and their activities and economic value) are autonomous and independent (Håkansson, 1982; Ratajczak-Mrozek, 2017). Baraldi et al. (2007) pointed out that "it is a characteristic of the IMP approach in studying business markets that the emphasis is placed upon rich description and efforts to understand the underlying processes behind interaction between organisations in networks, rather than on the formulation of managerial checklists and decision rules. Consequently, the overall contribution of the IMP approach to the strategy literature has been fairly slim". This statement allows for several questions on the IMP perspective on business relationships, network and actors' cooperation in developing new products and innovations. In particular, the IMP studies recognises a "market" as a business network, arguing that the actors are connected to each other through "extensive, intense, ongoing" business relationships but, at the same time, they remain independent (Håkansson, 1982; Håkansson and Snehota, 1995; Ciabuschi, Perna and Snehota, 2012).

One of the starting points for assessing the effectiveness of a firms' business relationships development is considering that every buyer-seller relationship requires an investment, in terms of financial, personal or tangible resources, from

both counterparts. These and many more implications that can be related to the IMP approach will be described later in more detail. They are the reasons that could trigger a firm which is buying or selling something to start analysing the investment made in the relationship, and thus the investment return rate, on the basis of the cost sustained to build and develop certain relationship with a supplier or with customers (Håkansson, 1982).

The critical arguments around investments and return on investments while discussing about the relationship with suppliers and customers are originated by the assumption of Håkansson (1982) that industrial markets are mainly characterised by stability and long-lasting relationships between actors. For this reason, the investment on relationship could be perceived as a typical investment cycle (Håkansson and Snehota, 1995).

In synthesis, the guidelines to manage this type of business relationships in the industrial settings that the aforementioned author described were, in the first instance, that both buyers and sellers are active participants in the 'market'; their relationships (between buyers and sellers) are often long term, the links between buyer and seller often become formalised into a set of rules and roles that each party expects the other actors to perform (Håkansson, 1982).

The main challenge faced by all firms is the development of new relationships, which are necessary in order to achieve long-period growth and continuous performance enhancement through interactions. Furthermore, the development of

new relationships allows firms to replace the potential customer loss and the declining or non-profitable business relationships. Acquiring new customers is, perhaps, the most critical task for a new venture, not only from the IMP perspective. Furthermore, according to the characteristics of the business relationship, the aspect that made it very complex (for a 'quasi-new' organisation) is to fit into buyer requirements. (La Rocca, Ford and Snehota, 2013)

Therefore, it is clear that the core of the relationship between buyers and sellers is the interaction process that occurs through time. According to the authors (Håkansson, 1982; Håkansson and Snehota, 1995), IMP theories assume that this process is composed by episodes and relationships. The episodes have been classified into four main classes, which are: product or service exchange, information exchange (technical, economic or organisational), financial exchange (quantity or quality of money) and social exchange (links, formalisation). The role and the performance of the firms could often be analysed by their ability to start and develop new business relationships (Håkansson and Snehota, 1995). The relationship has been investigated also in terms of the adaptation efforts required, the number of interactions between actors, their roles and links.

In the IMP perspective, business relationships has been described with several structural characteristics, the most important of which are the following:

- continuity: it means that business relationships usually are long lasting and quite stable;

- complexity: business relationships develop with a high number of different actors, involving several persons (in different roles and on both sides), with a shifting role of these actors within the single relationship over time. Furthermore, also the goal of the relationship may change over time for both parts, or only for one of the counterparts;
- symmetry: in the long term, resources and capabilities will balance out between all the actors involved in the relationships;
- informality: a high degree of informality is related to the ineffectiveness of formal contact in managing uncertainty and unexpected situations (Håkansson, 1982; Håkansson and Snehota, 1995).

Thus, especially for these reasons, the ability to develop and nurture business relationships represents for almost all the firms one of the most complex and important processes to deploy. This process requires from the actors also the development of a set of specific activities in order to involve and manage interdependencies:

- adaptations: they are prerequisite of the development and continued existence of a relationship between two companies (Hallen, Johanson and Seyed Mohamed, 1989);
- cooperation and conflict: while operating, conflicts - of larger or lesser degree – are normal and will continue to occur. The existence and survival of the

relationship is based on the commitment of the parties towards the development of constructive solutions;

- social interaction: personal bonds, and the related convictions, are always present and usually plays an important role in information exchange between actors in a relationship;
- routinisation: while business relationships are – as already described – complex and informal, they tend to become institutionalised over time (Håkansson, 1982; Håkansson and Snehota, 1995).

Then, a considerable number of empirical researches – not only developed within the IMP stream of literature – confirmed that a limited number of relationships could have a deep impact on a single firm's performance. This phenomenon is also known as 80/20 or "Pareto" principle, and it is adopted and intended by several scholars and managerial authors with the same meaning (Koch, 1997; Håkansson and Snehota, 1995).

The development of IMP theories on relationships pointed out a series of implications that firms have to consider while engaging in the business network:

- In a considerable high number of firms, single relationships could have a huge impact on their economic performance; for these reasons it is important to manage these specific relationships in order to preserve and cultivate the value of the business relationship.

- All business relationships are understood as “dyadic”, and for this reason firms cannot control nor decide in a unilateral way. Because they are part of a network of relationships, firms must adapt and learn from the interdependence with others (Håkansson and Snehota, 1995).

Prior studies on business networks showed that only a limited number of “key relationships” are crucial for the development and the growth of a firm. Within the business network, actors will indeed develop a shape in order to build up dyadic relationships with the other entities, in order to create value for themselves and for others (Håkansson, 1982; Håkansson and Snehota, 1995; Ciabuschi, Perna and Snehota, 2012).

In relation to these aforementioned implications about business relationships, personal contacts could have a crucial role in influencing the dyadic relationships between firms, governing the power balance between buyers and suppliers, and by regulating reciprocal dependence of all the actors involved (Håkansson and Snehota, 1995). It is useful to briefly conceptualise power balance according to the definition given by Dahl (1957) in describing the idea of power when “A has power over B to the extent that he can get B to do something that B would not otherwise”. Dahl (1957) also identified several different types of power. Here is presented a brief list with the ones which are the most relevant for our further discussions: reward power, coercive power, referent power, legitimacy power, expertise power and informational power. The reciprocal dependence between buyer and seller is

affected also by the purchasing strategies used by the buyers and the marketing and sales strategy deployed by the seller. It is clear that the selling firms have to adopt a purchasing strategy coherent with their marketing and sales strategy in order for it to be compatible with its use of the internal resources (Håkansson, 1982). The personal contact patterns are also recognised by Håkansson (1982) as the "most useful mechanism for influencing the relationship". Another main starting assumption made by Håkansson (1982) is that the supply market could have two fundamental characteristics: the degree of concentration and the degree of dynamism. The degree of concentration is regulated by the number of different producers of the same technology (or the number of the 'owners' of the same knowledge): the fewer they are, the more concentrated the business network will be. The degree of dynamism is regulated by both technical and economic changes that may occur in the ecosystem in which the firms are embedded (Håkansson, 1982). After all, it is important to consider that the organisation of the persons involved, the timing of deployment of the different activities and the ability to adapt their own procedures to those of the counterparts are important marketing and purchasing skills in the situations described before (Håkansson, 1982).

In conclusion, while in a relationship, both buyer and seller are involved in a continuous learning process that supports the two parties in realising if they fit together; if this is the case, they will intensify the interaction process and strengthen their relationship. It is known that these relationships are often characterised by the

absence of structural or knowledge obstacles to the interaction between the two parties. Particularly, the knowledge dimension of the relationship could be related to the information exchange between the parties involved.

The Industrial Network Approach

Since the early stages of IMP studies development, researchers emphasised the relevance of the firms' context in terms of business relationships and networks (Håkansson and Snehota, 1995; Aaboen et al., 2016). In IMP literature, the business network can be conceived as a loosely defined structure where a considerable number of actors related to each other for specific reasons (Håkansson, 1982). Ratajczak-Mrozek (2017) grouped different theories which were developed following the definition given by Håkansson (1982) and Håkansson e Snehota (1995) to define the business network in the IMP approach as a set of "repetitive trans-actions based on structural and relational formations with dynamic boundaries comprising interconnected elements (actors, resources, and activities)". A network is often understood in marketing and industrial theories as "as an intermediate form between a market and a hierarchy" (Ratajczak-Mrozek, 2017). A network can be seen also as a group of specific, indirect or hybrid connections which coordinate the economic exchange; and it is perceived as an effective way to coordinate strategic decision without limiting the autonomy of a firm (Håkansson and Snehota, 1995; Ratajczak-Mrozek, 2017). IMP theories tried to shed light on the main

characteristics of networks, i.e. the interdependence between dyadic relationships, which mean that an exchange between buyer and seller is influenced by other relationships in the business network in which they are embedded. This led to the idea of interdependence, which according to IMP network approach, is the impact on other actors, also known as externalities, of the results of the business relationship in the business network. Usually, interdependence is recognised as a bilateral dependency, when the impact that the firm could have on other actors is the same that others could have on the firm (Håkansson, 1982; Ratajczak-Mrozek, 2017). Baraldi et al. (2007) assumed that the paradigm of interdependence distinguishes the IMP network approach from the other stream of theories about industrial marketing. Networks are often conceptualised as a considerable number of firms connected through a direct or indirect relationship which constitutes a whole with blurred – or objective – boundaries that could extend without limits. Thus, in the network logic described by Gadde et al. (2003), "Activities and resources are not coordinated and combined spontaneously. They are purposefully directed by many individual actors who systematically try to influence one another". Håkansson (1987) talks about networks also in terms of several "visible hands" – meaning actors – that try to create, stimulate and influence situations that will be beneficial to themselves. The IMP approach is based on interactions, interdependences, and constant dynamism of business activity (Ratajczak-Mrozek, 2017). As a result of the IMP perspective on the business network, firms have

limited degrees of freedom when the results of their activities depend on the activities of the other actors in the same environment – i.e. business network. This idea originated in the IMP network approach the need to define a position in the network for every actor. Håkansson and Snehota (1995) developed the idea of network position rather than market position. This concept is more related to the power and dependence dimensions rather than to the evaluation of potential conflict between them. The same authors define a network position "with reference to the nature and type of relationship a company has, how it is situated in a network with respect to others, customers, suppliers and other third parties with whom it has direct relationships or to whom it indirectly relates" (Håkansson and Snehota, 1995). In synthesis, the industrial network approach focuses on inter-firm interactions, where firms are embedded in business networks, and in order to achieve the expected results, firms have to manage the business network by developing a network strategy.

A network strategy, therefore, can be analysed also in terms of structures and dynamics. The structural components of the network are related to the number of firms involved, the long-term features of each business relationship, and the configuration of external resources, their transferring and their exchanging. These interactions within the network are understood as "dynamic" because the processes activated by the actors can change with high frequency and, thus, can generate a direct or indirect effect that can lead to major changes also in the structural

components of the relationship, such as the emergence of a new goal or a new vision (Baraldi, 2008).

The aforementioned heterogeneity of the actors on the market, that in IMP theory is conceived as the business network, makes it difficult and costly for the firms to change or shift counterparts. Therefore, large resources should be put into the improvement of an existing relationship in order to make them more effective and efficient. This so called dynamic and heterogeneous environment makes the development of the relationship with a counterpart a necessary activity for firms, otherwise the firm must be ready to shift to another counterpart with great attention to the potential costs and critical issues. In the first book about industrial marketing developed by Håkansson (1982), the network was described as “atmosphere”. The atmosphere is one of the dimensions that more than others could influence the relationship between the actors of the business network. According to Håkansson (1982) the atmosphere “can be described in terms of the power–dependence relationship which exists between the companies, the state of conflict or co-operation and overall closeness or distance of the relationship as well as by the companies' mutual expectations” or, in other words, “the atmosphere is considered as a group of intervening variables, defined by various combinations of environmental, company specific, and interaction process characteristics”. Thus, it is possible to say that, in every single relationship, the atmosphere affects and is affected by a specific interaction process in a specific environment. Atmosphere

can be understood also in terms of trustworthiness, co-operation and closeness that is built between two companies.

Business networks can be understood also as a way to achieve success in interaction with the other actors of the business network by blurring the firm's boundaries (Håkansson e Snehota, 1995). The benefits that could be addressed to an efficient business network can be conceptualised in the possibility to have access to a wide variety of business opportunities, resources, information, new ideas, and to build up reputation and other dyadic business relationships through trust developed with the counterparts (McGrath and O'Toole, 2013).

In the first work on the industrial network approach, Håkansson (1982) tried to conceptualise the buyer-seller relationship by identifying five different stages of their relationship. These stages are: (1) pre – relationship stage, (2) early stage, (3) development stage, (4) long-term stage and (5) final stage. In order to provide a brief explanation of these stages using Håkansson's (1982) suggestions, it is possible to recognize - in terms of requirements and activities - the early stage of a relationship as the one that requires a speedy evaluation of the counterparts' requirements and performance; the development stage requires the demonstration of commitment by resource allocation and adaptation to the counterpart's requests. Perhaps even more importantly, the long-term stage requires a constant re-examination of the activities by the counterpart, in terms of routines and standard operating procedures which have been established. The final stage means the

reaching of a stable condition over long periods of time, and the counterparts have to look for institutionalisation processes, codes of practice and formalisation.

These relationship stages could be useful also to depict the relationship between buyers and sellers and analise the deployment of their relationship. The authors recognised a set of six different roles that could be covered by the actors involved during the business relationship. These are: (a) information exchange role, related to the soft information transfer within relationships; (b) assessment role: thanks to personal judgement and perceptions, is possible to evaluate new partners with reduction of the risk dimension; (c) negotiation and adaptation role: personal contacts are the media of persuasion and negotiation for adaptations, processes and deliveries that are discussed and agreed upon through personal discussions between specialists from each firm; (d) crisis insurance role: a personal contact can be seen also as a 'safety valve' to manage critical situations between firms; (e) social role: the fact that people establish social relationship besides professional relationships could help make the work relationship more congenial; and (f) ego-enhancement role: when a relationship is established with senior or top management people in order to enhance one's own status within the organisation. This contact could become a critical issue if it is not managed (Håkansson, 1982). In the IMP approach, firms or single actors are not conceived as autonomous (free) in resource creation, collection, and development. Thus, the firms' access to resources and information is strictly connected to the interactions and the relationships developed with other

firms. It is important to highlight that the informal relationships between actors should be developed by respecting norms of reciprocity, solidarity and trust. Otherwise, firms can choose to develop the relationship through formal agreements, which means that the relationship will be developed via contracts, rules and regulations (McGrath, O'Toole, 2013).

But, as mentioned, the main dimensions that can be taken into account to conceptualise the business exchange are, in this case, adaptation and commitment. Adaptation can be shaped into two different forms: formal (i.e. contractually agreed upon) and informal (agreed upon later in order to deliver the object of the exchange or to cope with particular issues) (Håkansson, 1982). When talking about adaptation and commitment in the business relationship, the author emphasises the clear difference between the supply of simple materials – like paper clips – and complex products – like automotive components. One of the main reasons of this difference is that the product and process technologies of the two companies involved are crucial factors in determining the nature of the buyer-seller relationship. When involved in several relationships, a firm has to adapt its activities in order to raise the complementarity with its counterparts and to face the complexity of the interaction pattern as it arises. Relationships are often understood as dyads, and these are also parts of a network where the firm is embedded (Håkansson, 1982; Håkansson and Snehota, 1995; Ratajczak-Mrozek, 2017).

The formal and informal, as well as direct and indirect contacts – both resulting in interactions and business relationships - are useful to stress the concept of the significance for a company of the surrounding environment and ecosystems or – as defined by the IMP theory – of the network context (Håkansson, 1982). Commitment in business relationships is intertwined with the adaptation dimension, in fact – as the author clarifies – it is often said that "a company's commitment to a relationship is often underlined by its `flexibility' in meeting problems in the relationship" (Håkansson, 1982). It is recognised that the more technically complex the product and the higher the intensity of the contacts, the more adaptations and commitment will be required from the counterparts as opposed to what is required for less complex products or relationships.

Thus, in the industrial network approach theory, frequent personal contact can be seen as one of the focal elements. Personal contact can be understood also as an important means for establishing trust, loyalty, and technical confidence with the actual and the potential buyers. it often happens that firms tend to formalise personal contact patterns with the specific aim of maintaining and developing the counterparts' higher level of confidence, loyalty, and technical and business information exchange (Håkansson, 1982).

In order to complete the picture about buyers and sellers' relationships, it could be useful to introduce two more dimensions utilised by the authors that characterise the interactions between the counterparts. These are the concept of problem solving

and transfer. According to Håkansson (1982) the buyer's needs can be analysed in terms of the solution required to solve its specific problems, or to satisfy its needs, and how these solutions could be transferred in the most effective way to the buyer who is in need of them.

These assumptions on the buyer-seller relationships are built on the paradigm of "markets as a network", where a firm can be seen as a small part of a larger network of relationships, and the network can be seen as the result of the interactions and the relationship between entities with diffused and/or blurred boundaries. (Ratajczak-Mrozek, 2017) IMP uses a different perspective of the market described by textbooks or other streams of literature that understood a "market as an impersonal mechanism existing 'out there'" (Håkansson and Snehota, 1995). A relationship developed between two or more firms is classified by IMP using activity links, resource ties and actor bonds that are developed between these actors during their relationship. These links, ties and bonds develop a relationship between several actors that could be conceived as a quasi-organisation. (Håkansson and Snehota, 1995)

Thus, for IMP researchers, three different layers of substance can be identified in a business relationship: activity, resources and actors of the developed model. This is known as the ARA model, and here below is presented a description of the model and its components.

The A.R.A. model

The IMP researchers developed several models, or frameworks, in order to analyse and shed light on the dyadic relationship between the actors embedded in the business network. One of these models that particularly took ground amongst IMP scholars and practitioners is known as A.R.A. model, and it was developed by Håkansson and Snehota in 1995.

It has been already described that IMP understood business organisation as heterogeneous, and that buyer and seller are active actors in the business network. Conceptualising these relationships is fundamental to understand the behavior of the actors in the network in terms of marketing and purchasing activities. Moreover, these relationships between two firms are influenced or are dependent on other relationships that these firms could build up with third parties, or from other interaction processes or other network of relationships. The implication of the IMP ARA model, as described by Håkansson and Snehota (1995), is that "the environment is understood as not faceless, atomistic or within the control of an organisation, but rather as ruled by the interdependencies created by the interaction between actors" (Gebert-Persson, Mattsson and Öberg, 2014). Therefore, it is important to underline that a business network is seen as a context-specific element for every actor (Gebert-Persson, Mattsson and Öberg, 2014).

The ARA model can be considered one of the several frameworks developed by IMP scholars in order to attempt to investigate and explain the business relationships within networks (Håkansson and Snehota, 1995).

The ARA model is centered on a 'relationship view' and conceives business relationships as voluntary and created by the actors involved (Håkansson and Snehota, 1995). Earlier in this paper, it has already been discussed that these relationships will create interdependencies between the actors in terms of technology, knowledge, social relations, routines, and that this could in a certain way enhance some processes and constrain others (Gebert-Persson, Mattsson and Öberg, 2014; Håkansson and Snehota, 1995).

This theory conceptualised the substance of every business relationships by using three different layers that can be used to investigate, asses, predict or explain the characteristic of every relationship; these layers are: activities (links); resources (ties); and actors (bonds). (Gebert-Persson, Mattsson and Öberg, 2014; Håkansson and Snehota, 1995).

Gebert-Persson, Mattsson and Öberg (2014) highlight that "The function of a relationship refers to who is affected function; for the two companies their activity structure, resource collection, organisational structure; for the dyadic relationship the activity links, actor bonds and resource ties are affected; and for third parties, that are directly or indirectly linked to a focal relationship".

Business relationships are intended as connected in a heterarchical mode, with a dynamic structure, no given center and an open structure with blurred boundaries: the management of these issues is usually termed as "coping" (Håkansson and Snehota, 1995). Ford and Håkansson (2006) argued that business relationships cannot be monitored nor managed by any business organisation; these relationships are rather the outcome of doing business and thus the outcome of the interaction between two or more parties (Håkansson and Snehota, 1995; Gebert-Persson, Mattsson and Öberg, 2014).

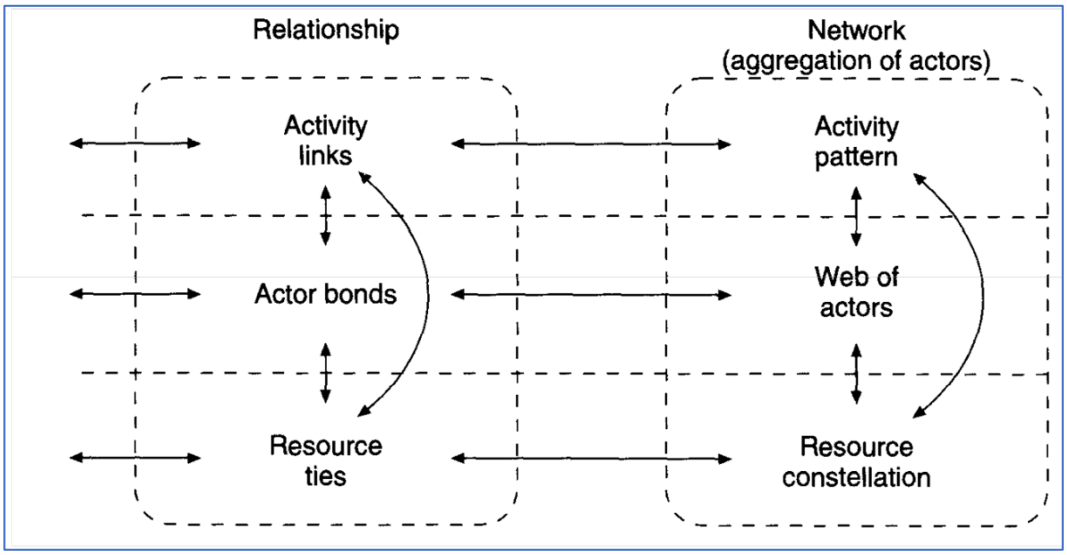

Figure 1.1 - Relationship as a dyad: activity links, resource ties and actor bonds (Adaptation from Håkansson and Snehota, 1995, p. 44)

In these dyadic relationships (See Figure 1.1), the development requires the co-alignment of both parties. Thus, how the relationship will develop depends on the

actors' actions and reactions within their interactions. Relationships could improve or deteriorate as a results of the actions of the actors. The relationship takes the form of activity links, resource ties and actor bonds (Håkansson and Snehota, 1995).

Activities

Håkansson and Snehota's (1995) conceptualisation of the ARA model suggests that "activity links regard technical, administrative, commercial and other activities of a company that can be connected in different ways to those of another company as a relationship develops".

Furthermore, the IMP approach highlights that the firms' activities' structure may affect the relationships between two or more companies, thus the way these companies perform their activities.

I order to provide a precise definition of activity, it is useful to consider the view of the developers of the model themselves, Håkansson and Snehota (1995): "Companies do things, they perform various activities, develop products, produce and process information, purchase and sell. Activity can be defined broadly as a sequence of acts directed towards a purpose. developing activity links in a relationship means that activities performed by a company become connected to the activities of others."

The aforementioned authors pointed out that all the activities previously described (developing products, producing, processing information, purchasing and selling)

are not carried out in isolation by actors, but that these are strictly dependent on the activities of all the other parties involved in the business process. This phenomenon laid its basis on the IMP perspective about the "actors" of the relationship; these entities "are related by activity links in business relationships to the other company's activity structure and to the wider activity pattern spanning several companies" (Håkansson and Snehota, 1995). Indeed, business relationships are described as one of the ways, or, more precisely, the mechanisms by which the activities' interdependencies between actors are handled. The whole set of activities developed by firms is embedded into a broader activity pattern that is grounded in the interdependency relationship with other firms (Håkansson and Snehota, 1995). The interdependencies between the actors' activities arise because in the industrial network approach, a relationship between two or more actors has the power to connect the activity structures of the counterparts involved. It is clear that activities can link, more or less tightly, a considerable number of parts of the activity structures of the parties involved in the business exchange. The number and type of activity links in a relationship can vary amongst different connections. It is possible to understand activity links also as a form of coordination of the dyadic relationship within the actors. This coordination is achieved by mutual adjustments of activities of the participants. Adaptation is the first condition, and the main consequence of activity linking. Håkansson and Snehota (1995) made clear that "Adaptation is also

the critical ingredient in intercompany relationships" in order to point out the crucial function of adapting in relationship.

The deployment of activities and the strengthening of activity links amongst companies tend to establish routinisation and institutionalisation in the relationship (Nelson and Winter, 1982; Håkansson and Snehota, 1995).

The main effect of every activity link in the business relationships is directly related to the structural (efficiency – in terms of capacity to solve problems and seize new opportunities) and the dynamic (development – shifting over time) sides of the interactions. The more the firms are engaged simultaneously in several business relationship, and thus in developing together a considerable number of different activity links, the more the combinations and the impacts of these different links are relevant for the business network (Håkansson and Snehota, 1995).

Resources

Resources (i.e. technological, material, knowledge and other tangible or intangible resources) are connected between two or more entities – or actors – through business relationships. Resources also have the role of connecting via business relationships two or more entities – or actors – within a business network. IMP group theories intend a resource as "a combination of technical, personal, financial and other factors needed in a business relationship" (Håkansson and Snehota, 1995). Every firm is built on a specific set of resources, that constitute the starting

point for the creation of value through resource assembly and business interaction with other actors (Ciabuschi, Perna and Snehota; 2012). Therefore, it could be possible to identify firms' resources with tangible or intangible elements – or assets – that are not free in supply (manpower, technical facilities, know-how, financial resources, material, relationship, knowledge, trust, company image, etc.). Furthermore, resource ties are seen as the result from the development of the business relationship within a network, and could represents themselves a "new" resource for the firm. A relationship between two actors may have various effects on the way the same actors will utilise resources. Thus, the conceptualisation of resource heterogeneity in use is not new. Alchian and Demsetz (1972) (Håkansson and Snehota, 1995) argued, for example, that the very existence of firms could be explained by resource heterogeneity, and that the first capacity of a business network is to connect the actors' resources.

As described for business relationships, the development of the resource ties between actors in the business network may take a long time (Håkansson and Snehota, 1995).

The combination of resources and activities could bring about the development of new types of resources and activities; these could be the development of innovation or new capabilities that will be embedded in the firms involved in the process. This is possible thanks to a transfer of resources and to the conjoint deployment (or

development) of several business activities towards a unique goal (Håkansson and Snehota, 1995).

It is obvious that some resources will be more critical than others in the performance of certain activities. For this reason, the nature of the activity pattern and thus the overall availability of resources are relevant factors to investigate in order to understand business relationships. By controlling critical resources, actors could gain advantages over other actors in the business network or could effectively manage power balance and drive the decisions within the dyadic relationship.

A relationship usually creates interdependencies among actors. Håkansson and Snehota (1995) described this process of interdependence creation in this way: "Activities in a company are linked to the activities of others and resources are tied to the resources of others, actors have bonds to others". Thus, relationship benefits often originate in 'co-action', that is, in the team effects that can be obtained in a relationship so that every actor could grasp an advantage from the resource generated through the relationship (Håkansson and Snehota, 1995). The development of resource ties takes time: all the actors have to learn how to take advantage of others' resources and abilities in order to develop new types of resource ties by exploiting these efforts (Håkansson and Snehota, 1995).

Summarizing, resources are not given entities but rather variables; their value lies in their use in combination with other resources and other actors; resources are exchanged in business relationships, and not only acquired; there is not a clear

distinction between internal and external resources in business relationships; the way the resources are handled is more relevant than their possession; the resources could be developed through network reactions (Håkansson and Snehota, 1995).

Actors

In the conceptualisation of the IMP approach, the founders Håkansson and Snehota (1995) identified the term "actor bonds" to explain how actors connect to other actors and influence how the two actors perceive each other and shape their identities in relation to each other. It is clear that what happens in a business relationship can be attributed to the behavior of the individuals, and thus that the identity of the actors involved in the relationship can be related to their own perception. As suggested by Håkansson and Snehota (1995), "the identity of the actors is in the eye of the beholder". These bonds become established in an interaction and reflect the interaction process. Bonds between two actors may alter their way of seeing and interpreting situations, as well as their identities both in relation to each other and to others.

Håkansson and Snehota (1995) suggested that "Bonds arise in business relationships as two related actors mutually acquire meaning in their reciprocal acts and interpretations". In the IMP perspective, bonds are understood in terms of identity construction and formation of trust and commitment as the relationship develops between the actors. This mutual identification between actors is developed by interactions and business relationships.

Bonds, like activities and resources, are not independent. They are connected to other bonds, and thus other actors and third parties (Håkansson and Snehota, 1995). Håkansson and Snehota (1995) consider the three layers of the ARA model as not independent; in their perspective, there is an interplay between the actor bonds, activity links and resource ties. Actors carry out activities and activate resources. Activities are resource-consuming, and then they evolve as the capabilities of the actors develop. Thus, resources may limit the range of activities an actor can pursue. Then, it is relevant to make clear that bonds between firms arise because of bond development between individuals. Bonds between actors become important, as they are critical in developing the shape of the identities of the actors. In these situations, individuals will not just be perceived as individuals, but as representatives of the units to which they belong. A mutual identification will take place through a task-oriented interaction, and it will be a matter of reciprocal perception of attributes, intended as capabilities and intentions. It is important to underline the growing importance of referrals and testimonials in the evaluation of potential suppliers, customers and partners; the supposed role of the firm's image and the firm's efforts to improve it through better management of communication only testify the importance of this aspect of actor bonds.

Summarizing, actor bonds are developed by single individuals between companies. These will bring about also their limits (in terms of rationality) and their capabilities (in terms of learning and reflecting). The development of bonds is driven by the

development of trust, commitment and the establishment of the firm's identity. In relationships, resources and activities are oriented by the bonds' relevance. Actor bonds affect also the development of the network by shaping the identities of the individual actors and the level of commitment between them. As suggested by Håkansson and Snehota (1995), it is relevant that "actor bonds can be useful in company development as they can be utilised in order to learn and develop a company's capabilities and to mobilise external resources".

At last, several empirical and theoretical researches found that the actor bonds are relevant in the business relationship, as they can strengthen or weaken the dimension of activities and resources. Like activities and resources, actor bonds develop through interactions. Actor bonds are crucial for the development of a firm's capabilities, as they are a prerequisite to have access to the counterparts.

The actor dimension is crucial in the business relationship development, as it can reinforce or diminish the importance of activity and resource dimensions. Interaction is a way to develop bonds. Actor bonds are important also for the development of a company's capabilities, because they act as a prerequisite for access to the counterparts, their resources and activities, and thus a necessary condition for effective learning and capability development. (Håkansson and Snehota, 1995)

In order to conclude the description of the industrial network approach and the ARA model developed by IMP founders Håkansson and Snehota (1995) (Håkansson,

1982), business relationships are often associated with exchange, adaptation, accumulation, and creation of input and output that are understood in the IMP perspective as resources, as well as activities and actors (entities) of the network. Therefore, in our research, business relationships could be understood as being made up of three overlapping levels created by actor bonds, activity links, and resource ties (Håkansson, 1982; Håkansson and Snehota 1995; Ratajczak-Mrozek, 2017).

Business relationships are connected and thus create the peculiar characteristic of the network structure that is described as the chain effect resulting from actors' connectedness. In this perspective, the firms can be seen as the linking units between activities, resources and people. As seen in the description of the ARA model, a business network is made of activity links, resource ties and actor bonds that are combined and developed in a purposeful and understandable way. In the next section, one can find the description of the theoretical stream about new product development in the IMP perspective – thus using the industrial network approach – in juxtaposition with other theories – if there are any. The ARA model is often used as a scheme to analyse the case study and a classification scheme to reveal the factors that constitute the key in the deployment of marketing and purchasing strategies by the firms under investigation or to understand the essence of the relationship by analyzing its components: activity links, resource ties and

actor bonds (Håkansson, 1982; Håkansson and Snehota 1995; O'Toole and McGrath, 2018).

1.2 – New Product Development Process Literature

Resource allocation is still one of the greatest issues for firms when it comes to creating new value for customers (Hsu, 2016), and particularly when firms are involved in new product development activities. From a marketing perspective, new product design and development is still a relevant part of the marketing process: the internal interaction between designers/developers and the marketing department is crucial for developing and launching new products, but and an even more important role is that of the interaction between firms and external actors of the business network (Håkansson and Snehota, 1995; Hsu, 2016). Innovation here can be defined as "the implementation or the exploitation of creative ideas that could results in incremental improvements or radical changes; innovation can be seen as a social process" (Corry et al., 2017). It is possible to conceptualise innovation by classifying it by different levels of newness, from the very new to the slight update of features or product components: radical innovation, significant innovation and incremental innovation (Serrano and Fischer, 2007). In short, a firm could be able to deploy three major innovation strategies: technical innovation, business model innovation or managerial innovation (Hsu, 2016).

Now, in the middle of the Industry 4.0 era, firms are still increasing their dependence on new products: Schilling and Hill (1998) suggested that since the 2000's, more than 50% of sales are dependent on new products. Development and commercialisation of successful new products are still the most critical and challenging activities for firms and their managers (Tzokas et al., 2004). Innovation (for both new products and services) can be understood as the product of a network of actors rather than that of a single entity or actor. Innovation can be understood also as a new technology adopted by users that are ready to pay for its features (Baraldi, Gregori and Perna, 2011). Innovation could emerge through social interactions where different actors are sharing their resources (Kirsimarja, Blomqvist and Juha Levy, 2006). Indeed, as suggested by Edqvist (1997), "Companies rarely innovate by themselves" (Luzzini et al., 2015). Taking the view on innovation proposed a long time ago by Takeuchi and Nonaka (1986), the new product development process is often pushed by "changes in the environment – intensified competition, a splintered mass market, shortened product life cycles, and advancement in technology and automation – that are forcing firms and their management to reconsider the traditional ways of creating a new product". More than thirty years have passed since this statement, but the contextual conditions in which firms have to perform maintain the same prerequisites: the speed of the dynamics in the change, business ecosystems characterised by high technological

turbulence, and the evolution of customers and technology call for the adoption of a new way to develop new products.

Within the IMP perspective, “product development” is recognised as one of the most important functions that a firm should deploy. The IMP perspective suggests that any innovation is performed within relationships in the business network, and that it is dependent on developments in both direct and indirect relationships (Håkansson, 1987, Håkansson and Snehota, 1995). IMP theories highlight that new business formation and new product development can be often seen as a new combination of resources emerging in the business network (Ciabuschi, Perna and Snehota, 2012). Håkansson and Waluszewski (2002) emphasise that “an innovation can be seen as a new solution created through a combination of existing resources”. Thus, even if the manufacturing cycle is often started by a sales order, the ability to get those orders is mainly dependent on the ability to design and develop products according to the needs of specific customers. For these reasons, high technology products necessitate the involvement the actors of the business network in order to find the right solution to customers' and users' needs (Håkansson, 1982). Thus, it is recognised in NPD theories that prior to starting developing the development of a new product, it is necessary to identify a “gap”, understood as new perceived needs, a threat to the actual existence of need satisfaction or a shortfall of performances below optimal levels (Noteboom, 1999).

In order to understand the progress of the NPD processes deployed, firms should be aware of their level of NPD performances. These can be measured by using common financial KPIs, such as sales amount, profitability, market share trends and customer satisfaction; besides this, is possible to use KPIs dedicated to evaluating innovation, such as new product success rate, percentage of sales provided by new products, ROI on new products, to meeting sales and profit targets. Some non-financial KPIs could be decision making, speed, development time, development ability, NPD decision converted into action, improved corporate competence, image, and customer product evaluations (Barczak, 1995).

Actors involvement in NPD

Since Von Hippel, the users' involvement alongside the whole NPD process has become a common tactic to develop innovation within firms (Lynch and O'Toole, 2003). Although Tzokas et al. (2004) highlighted that the "majority of product development processes by firms are focused on improving the existing one", the study is focused on the development and commercialisation of a "brand-new" product. The term "new product development process" indicates all the processes and activities performed by firms in order to innovate or develop a new product with the aim to cope with changing markets or to exploit inventions and innovation efforts. NPD can be understood also as a cross-functional business process (Keszey

and Biemans, 2016). For the reason discussed, NPD, as suggested by Mu et al. (2017), “has become an important source of competitive advantage for firms”. Firms’ NPD strategic orientation may affect the way these manage knowledge creation and sharing in business network as a resource, and thus developing their network capability as a strategic capability (Mu et al., 2017). Companies generate new products or technologies (these can be understood also as resources) by combining their different capabilities/resources. These new products will not exist without the combination of different resources and activities from different actors within the network (Ylimaki, 2014; La Rocca et al., 2016). Moreover, the new product development process has now become more participative than ever before (Bettiga e Ciccullo, 2018).

The NPD process calls for buyer-seller interaction in order to cope with the complexity of the solution required to fill the needs of the customers (La Rocca et al., 2016). It is the adaptation process within the relationship that leads to the emergence of a unique combination, intended as a new product or innovation. Innovation can be initiated in an extensive and stable relationship (Håkansson and Snehota 1995). Furthermore, it is recognised that the most important success factor in technological innovation and NPD is the firm's understanding of customer needs (Laage-Hellman, Lind and Perna, 2014). The NPD process is also influenced by the business network and the embeddedness of the focal firm in a stimulating environment, such as universities and research centers, which could trigger the

innovation sensitivity of the firm (Van der Valk and Finstra, 2005). Innovations are often developed within a commercialisation network where firms can build awareness, customer education and can engage with the customers to obtain feedback and to give them the opportunity to try the product (Sandberg and Aarikka-Stenroos, 2009). It is recognised in the literature on innovation – from the classical studies of Schumpeter to the newest theories - that smaller and younger firms (in terms of seniority) are keener on innovation development, new product commercialisation and technology or the identification of the user needs for the development of new products (Noteboom, 1999; Schumpeter, 1943; Ries, 2015). It is useful to point out that "smaller and younger firms" should follow the suggestion made by Sutton-Brady, McGrath and O'Toole (2011) in clarifying that "a small firm is not a scaled down version of a big firm", and that it could be seen as an early stage of development of the firm itself.

This means that firms are called more than ever to take the risk of transferring R&D investments into a commercial product at a faster pace than ever before, with the purpose of creating a new product that will match user needs (Schilling and Hill, 1998). The premise of the study is that a single company does not have sufficient resources to cover all the aspects of the NPD process (Aarikka-Stenroos and Sandberg, 2012). Since the beginning, one of the emerging themes in NPD research was the need to mobilise external actors (Bonaccorsi and Lipparini, 1994) and thus external resources and activities in the NPD process. Usually, when describing the

NPD process, researchers tend to focus mainly on the product and the producer perspective, and this way of analysing the issue often tends to miss the interaction with customers and other actors of the business network that support the development of the new product (La Rocca et al., 2016). Since the first studies in IMP theory developed by Håkansson and Snehota (1995), researchers recognised that the customer-supplier involvement in the NPD process allows the ideation of better solutions (intended as products or services) and eases the adoption of these solutions by the targeted users. Thus, as described by the IMP theory, even NPD can be understood as a result of actor interactions within the business network (La Rocca et al., 2016).

Although supplier and customer involvement in innovation is a common practice among firms, and even though the phenomenon is widely studied in literature, the aim of this study is to highlight the NPD process that brought seller and buyers/users to cooperate in order to develop together a new product and to continue enhancing its capabilities. In particular, the study will focus on understanding how the focal firm could obtain knowledge and critical resources from its customers in order to develop and enhance product capabilities according to the customers' needs. Partnering in the initial stages of the NPD process is a critical task for firms, and user involvement and their management is still a grey area for NPD researchers (Lynch and O'Toole, 2002). The authors Bonaccorsi and Lipparini (1994) suggested that supplier involvement in NPD may appear in 3 different ways: the

traditional model (suppliers are involved at the end, innovation is like a black box), the Japanese model (supplier involved in the concept stage); advanced model (a small group of preferred suppliers are involved in the NPD before product specification). Although customers have been recognised as crucial for NPD – thanks to their insight and knowledge –, these actors cannot be easily involved to give a substantial contribution to the development of the product for the creation of innovation (Coviello and Joseph, 2012). Indeed, customer involvement can be seen as the "the interaction between customers and the design process" (Kaulio, 1998), (Ylimaki, 2014). The early involvement of suppliers and customers is a well-known concept in the literature about NPD theories: moreover, it is relevant for the study the theme of the actors' involvement is important for this study as it allows to obtain their poitn of view since the designing or idea generation phases (La Dain, Calvi and Cheriti, 2011). Literature on the NPD process suggests that intense customer involvement since the early stages could provide success to the NPD process (Lynch, O'Toole and Biemans, 2015). But it is important to underline that there is not a "best timing" to involve external actors in the NPD process, that "early" or "intensive" are not common requirements, and that what should be important is to engage with customers when it is relevant and contingent (Bettiga and Ciccullo, 2018). Lead users, another relevant theme in NPD, are recognised as those who are the first to adopt the new solution because they have needs that could benefit from the new product being developed (Johnsen and Ford, 2000). The interaction with

customers has the aim to support a firm's decisions to developing customised integration products and services in order to cope with customer needs. The assumption underlying such a view is that customer needs and preferences can be anticipated and translated into effective product and service solutions within companies (mostly by the Research & Development Department with the inputs from the Marketing Department). Three main types of collaboration were recognised in supplier involvement: black-box, grey-box, white-box. Three main types of collaboration were recognised also for customer involvement: design for customer, design with customer and design by customers (Ylimaki, 2014; Kaulio, 1998; Petersen, Hardfield and Ragatz, 2005). Furthermore, the involvement of the customers in the NPD process is crucial because they are the users who, through their choices, determine whether an invention becomes an innovation (Baraldi et al. 2011); this means that the customers, through the adoption of the new product, are able to sustain the "commercial success" of the product and its diffusion in the business network.

The main benefits of partnering are cost reduction, availability of early MVP (Minimum Viable Product of Beta Version), reduction of engineering adjustments in the commercialisation phase, price-needs fit, reduction of the time-to-market which is possible thanks to the adoption of concurrent engineering and the overlapping of the different development and commercialisation activities (Bonaccorsi and Lipparini, 1994; Schilling and Hill, 1998; Takeuchi and Nonaka,

1986), early identification of technical problems, reduction of the adoption risk by customers and the continuity of the relationship with the actors involved (Bonaccorsi and Lipparini, 1994). Further studies of customer participation in NPD processes found that benefits were not only addressed to product development and testing, but also to "opportunity recognition", "securing customer-based funding", "wider commercialisation" and "feedback" (Coviello and Joseph, 2012). Customer collaboration aims to improve adoption rates among users, complementors and intermediaries with the purpose to ease the commercialisation of innovation amongst end-users (Woodside and Biemans, 2005) (Aarikka-Stenroos and Sandberg, 2012). To obtain the benefits already described, it is recognised that since the beginning, firms have to select actors who are willing to cooperate and that could bring unique insight on technology, and that could influence the choices of the other actors in the business network (Aarikka-Stenroos and Sandberg, 2012). In customer collaboration, it is possible to adopt the built-test-feedback-revise development loop in order to enhance and improve product capabilities (Cooper, 2018). NPD collaboration is recognised as one of the main sources of relational advantages (Ylimaki, 2014).

In the IMP perspective, long-term relationships are seen as a source of innovation. The logical reason for collaborating in NPD are complementarity in knowledge and resources that firms can achieve through cooperation (Ylimaki, 2014; Håkansson and Snehota, 1995). To capitalise knowledge complementarity, firms are called to

an extensive information exchange process between themselves to ease the transfer of this complex information (Ylimaki, 2014). Knowledge can be explicit (codified and formalised) or it can be tacit (rooted in experiences, procedures and skills of people) (Najafi-Tavani et al., 2018). This resources and activities exchange between firms is triggered by the asymmetric nature of business relationships (Ylimaki, 2014; Håkansson and Snehota, 1995). In order to achieve effectiveness in the transfer of complex information, firms started to engage with external actors (be it suppliers or customers) (Ylimaki, 2014). The result of the interaction among actors of the business network in the NPD process is often the creation of a potential collaborative innovation network. The Collaborative Innovation Network "refers to a firm's interaction with different actors (supplier, customers, competitors, research organisation, etc.) with the purpose of NPD" (Najafi-Tavani et al., 2018, p. 193). Innovation capability is "recognised as one of the most important internal resources that can result in superior firm performance" (Perna, Baraldi and Waluszewski, 2015; Najafi-Tavani et al., 2018, p. 194). In the new product development process, firms have to work in order to achieve two main goals: the product-customer needs fit and the evaluation of the right time to market in order to commercialise the product (Schilling and Hill, 1998). The success of the product developed is often linked to the creation of a unique and differentiated product (Cooper, 2018).

The conceptualisation of the actors' involvement within innovation processes could be also often addressed to the term "adoption" of new product, new technologies or

newness in general by users or customers. The adoption rate is influenced by the users' perception of the advantage that the innovation can generate to them (Woodside and Biemans, 2005). Thus, these decisions are influenced by the quantity and quality of the actors' information and by their ability to understand the innovation and to transfer their perception to others (Bettiga and Ciccullo, 2018). When discussing adoption, the decision making process made by firms could give 4 outcomes according to Woodside and Biemans (2005): passive rejection, called non-adoption; a priori active rejection, when the newness is considered but later rejected; a posteriori active rejection, when the consideration of the adoption ends in rejection; and adoption. The innovation adoption process can be divided into many stages; according to Woodside and Biemans it is possible to distinguish between: initiation, when the encounter between the firm and the new product; adoption, when the firm decides to invest in the new product; adaptation, when innovation and the firm work to adapt each other in order to create value; acceptance, when employees are induced to commit to using the innovation; routinisation and infusion, when the innovation increases the efficiency of the firm. The adopters can be categorised, according to the study made by Rogers (1995), in the following groups: innovators, early adopters, early majority, late majority, and laggards (Woodside and Biemans, 2005).

NPD process implications

Innovations (products, services or processes) can be understood as the outcomes of a process where several actors contribute with resources and jointly developed activities. NPD collaboration between buying and selling firms is a crucial part of the innovation process. In fact, the combination of resources and activities could create value for all the actors involved (Laage-Hellman, Landqvist and Lind; 2018) The optimisation of NPD processes passes through 4 main dimensions: development of a clear technology strategy, which brings two different strategic implications: the formalisation of the technologically strategic intent and the creation of an R&D portfolio; the organisational context, referring to the use of strategic alliances (with actors of the business network) in order to gain access to assets or knowledge (i.e. enabling technologies or resources) that the firm does not possess. Firms are called to put great attention to the choice of the partners and the assessment of the collaboration results. Particular relevance is placed on the creation of a team – that has to include also customers and suppliers – that should be built up in order to manage effectively the NPD process (Schilling and Hill, 1998).

In the research, the stage model of the new product development process that goes from ideation to development and commercialisation is taken as a framework (La Rocca et al., 2016), in order to analyse the story of the case study, but our focus – both in theory and in empirical results – will be, rather, on the implication of customer involvement in the new product development process. La Rocca et al.

(2016) in their study suggested that, according to the model adopted, customer involvement is expected to be relevant in the first stage. In the past years of research in the field of NPD, a series of stages/phases were highlighted by which every new product development process can be deployed and analysed (Tzokas et al., 2004). The NPD process is commonly recognised in literature as a sequence of phases. Several authors provided a unique framework in order to try to depict the process that results in new product development. In this study, the same thought of (Cooper, 2008, 2018; Tzokas et al., 2003; La Rocca et al. 2016) is adopted, and for the case it will be possible to analyse four different phases of new product development: (1) Origins of the product, the background of the idea and the roots of the process; (2) Validation of the product, the initial relationship with customers and users for product testing; (3) Product development, engineering of the product according to the customer feedback of early adopters; (4) Commercialisation. Cooper (2018) suggests that the best ideas come from customers, and that the customer input has a vital role in the designing of the product for determining product requirements and specifications. A clear strategy in terms of product scope, positioning, feature, and benefit will support and ease the customer collaboration (Cooper, 2018). Adopting the IMP perspective, researchers identified three main network settings in which actors could combine their own resources and activities in order to develop innovation (i.e. new products or services); these settings are named: developing setting, were actors are looking for new solutions; producing setting, were actors

transform resources into new product or services; using setting, were actors are willing to use the new product (Håkansson and Waluszewski, 2007). The actors can also take different paths in order to establish a collaboration measured on the level of formalisation of the agreement, according to Marshall (2004): a process coordinated by volatile agreements; a process that involves continuous reevaluation and reorganisation; and a process where the "co-participants" are challenged to work on their relationship.

In particular, researchers find that the development stages of a software could be identified also as interrelated sub-phases such as analysis, design, coding, testing, deployment, maintenance and improvement. After these phases, the software is commercialised to reach customers and users (Aramand, 2008). It is possible to view the software development process, with the four stages model already described (including all the sub-phases) in the origins, validation and development phases of the model discussed.

One of the deadly sins that a firm could commit is losing touch with the customers, and thus fail at understanding their needs and desires (Tzokas et al., 2004). A Product developed together with the customer can be of advantage for other customers who have similar requirements, but it can become a disadvantage for customers with different requirements, as it absorbs important development resources. (Håkansson and Snehota 1995)

1.3 - Network and Co-Creation Capability

While describing the NPD processes and its characteristics, the highlight was on the crucial role and relevance of the actors' involvement in order to enhance the performance of NPD activities. In the study, actor engagement can be considered like a cornerstone for NPD processes, but in order to get the most from the firm's partners, it is still crucial to develop mutual trust with the aim to obtain higher benefits from the network relationships (O'Toole and McGrath; 2018). Adaptations in the interaction with other actors of the business network is still the way to create commitment within the business network (Håkansson and Snehota, 1995; Aaboen et al., 2016). One of the most important activities, thus, is assessing the potential of the network context in order to deploy a smooth NPD process (O'Toole and McGrath, 2018). The engagement of the actors in the business network is important because an NPD process cannot be deployed in isolation, but only within a business network where resources, activities and actors are efficiently mobilised (Landqvist, 2017). Moreover, the development of complex products requires the interaction between users/customers and the producer: this can be seen as the stepping stone for understanding users' needs (La Rocca et al., 2016). In this study, actors are identified as the potential customers of the product under development. They are conceived as active players in the creation of value within the business network. The study assumes that customers can be seen also as providers or links to a wide set of resources (Prahalad, and Ramaswamy, 2000). Customer involvement in this

study can be defined as a complex iterative interaction at a dyadic level between buyer and seller firms; this relationship can also be the link to other dyadic relationships within the same business network (Lynch, O'Toole and Biemans, 2015). In the scenario described, customers can provide ideas, feedback on products or support in developing new products or services; they can surely provide a fair point of view and a deep understanding of the users' product requirements (Lynch, O'Toole and Biemans, 2015). The NPD process should be considered as a non-linear process that can be accomplished thanks to external integration that will come from the business relationships that the firm will be able to build and develop within the business network; in this case, the relevant relationships are those with customers. Obviously, a firm cannot adapt a product to every customer, but it could engage with major customers in order to obtain direct evidence of its users' needs and to ease the technological exchange between different parties. Moreover, a firm has to choose the right partners to involve in the NPD process and – where possible – to adopt a parallel development with several customers (Laage-Hellman, 1997). These relationships, which are supposed to support the NPD process, can be addressed also to specific functions or technologies managed by the firm (Tzokas et al., 2003). The case, and thus our theoretical background, is focused on understanding the way a focal company can attract, extract and exploit the resources available in the customers' network. In particular, the study will focus on the co-creation capabilities that could support the focal firm in the engagement of the

customers in resources, activities and actors sharing amongst the actors of the business network whilst in the NPD process (Luzzini et al., 2015).

Collaboration with customers is recognised in literature as one of the effective ways to manage uncertainty and risk in NPD. Risk management through customer involvement in NPD has the aim to improve feedback and ensure the continuity of the relationship with customers; the main benefits are related to the reduction of innovation cost and risk. A close relationship, especially at the early stage of the development, can reduce the hazard faced by the firms by managing the risk of newness – i.e. supporting the adoption rates of the new product – and by enhancing the product capabilities through the resource exchange with the partners that will compensate for the inexperience of the venture (Baum, Calabrese and Silverman, 2000; Baglieri and Zamboni, 2005; Laage-Hellman, Landqvist and Lind, 2018).

First of all, no NPD process can be conceived as the result of a single firm's effort, because the internal R&D capability is usually not enough for creating innovation. Thus, firms need to create links with customers and users to establish a resource exchange which is crucial in NPD collaboration because firms are notoriously poor in resources (Laage-Hellman, 1997; McGrath, Medlin and O'Toole, 2018). Building collaborative relationships with customers is important, since the scarcity of resources is a common trait of every firm, thus collaborations are needed as a way to access complementary resources available on the business network (Laage-Hellman, Landqvist and Lind, 2018). The study assumes that the term "resource"

can be addressed to all tangible or intangible resources such as knowledge, skills, relationships, actors and core activities that a firm could profitably exchange within the business network. The development of the right capability to access, co-shape and exploit the resource set already available on the business network is related to the firm's capability to understand the potential of every customer's relationship (McGrath, Medlin and O'Toole, 2018). The firm's ability to access critical resources through the business network is described in the extant literature as network competence (Aarikka-Stenroos and Sandberg, 2012).

Customer collaboration is directly influenced by both the firm's culture in sharing their resources whilst in the NPD process (Leonard-Barton, 1992) and by the strategic orientation developed by the focal firm in order to create the right conditions to obtain superior performance in the business network (Mu et al., 2017). The firm's ability to developing an effective collaboration with several actors within the business network is described as network capability. Müller et al. (2012) have given a conceptualisation of the different shapes of the collaboration between several actors within the innovation process: bilateral collaboration; direct collaboration; pooled collaboration; external collaboration. Collaboration capabilities are crucial both in the horizontal dimensions – through every stage of the NPD process – and the vertical dimension – in the relationship with the several actors of the supply chain (Müller et al., 2012). This can be useful in order to conceptualise the different forms that a collaboration can assume and to depict the

strategy used by the case company that will be analysed in the following chapters of the manuscript.

First of all, it is important to provide a conceptualisation of capability, which can be described as high the level routines given by Zollo and Winter (2002) (O'Toole and McGrath, 2018), or the repeated action sequence that represents a solution to particular problems (Teece, 2012). These capabilities are conceived as part of the skill set of a firm, thus are highly dependent on the network and the interaction with other actors (O'Toole and McGrath, 2018). Firms can develop new capabilities by manipulating the network's resource configuration (Sutton-Brady, McGrath and O'Toole; 2011). Sutton-Brady, McGrath and O'Toole (2011) defined network capability as the firm's ability to develop and utilise interorganisational relationships to gain access to various resources held by other actors. Then, McGrath and O'Toole (2013) defined Network capability as a firm's ability to initiate, maintain, and utilise relationships to gain access to various resources held by other actors. Later, Sutton-Brady, McGrath and O'Toole (2011) made further improvements to their given definition of network capability by providing a new description of this concept as the early stage development of the understanding, willingness and ability of the new venture to purposefully engage its business network of relationships to begin to gain access to and mobilise resources with other network actors. Baraldi (2008) added to the definition of network capability that, in order to meet the network, a firm should act in three main directions: by its own

specific competence; by creating interaction interfaces; and by promoting a network-oriented culture for a trusted and long term approach amongst the actors of the business network. Network capability can be understood also as a process that could ease the access and the sharing of tangible and intangible assets between firms, and that it itself represents a resource that can be shared or exploited by the owner (McGrath and O'Toole, 2013). Focusing on the NPD process, Coviello and Joseph (2012) tried to define the most relevant capabilities for developing major innovation. These are: customer mobilisation (that can also be referred to as network capability); learning agility and mindful trial and error.

The result of the collaboration between the focal firm and its customers within the NPD process can be described also as collaborative innovation. Wanga and Hu (2018) assumed that "two or more supply chain members […] sharing knowledge with each other and working jointly to plan and execute R&D in the supply chain network", can be seen as an example of collaborative innovation. This process – in coherence with the description of the network capability already described - is useful for stimulating creativity, reducing costs and risks in NPD, and improving innovative performance (Wanga and Hu, 2018). Thanks to these interactions, firms can learn from each other and develop new knowledge together. The ability of the firm to apply and gather extant knowledge in the business network is termed collaborative innovation capability (Wanga and Hu, 2018). The authors found that this capability can enhance quality and customer engagement in innovation

activities, and, nonetheless, it plays a crucial role in knowledge sharing amongst actors within the business network. Wanga and Hu (2018) follow the suggestion of Singh et al. (2016) in describing that collaborative innovation capability is a prerequisite for higher levels of innovation performance.

NPD co-creation processes are often characterised by a cross-company collaboration where it is possible to recognise an intensive exchange of data and information. Efficient collaborations amongst firms are crucial for the development of complex products, radical innovations, high tech software and customised products. Moreover, with the increasing complexity of the high technological degree of the innovation and new products there is still a need for collaborative product development processes (Müller et al., 2012; Corry et al., 2017).

Collaborative capability whilst in NPD co-creation process can be defined also as collaborative-creation capability of innovations and new products. Perks, Gruber and Edvarsson (2012) provided one of the commonly used definitions of co-creation (collaborative creation): “the joint creation of value by the firm and its network of various actors. Innovations are thus the outcomes of behaviors and interactions between individuals and organisations”. Co-creation refers also to the active involvement of end users in NPD, and according to Rasool et al. (2017), it represents an effective strategy to overcome barriers in understanding customers’ needs. Frow, Nenonen, Payne and Storbacka (2015) gathered from the co-creation literature some of the potential benefits of the deployment of this strategy: enhanced

engagement of the employees, better business network integration; improved shareholder commitment, and improved knowledge sharing. Furthermore, they found that co-creation can enhance NPD processes and resource combining between the focal firm and other actors of the business network. Co-creation can be understood also as the process of "developing systems, products, or services through collaboration with customers, managers, employees, and other stakeholders". Co-creation can be seen as the innovation process where it is possible to recognise the joint participation of several actors in function of their knowledge and experiences (Ramaswamy, 2011). The same author pointed that the value of the innovation often originates from the outcomes of the collaborations and the experiences shared by the partners in the value chain (Ramaswamy, 2011). Ramaswamy and Ozcan (2014) conceptualised co-creation as "the practice of developing offerings through ongoing collaborations with customers, employees, managers and other stakeholders". Firms can engage in product innovations in order to enhance their developing capabilities (Hsu, 2016). Co-creation can be conceptualised also with another point of view made by relevant scholars over time: Corry et al. (2017, 630) gathered some definitions that included: "co-creation is a combination of social capital and knowledge", " co-creation is a participative process in which people and organisations generate and develop meaning together", and "co-creation is a collective process of teamwork across an organisation that is creative and geared to generating and developing new products, processes and

services, which causes incremental development or radical innovations". Keszey and Biemans (2016) pointed that co-creation "refers to cases where customers actively contribute to the development of new products". Rasool et al. (2017) conceptualised co-creation as "an active, creative and social process which includes some special methods and strategies applied by firms to involve the end users in the firms' initiated NPD process". In particular, according to Hsu (2016) it is possible to distinguish between internal co-creation, amongst all the strategic levels and functions of the firms; and external co-creation, when the firm is partnering with the actors of the business network. Co-creation can be deployed at every one of the NPD's stages identified before (Cooper, 2018, 2008). Timing is relevant in order to engage with the right actors when it is necessary to collect information and knowledge to develop innovation (Bettiga and Ciccullo, 2018).

A firm's capability to collaborate with other actors in the business network is thus termed "co-creation capability". This can be considered a set of capabilities that aim to ease the collaboration between the focal firm and the business network (in this case, with particular reference to customers) while deploying NPD or innovation processes. These capabilities can be addressed at micro-level analysis to specific skills or activities: information processing, communication skills, knowledge management, interaction coordination, trustworthiness or the ability to gain trust and negotiation skills (Blomqvist and Levy, 2006). Collaboration capability is relevant to innovation processes because developing new products

implies the interaction between many different actors in information and knowledge sharing, joint planning and joint problem solving (Serrano and Fischer, 2007). Collaboration capability can be broken down into many different components: social networking capabilities; management capabilities, and learning capabilities. Collaboration capability eases the renewing of the skill set of the firm and its openness to new knowledge. The role of such capabilities – and thus of the collaboration itself – is more relevant in the context of high technology products or high complexity products where the need of precise information and knowledge is a precondition for the good result of the NPD process (Blomqvist and Levy, 2006). Co-creation processes can involve more than one actor. This multiple-actors process could involve academics, public authorities, private firms and also citizens in order to create a new offering (Alexa et al., 2017). Co-creation processes can be addressed under three different approaches according to Bettiga and Ciccullo (2018), which are: supplier-driven approach, customer-driven approach and firm-driven approach.

The relevant factors that play a crucial role in NPD's co-creation processes between actors of the business network gathered by Corry et al. (2017) are: communication, courage and decisiveness to act, collaboration, team spirit, autonomy, trust, innovation capability, support, shared goals, good atmosphere, facilities, subject expertise.

Rasool et al. (2017) pushed themselves in an interesting attempt to establish some relevant co-creation characteristics, which are: two-way communication channels between the actors; staff training in customer relations; manufacturing personalised items; firm's willingness; effective information sharing; effective management of the new content; communication amongst end-users; exploitation; current market-share; satisfaction level; multiple communication channels; screening systems; effective information management systems; openness to new ideas; research and development activities and flexibility.

These characteristics are the basis used to conceptualise the process of co-creation. In this case, it is possible to observe many shapes of the process given by several scholars gathered by Biggemann et al. (2013), who end up reporting these crucial stages: analysis of the customers' problems or needs, development of the product or services aimed at solving the customers' needs, deployment of the product and diagnosis of the effects of the solution and customers' support. In particular, Alexa et al. (2017) described the effects of the co-creation process as result of directing the interest of a wide number of actors who differ in terms of knowledge and information management and who participate in the new product development process in order to meet customers' needs and expectations.

Sensemaking the NPD co-creation process

The literature review about the IMP marketing approach, new product development and co-creation proposed in this study give evidence of the complexity of the subjects under investigation. For this reason, it is desirable to give the readers a final paragraph where all the information is wrapped up in order to provide a meaning of the NPD co-creation process that the empirical case will describe later. In fact, the study aims to cover several marketing issues related to the NPD process and the co-creation concept. The latter is usually a subject treated by scholars with an engineering background, thus the effort in conceptualizing the phenomena in a marketing environment may not be immediate. To deploy the study, the concept of the Industrial Network Approach and the ARA model according to the IMP Group perspective is used in order to make an attempt at understanding the empirical case of NPD process in co-creation (Håkansson, 1987; Håkansson and Snehota, 1995). Particularly, the complexitiy of the subjects stems out from the several interactions that the actors of the business network carry out in order to achieve the development of new products; as suggested by the IMP school (Håkansson and Snehota, 1995), these interactions among all actors of the business network are the *conditio sine qua non* for the firms' development, in terms of new products and new businesses (Håkansson and Walusewski, 2002; Ciabuschi, Perna and Snehota, 2012; La Rocca et al., 2016). These interactions take place within the processes usually described in the traditional split-up stage-gate phases NPD framework proposed by some previously cited authors (Cooper, 2008, 2018; Schilling and Hill, 1998; Kaulio,

1998; Takeuchi and Nonaka, 1986). According to the IMP conceptualisation, the NPD process can be seen also as a smooth path within the business network that leads to the commercialisation of the innovation, and for this reason, it is possible to see the stage-gate framework as a continuous loop of the proposed stages and gates in every situation along the innovation pathway (La Rocca et al., 2016). In every one of these phases identified in literature, firms tend to engage with customers/users (other actors) in order to adapt the product, to validate the solution and to develop the main features of the product. As suggested by Ivan Snehota (Håkansson and Snehota, 1995; Ciabuschi, Perna and Snehota, 2012), the NPD process can be considered also as a sort of never ending story between the actors of the business network; even when the product is in the commercialisation stage, the firm is willing to go on developing and enhancing the product with the support of its customers/users. More precisely, thus, it is possible to understand the NPD process as a back and forth process between all the stages of origin of the product, validation, product development, and commercialisation.

In this theoretical scenario, the focal company should be focused on attracting the relevant contributions of all the actors of the business network in the NPD process – in several cases, said contributions could become a matter of life or death for the existence of the new product – by deploying several co-creation methodologies. All the firms that are eager to engage customers/users in supporting the development of the product by exploiting their knowledge (explicit or tacit – Najafi-Tavani et al.,

2018) within the NPD process could be in some ways facilitated in the diffusion of the innovation and, moreover, in the adoption of the new product – in terms of sales and users involved –, which could be easier amongst the customers who supported the development (Bettiga and Ciccullo, 2018; La Rocca et al., 2016; Laage-Hellman, Lind and Perna, 2014).

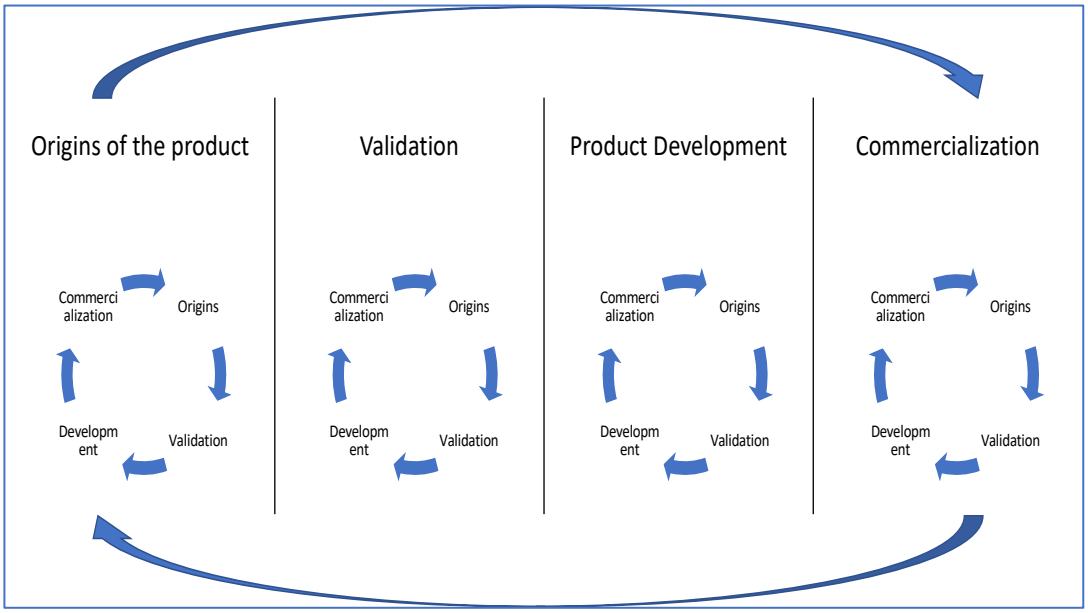

Figure 1.3.1 - NPD co-creation process, a never ending story

(our adaptation from Håkansson and Snehota, 1995; Cooper, 2008, Schilling and Hill, 1998; Kaulio, 1998; La Rocca et al., 2016)

For these reasons, the network capability of the focal firm to engage, involve and manage all the relationships in the business network that could enhance the product

development is crucial (McGrath, Medlin and O'Toole, 2018; McGrath and O'Toole, 2013). But besides all these aspects, the focal firms might be aware that all the interaction platforms (Baraldi, 2008) made available to the users could represent a sort of physical way to exchange knowledge and information with customers.

Co-creation in NPD processes can be understood also as one of the ways in which firms could manage NPD complexities. The relevance of these complexities was already described before, thus, the more complex the product is (for example, high technological products or services, customised/made to measure/ custom products, ecc.), the more valuable the contribution of the users could be in order to develop the innovation coherently with the needs of the latter (Payne, Storbaka and Frow, 2008; Kaulio, 1998; Ylimaki, 2014). Co-creation is relevant also when the focal firm, in order to develop the product features and capabilities, needs to gather a wide body of knowledge and information from the users (Ylimaki, 2014; Håkansson and Snehota, 1995). The actors' involvement tends to ease the commercialisation and the diffusion of the new product (Woodside and Biemans, 2005); and also, as is already described, there is not a perfect timing formula (Bettiga and Ciccullo, 2018), usually it is possible to assume that the sooner, the better.

In order to build up the process that can allow firms to involve the actors of the business network, these might build up a specific set of capabilities that could

support the engagement and the management of the collaborations with customers while they are within the NPD process. The empirical study proposed would like to explore which capabilities these firms might use in order to manage the relationships with their co-creator's users/customers and which NPD pathways these firms could take in order to develop effective innovative processes.

1.4 - Research Questions

The calls for empirical studies focusing on NPD co-creation processes were made by many authors over time. From La Rocca et al. (2016, p.45) who argued that: "Empirical studies on the customer involvement process in NPD are rare and there is a tendency to black-box the process through which customers are involved". More longitudinal case studies on customers involvement within NPD processes are called also by Lynch and O'Toole (2003). Biggemann et al. (2013) call for more studies on the process of customer involvement in NPD and for the implementation of customer solutions, and moreover, as suggested by Laage-Hellman, Landqvist and Lind (2018) "empirical study on co-creation capability in networks are rare". Bettiga and Ciccullo (2018) stated that "no one has investigated in empirical terms the role customers and suppliers assume in cross-functional teams and their cross-interactions". Barczak (2012) has identified as an uncovered item in co-creation research "What tools and processes enable effective co-creation efforts with

customers?". Thus, it is possible to conclude that there is high demand for empirical studies in NPD co-creation in order to explore and shed light on this phenomenon. *For the reasons described, this paper aims to contribute to the current literature on customer involvement in NPD co-creation by using a process-based, longitudinal single case study approach (Biggemann et al., 2013; La Rocca et al., 2016; Yin, 2014; Strauss and Corbin, 2015) in uncovering two different areas of the co-creation implications in NPD processes:*

- *how do actors co-create a new product in an industrial network?*

Here, the study will try to identify the primary pathways taken by Hyperlean in order to develop the new product (LeanCost) in co-creation with the other actors of the business network.

First of all, the study adopts the term "pathway" to describe the way a firm could develop a new product in order to strengthen the perceptions of the readers that NPD in co-creation could become a tough process full of complexities and pitfalls. Secondly, it has to be highlighted that all the pathways that will be described further in the manuscript stem out from the systematic combining approach that consisted also in a reiterative process of analysis of the case findings conducted with the support of supervisors and colleagues.

- *What co-creation capabilities can be used in a network?*

First of all, it can be useful to specify that in order to conceptualise the term "capabilities", the study considers the same definition provided by O'Toole and

McGrath (2018). Then, to answer the research question above, the study will focus on identifying the core capabilities that Hyperlean deployed and/or developed through time in order to manage the business network and the consequent NPD co-creation process.

These capabilities will be strictly intertwined with the pathways that the study will identify. As cited, these capabilities stem out from the systematic combining approach that consisted of a reiterative process of analysis of the case findings conducted with the support of supervisors and colleagues.

Chapter 2

RESEARCH METHODOLOGY

Within the IMP approach, is possible to recognise a tradition of empirically based studies on how companies manage interactions and business relationships, and consequently on what is being created through actors' interactions in a business network.

It is common in IMP group NPD literature to address the NPD processes' benefits to the customers involvement, and that customer involvement can be crucial in order to develop successful products. Thus, IMP tradition expected to use empirical cases in order to build evidence with the aim to shed light on the phenomena under investigation. (La Rocca et al., 2016)

La Rocca et al. (2016) pointed that there are still few empirical studies on customer involvement process in NPD, and, as a side effect, that the few ones already done tend to black-box the process of involvement and co-creation of the new solution. While great attention was given to purchasers or suppliers in shaping new products, little was said on customers that aim to use work-in-progress technology, and who are keen to support the product development and the firm's efforts on improving the product, and on their role within the network for the co-creation of new products (Van Der Walk and Fynstra, 2005). Moreover, as suggested by Laage-Hellman,

Landqvist and Lind (2018) empirical studies on co-creation capability in networks are rare and, as suggested by La Rocca, et al. (2016), what is missing in NPD's IMP based studies is uncovering the black box that could explore how firms should relate between themselves and with which capabilities.

Longitudinal Case Study

In order to obtain a detailed view of the NPD co-creation process deployed by the focal firm over time through events and interactions with other actors, a qualitative research methodology was chosen. Indeed, despite its limitations, we decided to use the longitudinal case study methodology in order to gain the opportunities given to explore interaction patterns in full detail (Hutt, Reingen, and Ronchetto, 1988; La Rocca et al.; 2016). In fact, according to the extant literature on qualitative research methodology, longitudinal case studies are one of the best ways to explore and define the how of a specific phenomenon (Strauss and Corbin, 2015; Yin, 2014; Eisenhardt, 1989).

Therefore, as suggested by Perks, Gruber and Edvardsson (2012, 938) "*Case study research is well suited to investigate microlevel activities […] Changes in behaviours occur over periods of time";* that for the Hyperlean case will be very relevant in order to uncover the uniqueness of the NPD co-creation story. The same authors, who agree with Eisenhardt (1989), pointed out also that "*the case study methodology allows the investigators to research phenomena as they unravel over*

time, rather than at a snapshot in time", by adopting the same process view introduced by Pettigrew (1997).

In order to shed light on the case's details, the choice was to adopt the case study and qualitative methodology, because as suggested by Voss, Tsikriktsis and Frolich (2002), this approach is particularly adequate when the construct or the phenomenon under examination is not well understood, and there are few already developed theories that explain the explored link between the construct and the phenomena being studied and the empirical evidence that comes from the case study.

Furthermore, this research approach could allow us to capture the complex patterns of collaboration between firms in a detailed way (Yin, 2014; Laage-Hellman, Landqvist, and Lind, 2018). The methodology of the single longitudinal case study is also advantageous for capturing processes during time and space, as referred by Langley (1999).

In-depth longitudinal case study as a method has been deemed appropriate also for studying change processes, because it allows to investigate contextual factors and process elements in a real-life context (Eisenhardt, 1989; Halinen and Törnroos, 2005).

Process research is suggested in order to understand how things change or develop through time and events, and for strengthening the case study capability to shed light and understand how things happened. Pettigrew (1997) defined a process as

"a sequence of individual and collective events, actions, and activities unfolding over time in a specific context" (McGrath, Medlin and O'Toole; 2018, p. 2).

In conducting our study, we followed a systematic combining for the case research, which has been described, as suggested by Dubois and Gadde (2002) and Eisenhardt (1989), as a "non-linear, path-dependent process of combining efforts with the ultimate objective of matching theory and reality. Furthermore, frequent overlap between data analysis and data collection can be useful to address and analise facts with theory". Thus, in order to develop the case study to make a useful theory contribution, we adopted systematic combing, and following the rules of Dubois and Gadde (2002), adjusting between theory and empirical data, this methodology allows us to explore the case and to obtain good awareness of the subjects which constitute the basis of our work

Case Selection

We decided to choose Hyperlean[1], an Univeristà Politecnica delle Marche's Spin-off, because of its revelatory potential, as it could allow us "to gain certain insight that other organisations would not be able to provide" (Siggelkow, 2007, p. 20). However, in the selection of the case, the researchers followed the suggestion given by Eisenhardt and Graebner (2007) about theoretical sampling: '*Theoretical*

[1] http://www.hyperlean.eu/

sampling simply means that cases are selected because they are particularly suitable for illuminating and extending relationship and logic construct'.

Indeed, this case was chosen also for its revelatory potential (Coviello and Joseph, 2012), as it is possible to follow the development of the new product together with the customers' support over time. Another motivation for choosing this case was the availability of several of the key persons in the data collection process under exploration (see following Table 2.1 about firms and interviewees). Furthermore, the relative newness of the topic consents to adopt a higher degree of freedom in the case selection, also because the study adopts a qualitative longitudinal study, and all the analysis processes were driven by the empirical phenomenon.

Data Collection

Empirical field-data were collected by following the most cited guidelines in literature. The strategy for the collection of primary data, as suggested by (Strauss and Corbin, 2015; Yin, 2014; Eisenhardt and Graebner, 2007), was performed through interviews with key informants. In order to gather further information, we also collected field notes from meetings plus formal and informal documents provided by our case study's focal firm and downloaded from the web. As suggested by Eisenhardt and Graebner (2007) "*in this kind of research, approach interviews often become the primary data source*" because, the authors found, "interviews *are a highly efficient way to gather rich empirical data*".

This thought was reinforced by Yin (2014), who stated that "*the primary source of data used in case studies is structured or semi-structured interviews […]".* And thus that *"interviews are a highly efficient way to gather rich empirical data, especially when the phenomenon of interest is highly episodic and infrequent*".

We planned to interview the key figures in all the firms involved in our studies. To do so, we used what Robson (1997) termed 'snowball sampling', which is the main technique for identifying and gaining direct and privileged access to appropriate respondents. This data collection strategy involved establishing an initial relationship with an individual who would act as the main contact person, who in our case was Prof. Germani (CEO e Founder of Hyperlean). Then, after the first interviews, Prof. Germani provided the researchers with a short list of people o interview who were well informed about the development process of LeanCost, in order to help have a deeper understanding of the evolution of the firm.

Prof. Germani also supported the research team to identify further relevant interviewees also among customers. Those were selected according to their 'knowledge of the story of Hyperlean', the good relationship and trustability with Prof. Germani and their willingness to participate to our study. Before setting up the interview with them, as suggested by Johnsen and Ford (2007), we "discussed the appropriateness of each of them, evaluating their level of involvement in the project and their expected willingness to take part in an interview" with key respondents and with Prof. Germani himself.The interviewees who wished to

remain anonymous were promised confidentiality, therefore sometimes in the case study description it will be possible to find firms and people with fictitious names. This *modus operandi* was adopted according to the suggestion of Johnsen and Ford (2007), who pointed clearly how this choice could "*ensure a level of openness and objectivity' and could give to the researcher a better 'understanding of explanatory and contingent factors (Tsang and Kwan, 1999), which would have been very difficult to obtain otherwi*se"(Johnsen and Ford, 2007).

As far as it is possible to know from extant literature, by using this research methodology, the development of trust with the informant is critical in order to ensure high quality and consistency of information, therefore some of the name of individuals and companies have been concealed (Johnsen and Ford, 2007).

The study involved more than 14 different informants from 6 different entities, for a total of 28 interviews. Usually, the interviews were conducted face-to-face, via a formal meeting with the informants. We had to perform a telephone interview a few times due to distance or time-related issues. Each of these interviews lasted approximately from 0,5 hours to 1,5 hours. All the interviews were conducted with semi-structured guidelines, but with enough freedom to leave space for discussion and to encourage the informant to add further information and examples of real life facts (Johnsen and Ford, 2007).

Network Actors	Respondents	Number of Interviews
Hyperlean	CEO and Founder	6
	CTO and Founder	2
	CIO and Founder	2
	Founder & Former sales specialist	2
	Former board of directors	1
	Former Founder	2
	Sales Rep	6
Biesse	CIO	1
	Product engineer and Costing - 1	1
	Product engineer and Costing - 2	1
Loccioni	Procurement	1
General Electric	Product Engineer	1
Ferrero	Technical Sourcing	1
UNIVPM	Technology Transfer Office Director	1
Total number of interviews		28

Table 2.1 - Details of Interviews performed for data collection

In addition to the interview, there were a good number of informal information exchanges, many of which at the end of formal meetings, via email or instant messaging with key informants (Johnsen and Ford, 2007).

As suggested by Denzin and Lincoln (1994) and Yin (2014), data gathered from other different types of sources (formal documents, e-mails, informal chats and

meetings, websites, social media) were used in order to be able to ensure enough triangulation as to obtain a good quality of the information.

Data analysis

No computer aided software was used for data analysis, but the researchers worked with data and theory in order to come up with new insights. According to Yin (2014), within the study, data were worked from the "ground up", with the aim to extract suggestions and new perspectives and, by following the systematic combining approach to longitudinal case study methodology, developedan iterative data analysis process (Langley, 1999) was developed that continued over a long period of time with constant and periodic revisions (O'Toole and McGrath; 2018). The systematic combining approach supported the constant comparison by going back and forth between theory and data, strengthening the study's ability to find the right path for building an interesting point of view on the co-creation process experienced by Hyperlean.

In the data analysis process, a massive use of memos and diagrams was made, as suggested by Strauss and Corbin (2015), in order to show how the researchers interacted with data. Memos and diagrams can be very useful for addressing how concepts might be related to each other, in order to make comparisons, to come up with meaninful concepts, to suggest other possible relationships between concepts, and to give an overview of a wide series of events over a long period of time (Strauss

and Corbin, 2015). Following the suggestion of the authors mentioned, memos and diagrams were used from the beginning to the very end of the analytical process, and moreover, they were used also as a way to keep track of the research process through time and as tools for robust conceptual visualisation of the gathered data (Strauss and Corbin, 2015). The analysis process was driven by the empirical phenomena; all the thoughts deriving from the systematic combining approach - i.e. the comparing between literature and empirical data - weres shared and developed with my academic tutor Prof. Perna and my visiting professor Prof. O'Toole.

Limitations

Although the study unfolds during a wide time span and follows all the methodological suggestions in order to gain validity and relevance, an evident limitation of our study is that it builds on a single case study of a mid-sized company in a B2B context. That means that the external validity of our findings in other contexts needs to be verified (La Rocca et al., 2016). Also, to be honest,the case study approach is unfortunately still not recognised as a proper scientific method. The main arguments against it have been that case studies provide little basis for scientific generalisation (Yin, 2014). Despite this, the researchers posit that learning from a particular case (conditioned by the environmental context) should be considered a strength rather than a weakness (Dubois and Gadde, 2002).

Chapter 3

LEANCOST'S DEVELOPMENT CASE STUDY

This chapter presents the case description and the LeanCost new product development process; as mentioned, besides the product development process, our focus will be on the interaction between Hyperlean and the actors of the industrial business network who played a central role in the co-creation process of the LeanCost software during the different evolution phases of the product.

Below, it is possible to find firstly an introduction to the case, with a brief description of the company that stems out from the new product development process. Then, an overview is presented of all the milestones of the process with the aim to give the reader a clear point of view of the whole co-creation process. Soon after, the technology and the LeanCost are described in order to depict all the elements that make the new product development process possible. Finally, the new product development process of LeanCost is analysed with full details on the interactions and inter-organisation processes that lead to the development of the product in co-creation.

3.1 - Introduction to the Case: Hyperlean

In the early years of the 2000's, a group of mechanical engineering researchers of the Faculty of Mechanical Engineering of Università Politecnica delle Marche were already working on developing studies on the design-to-cost subject, and said studies would become the core paradigm of the product developed. Very soon, these researchers started to interact with important firms, and local businesses which were already in contact with the university, in order to deploy the researches developed by the research group until that period and to assess the practical validity and the application of these studies within industries. After a decade of university-industry collaboration on the subject mentioned, during which several public funded projects took place to enhance technology transfer between university and industries, a new spin-off was created by Università Politecnica delle Marche – Hyperlean – which has the purpose to commercialise the product of all these years of research on design-to-cost issues: LeanCost.

Since the beginning in 2010, LeanCost was Hyperlean's unique core product. Beside the software, the spin-off still offers related consulting and training support services. For the single LeanCost software license, Hyperlean demands to a potential customer an investment of around € 10.000,00, while for training and consulting, the price is roughly € 700,00 per day. Consulting and training have been used by Hyperlean, especially in the early years, as a manner to ease the adoption of LeanCost by new customers, and to train the users for an optimal use of the

software. In the first steps with customers, Hyperlean was willing to grant free LeanCost software licenses for a short period of time, while the customers paid for training and consulting activities. In this manner, Hyperlean managed to support the LeanCost adoption processes in a critical moment, because customers needed to be guided along the set-up of the software, and thanks to this choice, Hyperlean managed also to 'financially survive' in its first years before reaching the first 'real' sales of the LeanCost license. Training and consulting services were also a good manner for Hyperlean to ensure that customers would achieve the highest benefits via the correct utilisation of LeanCost. After the early years when LeanCost was not ready to be sold, these services became a minor revenue stream for Hyperlean. Since 2014, the LeanCost license sales grew and now Hyperlean can boast some of the best firms of the world as their customers.

Actually, Hyperlean's preferred targets – which they named top industries – are mainly medium-large enterprises with an annual revenue of more that 10 million euros, which are managing operations in the application area of research and development, product design, product industrialisation, cost engineering, purchasing, and sales. Hyperlean defined also which are the most attractive target industries for its LeanCost software, which are: automotive, aerospace, industrial automation, mechanics, packaging, heavy industry & off-highway only to mention some.

Nowadays, LeanCost provides: raw material database with more than 145 materials, 1300 metal sheets and 25000 beams; default machine database with more than 80 machines; more than 15 default processes; and more than 15 default logics to analyse different types of components. In terms of size of the business created, in 2017 Hyperlean had more than 30 directly employed people and a gross turnover close to 2 million euro per year.

3.2 - Overview of the Case

The aim of this chapter is to introduce the product development process, made of interactions and collaborative activities, that led to the creation of LeanCost, the design-to-cost software developed by Hyperlean. This first section of the findings gives an overview of the temporal development of the case study. It is possible to use the following Figure 3.2.1 to obtain an overview of the chronology of the development process's milestones of LeanCost. That figure represents the milestones of LeanCost's product development.

The case study of Hyperlean developed in a time span of more than fifteen years, commencing in the early 2000s until 2018. Hyperlean managed to create an innovative software through the interaction with several companies to create and develop the product. The case commences with the early development of the research activities of the Department of Mechanical Engineering of Università Politecnica delle Marche (from now onwards UNIVPM) in the subject of design to

cost, design for costing and estimation methods. In order to understand how Hyperlean originated and co-created its product LeanCost, it is necessary to clarify that design to cost, design for costing, and cost estimation methods are a branch of mechanical engineering focused on industrial design, geometric modelling, and information technology. The academic research on the subjects related to design to cost and cost estimation originated in the 1990s and evolved until 2018 in parallel with the new cost management approach.

Amongst all the companies and the organisations that participated in the LeanCost development process, the key actors at the beginning were Biesse and Università Politecnica delle Marche. Biesse Spa manufacture and distribute a wide range of tools and machinery for processing a range of raw materials such as wood, glass, stone, plastic, and metal. Biesse was established in 1969 in Pesaro (Ancona), and today it has 6 business divisions, 9 production sites, 37 between subsidiaries and offices, and more than 300 distributors worldwide. In 2016, Biesse Group's net sales was around € 619 million, with more than 500 systems installed. For Biesse, exports represent more than 80% of the total sales. Biesse employs more than 3,900 people, around 2,200 of whom in Italy and 1,700 outside of Italy. Biesse have 4 training centres and are very committed to innovation and R&D investment, currently they have registered more than 200 patents. Università Politecnica delle Marche[2] is an

[2] http://www.univpm.it/

important university of the Marche region. The Design tools and Method Group, incorporated in the Department of Mechanical Engineering (today named Department of Industrial Engineering and Mathematical Sciences – DIISM), is focused on the subject related to design to cost and cost estimation tools and engineering methodologies since 1998.

The collaboration between the Research Group and Biesse led to the creation of the software called LeanCost, and then of the academic spin-off called Hyperlean. The initial purpose of the software was to enhance the collaboration between the firm and its supply chain during product design, purchasing and commercialisation. Hyperlean was started by six researchers of the Design tools and methods group, with the financial and structural support of both Biesse and Univeristà Politecnica delle Marche. Hyperlean has its focus on commercialising and developing an innovative design to cost and cost estimation software solution. Actually, Hyperlean's core product is LeanCost, with the related training and consulting services that sustain the software adoption. On the following section 3.3, it is possible to find a description of the characteristics of LeanCost and its technology.

As can be seen from Figure 3.2.1, the collaboration between Biesse and the research group culminates in the creation of a new venture in 2010. The relationship between these actors started in the 2000s and consisted of ‘light’ collaborations on students’ master theses, laboratory case studies and research projects on products' life cycle costing methodologies. This initial collaborations between Biesse and the Research

Group laid the basis for a relationship that in 2005 led to the participation in a public funded project called Co.Env. (Collaborative Environment). This project was funded by Regione Marche and Ministero dello Sviluppo Economico, and has three main actors connected with the University: Biesse, Teuco-Guzzini (home and wellness furniture design) and Indesit Company (domestic appliances). The purpose of the Co.Env. project was to enhance the ability of the firms to creates innovation within their supply chain, thanks to the sharing of knowledge and resources (both tangible and intangible) through the creation of a computerised data exchange platform. While participating in the Co.Env. project, Biesse recognised the need to use a software that helps designers to improve design to cost and cost estimation operations. In 2007, Biesse started a market exploration to verify if there were potential suppliers of this kind of technologies. In 2008, after roughly one year of research, Biesse came up with the idea that there were no potential suppliers ready to provide the technologies they were looking for. During the Co.Env. project, Biesse asked the Research Group, guided by Prof. Germani, to study from scratch a new software capable of design to cost assessment and cost estimation. It is possible to consider the commencing of the development of the new software as one of the major outcomes of the Co.Env. project.

Since 2008, Biesse and the Research Group went through the creation of a cross-functional team. The long path to achieve a new product began with meetings, coding, testing, brainstorming, and research. Biesse and the Research Group aimed

to share their knowledge in order to build up a concept of the software. Biesse has a different background compared to the Research Group. Biesse's people were more skilled in operations and managerial procedures, while the Research Group had a deep theoretical background in engineering and information technologies. In 2009, after the first year of joined work, the team (Biesse and Research Group people) managed to create the first beta version of the software. The people who were part of the team named it LeanCost, due to its capability of time and effort reduction for design to cost, cost estimation, and cost analysis activities. The first release of the LeanCost software was a complex interface that did cost estimation through the combination of Microsoft Excel user interface and Microsoft Access database. The product was, basically, a minimum viable product which supported the team for the validation of the initial concept needed by Biesse. In 2010, Biesse and the Research Group decided to establish an academic spin-off based on the LeanCost software. This spin-off was called Hyperlean. Hyperlean has 8 different founders: Biesse, Università Politecnica delle Marche, five researchers of the Research Group, and one IT consultant who at that time was an external consultant of the Research Group. For Biesse, the main motivation for setting up an academic spin-off was to protect and develop the resources invested for the development of the first versions of the software. Instead, for the Research Group, it would represent an alternative career path to the academic one, and for those who engaged in

research it, would be a test bench for research experiments. Not much later, the collaboration between Biesse and Hyperlean would reveal several dark sides.

Since 2011, Hyperlean commenced to engage with new customers, but the feedback it received was not very encouraging. The majority of the new prospects claimed that the software that Hyperlean was proposing was excessively limited to Biesse's technological requirements, and thus was difficult to adopt in their firms, which required different specifications. This was an unexpected issue for the people of Hyperlean. However, soon after this feedback, Hyperlean commenced to rearrange LeanCost, and through this first customer feedback, Hyperlean learned that in order to attract new customers, it had to develop a more 'general purpose' software, easy to adapt to different firms in terms of technologies and applications. In order to achieve the development of the requested 'general purpose standards', since 2012 Hyperlean initiated several collaborations with new customers, with the purpose to co-create together the new version of the software. The result of this process was a new release of LeanCost, that when submitted to new customers obtained good results and positive feedback. The main field of co-creation with customers regarded the development and improvement of all the critical factors of the product: these are knowledge library database, user interface, applications, algorithm, software interactions and key features. All these factors required a different level of involvement by the customers. Then, in 2012, soon after new software releases that embedded all the requirements requested by the key actors, Hyperlean managed

to initiate new business relationships with a considerable number of new customers. Thus, from 2014, Hyperlean was able to increase its marketing and sales efforts in order to create new valuable customer relationships, like those with General Electric, SACMI, Gucci, FCA Group and many more. Valuable relationships mean that Hyperlean was able to attract relevant customers that could support the spin-off by improving the capabilities of LeanCost, by expanding the network to create more new customer relationships, and by purchasing the software license, thus helping financially as well. Today, the company is working on expanding their business network to create new relationships with international firms.

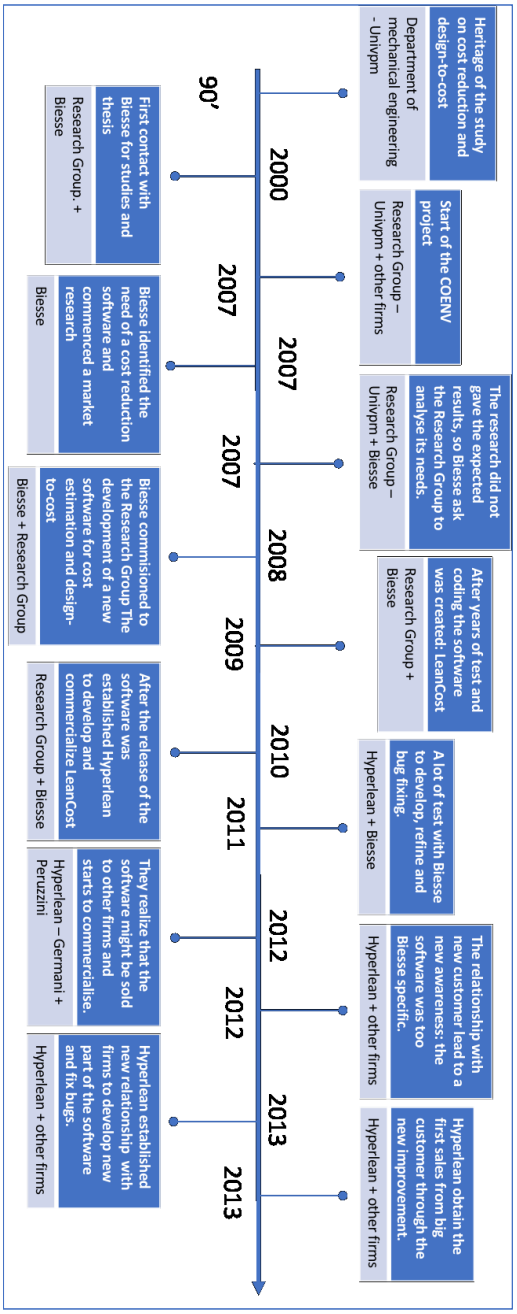

Figure 3.2.1 – Chronology of the development process of LeanCost

3.3 - Technology: Design to Cost and Leancost

In order to understand clearly the new product development process that will be presented in the following section 3.4 of this chapter, it is important to provide a clear picture of the technology and the scientific paradigm by which the LeanCost software is inspired. Below, it is possible to find a brief description of the Design-to-cost paradigm and methodology, taken from the academic research of the group who created LeanCost; and the analysis of the product in terms of functioning processes and critical factors.

3.3.1 – Design to cost

Many "Design-for-X" methods have been developed in order to support the design and engineering phases of product development (Favi et al., 2016).

The design to cost paradigm stems from the need of the companies to adopt new types of technologies that are able to reduce time to market, costs and uncertainty when it comes to develop a new product. Indeed, design to cost is strategic for firms to do accurate and fast estimation during the design stage of product development in order to achieve predetermined goals.

As stated by Mengoni et al. (2016), "manufacturing cost estimation and prediction in the early design phases is one of the main important aspects for company competitiveness. This estimation is not an easy task, because it is necessary to take

into account a considerable number of different elements such as manufacturing process and its related parameters, raw materials, production lot, and many more. Specifically, the mentioned analysis has to be based on knowledge, features, operations, weight, materials, physical relationships and similarity laws (Favi et al., 2016; Weustink et al., 2000). Usually, the design-to-cost approach is described as a multi-objective design approach suitable for a comprehensive analysis of the manufacturing aspects since the design phase of complex product development (Favi et al., 2016).

Finally, the strength of this paradigm is that it allows the designer to calculate costs in the early design phase by managing the knowledge of production processes. Favi et al. (2016) point that this approach is cost-driven and help designers and engineers also in the selection of a cost-effective design solution.

In the following section is presented a detailed description of the design-to-cost software solution developed by a team of researchers belonging to the Mechanical Engineering Faculty of UNIVPM: LeanCost.

3.3.2 – LeanCost

LeanCost is a CAD (computer aided design) based software that embeds design-to-cost and cost-estimation methods in the algorithm to support the activities of designers, purchasing and sales departments on product development. LeanCost's purposes are: to provide a fast and accurate cost estimation since the design stage

of the product life cycle; to support the decisions of designers by finding the effective manufacturing solutions before any investments are made by the firm; and to simplify all the activities required by the users for cost estimation with optimised interfaces that aim to ease and speed up the cost estimation operations. LeanCost focuses the analysis on the impact of the engineering and manufacturing choices on the final production cost of components and products, covering all the development activities from design to commercialisation.

Hyperlean claim that the software is easy to use thanks to the perfect integration with the most common 3D CAD systems: LeanCost is designed to automatically translate the geometric characteristics of the component and to initiate to define a bill of materials of all the requirements in terms of raw materials and manufacturing processes, then all the parameters could be managed by the users, who could define different scenarios to support 'make or buy' decisions. LeanCost enhances the information exchange within and among the actors – supplier and buyers – through the shared database of knowledge and by a considerable number of different reports that is possible to export from the software to compare the results of the analysis. This information exchange is supported by the availability of a complete range of information provided by LeanCost about costs that the firms, through the utilisation of the software, could share across the supply chain. Hyperlean ensure that LeanCost could support and ease the operations of different actors within firms: designers, cost analysts, buyers and sales. Hyperlean's sales reps claim that

LeanCost is suited specially for big firms who manage only the concept and design stage of new product development and then have to outsource all the components and products assembly to several suppliers. With LeanCost, these firms could reach a high level of efficiency in terms of time and costs and supply chain management. In a nutshell, the aim of LeanCost is to allow firms to manage efficiently their supply chain and to improve the relationships with suppliers thanks to higher accuracy of cost estimations and an improved exchange of information about product requirements.

Since the beginning, Hyperlean's team worked to improve all the critical factors that constitute the essence of the product. All the critical factors are described in the following 3.3.3 subsection. Hyperlean improved user experience, through the creation of a detailed and optimised user interface, minimising the 'number of clicks', reducing the time for setting up cost analyses and adding panels and windows to check the status of the processes that allow the user to fix possible errors while the software is running the estimation. To support the users in assessing the results of the estimations, Hyperlean's team developed detailed and customisable report cards, optimised for exporting the results of the analysis in form of a datasheet or with the integration to ERP systems. Hyperlean created from scratch a shared database of knowledge about common raw materials and manufacturing processes, which is one of the most prominent aspects of LeanCost. The database is updated at every new release of the software with the combination of all the

information and technical knowledge shared between Hyperlean and the actors of the business network. In parallel with the database improvement, Hyperlean developed from scratch the code of the software, combining information from the empirical knowledge of the customers and the theoretical functioning logics that make up the LeanCost algorithm. Now, as a result of the collaboration with the customers, LeanCost is suitable to be used in a wide range of different industries (the list is updated according to the latest 9.0 version, released at the end of 2017): machine tools; packaging machinery; wood, ceramic and paper processing machinery; agricultural machinery; industrial automation machinery; automotive, oil & gas and defence components machinery. The development path of LeanCost since its genesis is discussed in the following paragraph 3.4.

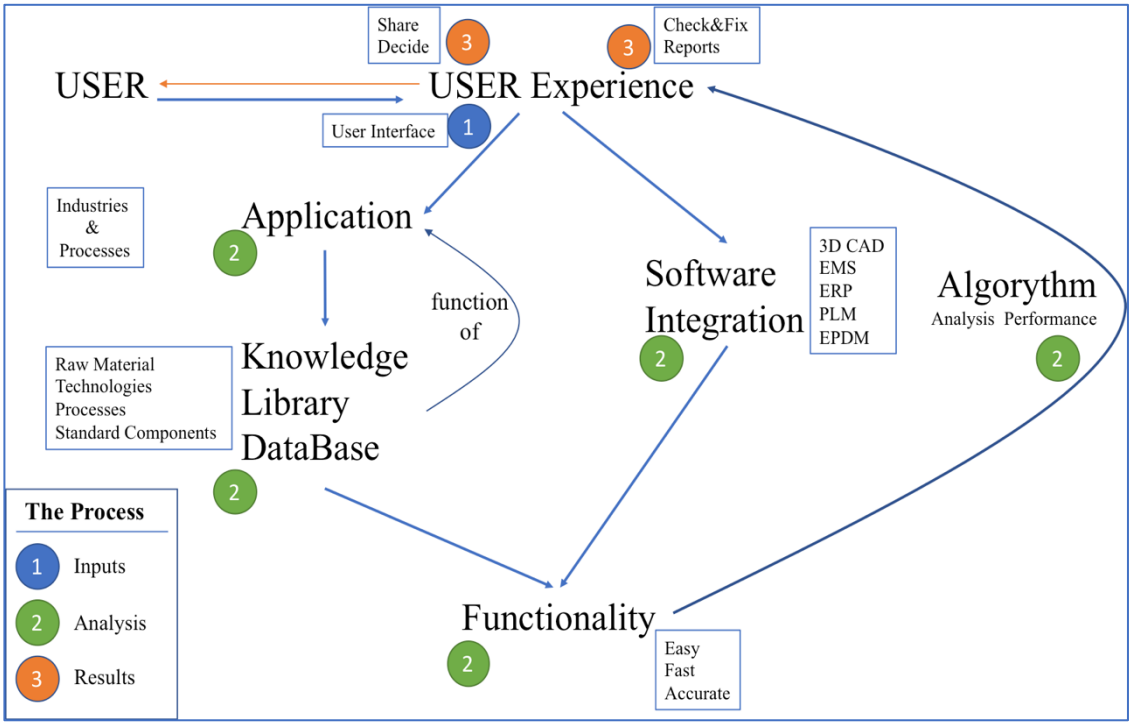

Figure 3.3.1 - Process and critical factors workflow of LeanCost

The blue and orange arrows describe the workflow of LeanCost. For every main step of the analysis, it is possible to find the critical factors that play a key role: for the inputs stage, it is User Experience; for the analysis, the factors are Application, Knowledge Library Database, Software Integration, Functionality, and Algorithm; for the results, it is User experience.

3.3.3 – How does LeanCost work?

As said before, in order to understand the process that led to the creation of LeanCost, it is fundamental to describe in detail the technology and its functioning.

Following, it is possible to find an analysis of the software in order to depict the process and all the critical factors that played a crucial role in its performance. Finally, it is possible to find a brief overview of the desired effect of the adoption of LeanCost and a few considerations about the other technology providers currently active in this field.

LEANCOST'S ANALYSIS PROCESS

LeanCost is a real time cost estimation software integrated in the most common 3D CAD systems. Currently, LeanCost can attain a cost estimation of a broad range of mechanical components with a computing process that goes through the assessment of the components' 3D model, raw materials and manufacturing processes. This cost estimation procedure standardisation takes place with the possibility to customise a wide number of parameters during the software setup stage. These customised parameters are established by taking into account the specific requirements of the firm and its industry compared to LeanCost's Knowledge Library Database's shared parameters. In order to give a clear picture of the functioning of LeanCost, it is possible to break down the computing process into three main steps: inputs, analysis and results.

Inputs

The inputs are all the information required for cost analysis, which could be uploaded on LeanCost by the users or imported directly from the 3D CAD system. With the latest updates, LeanCost can automatically recognise the geometry of the model and start the analysis. The information required consists of 3D model geometry - the design of the assembly/components - and the attributes – a list of components and the bill of materials – related to the product analysed. Since the beginning, Hyperlean worked to facilitate the inputs of data and the submission of the 3D model through the development of optimised user interfaces that could guide the user from the beginning to the end of the cost estimation procedures.

Analysis

The LeanCost analysis starts with the recognition and assessment of the 3D model requirements in terms of suitable raw materials and manufacturing processes according to the knowledge library. The knowledge library that LeanCost uses to recognise and perform cost estimation analyses is a huge database of materials and technologies created, updated and validated with the support of the customers. The information about material and processes are set up based on the application required by the firms. The core 'engine' of LeanCost for the analysis activities is the algorithm that the software uses to provide the users with design-to-cost estimations and solutions. LeanCost is also suited for multiple scenario analyses: all the cost estimations were done showing the different impacts caused by using

different materials and production technologies. The analysis considers also the economic manufacturing volume and supports the users to find the economic batch quantity. Throughout this process, the users are supported by dedicated interfaces that guide them through the main stages. In the latest release, it is possible for the user to check and monitor the analysis and, when necessary, to change parameters while the software is performing the estimation.

Results

The results of the analysis performed by LeanCost are a production time and cost estimation of the 3D model submitted with a detailed description of raw materials, processes and technologies to be used to produce the components analysed. All the estimations are detailed with a wide range of geometrical and technological parameters that the user could manage to change the setup of the estimations. LeanCost represents the results of the analysis through different reports. There are reports that could be exported to Microsoft Excel for further operations; in addition, there are reports that could be exported as PDF static documents. Thanks to the latest update of LeanCost, the results of the LeanCost analysis can be exported directly to other management software systems thanks to LeanCost's integration with common ERP (enterprise resource planner), PLM (product lifecycle management) and EPDM (enterprise product data management) software.

LEANCOST'S CRITICAL FACTORS

LeanCost incorporates several different elements regarding mechanical engineering logics, empirical knowledge, software code, costing models and user experience principles. In order to shed light on LeanCost, is it possible to analyse the software distinctiveness under 6 different critical factors that made possible for Hyperlean to disseminate its product across different firms. These factors are directly connected to the development of the software capabilities. Since the concept of LeanCost was released, Hyperlean collaborated with customers to develop and upgrade the capabilities of the software. Almost every year, Hyperlean released a new version of the software which was awaited by customers and managed to satisfy them. A fair portion of this successful development has to be addressed to the collaborative capabilities expressed by Hyperlean's people to start several concurrent development pipelines. In order to give the readers a clear meaning of these critical factors, below is a schematic description of each of them.

Knowledge Library Database

The Knowledge Library Database is the *'central intelligence'* of the software. It consists of a body of information and technical data about raw materials, manufacturing technologies, manufacturing processes and standard components. This set of information and technical data includes unit costs, processing time,

technological specifications and design optimisation. The information is gathered by Hyperlean through the relationships with the actors of the business network.

User Experience

Hyperlean managed to improve and optimise the user experience of LeanCost in three different ways: the development of an optimised and well designed user interface, with the purpose of reducing the number of clicks required by the user for completing the tasks; the creation of an analysis monitor that allows the user to check and tune the setup during the analysis, and the creation of a considerable number of detailed standard reports in function of the information required and the option to personalise reports according to the requirements of the users.

Algorithm

The algorithm is the '*engine'* of LeanCost, i.e. the element that makes it possible to perform the analysis. This is the part of the 'code' that characterises LeanCost as a software. It takes shape from two streams of data: the empirical information provided by firms about specifications, processing times and methods, rules of costing, cost models and the logical functions and assumptions provided by academic research, and the theoretical background of the engineers working on LeanCost. LeanCost's algorithm processes the 3D model with all the information updated on the Knowledge Library Database adjusted according to the needs of the

firm. Hyperlean developed several parts of the code in collaboration with its customers or by giving them the opportunity to have the ‘open license’ of the software that allowed the users to customise the code of LeanCost.

Software Integrations

Since its early stages of development, LeanCost has been well integrated with the most common 3D CAD systems for processing 3D model and their related technical features and attributes. Soon after, Hyperlean improved LeanCost's capabilities by creating, with the support of its customers, the integration between LeanCost and common enterprise management systems such as ERP (enterprise resource planning), PLM (product life-cycle management) and EPDM (enterprise product data management). By the way, LeanCost maintains compatibility for data management with external applications like Microsoft Excel & Access.

Key Features

Among all the key features Hyperlean provided in LeanCost, those which are able to characterise and make LeanCost unique for the customers are: fast geometry recognition, the software automatically recognises the geometry of the 3D model and immediately starts to give feedback to the users; fast cost estimation, LeanCost provides a fast and accurate cost estimation without the need to input all the technical parameters required for a ‘manual analysis’; LeanCost is able to provide

a multiple-scenario analysis linked to the economic batch quantity analysis. Data accuracy and data 'shareability' are the strengths of LeanCost.

Applications

In order to be consistent with customer requirements, Hyperlean developed specific applications for LeanCost linked to specific industries, for example Defence or Automotive, to specific materials and processes or technology requirements, for example titanium, laser welding, injection moulding or T-milling. These improvements made the software consistent for a specific industry and they facilitated the creation of new customer relationships.

LEANCOST'S EFFECTS

The main effects that LeanCost brought to the users and their organisations are directly connected with time and costs saving. Since the beginning, Hyperlean worked with the purpose to make the design-to-cost and cost-estimation procedure smooth, with the aim to facilitate the job for the users. The adoption of LeanCost as a method to perform cost analysis leads to an immediate reduction of the resources (in terms of time and persons, thus costs) required to perform cost estimations. The cost reduction benefits are evident also under the form of better design and procurement choices. LeanCost can give the users very accurate costs information. This costs information could be used to enhance strategic management

decisions in terms of design, product development, commercialisation and procurement; or the information could be used to improve management operations and activities. Several effects are directly referred to management issues, particularly with the accomplishments that could be achieved within or across firms. Within the firm, the effects are directly related to an improved information exchange among employees about product specification and product costing; said improvements in information sharing could lead to more profitable choices about design and procurement. Taking a point of view external to the company, the effects among firms are related to an enhanced relationship alongside the supply chain thanks to clear information about product and production costs and time targets while requesting for collaboration or requesting offers.

3.3.4 - Other technology providers

In order to give the readers a full understanding of the business network within which Hyperlean is embedded, it is useful to briefly describe the other main technology providers. Actually, LeanCost is perceived as a very innovative software in its relatively new field, and for this reason, the actors can choose between few other technology providers. Most software systems that are similar to LeanCost were launched a few years before Hyperlean invented LeanCost, and in some cases these software systems were already used by a considerable number of potential customers while LeanCost was still under development. These design to

cost software systems are now held by big companies which have a bigger 'investments capability' with respect to Hyperlean, and thus could spend more resources on marketing or product development activities to attract more new customers.

It is common for firms to use more than one design to cost software at the same time, and for this reason, it is possible that different technology providers can be work with the same firm. This helps big firms to adopt new solutions like LeanCost. In fact, usually Hyperlean's customers use more than a single software system to obtain design to cost analyses, because this is a way to 'double-check' the results, and because every software has its strength in a certain stage of the product development life cycle. Those that can be considered 'direct competitors' of Hyperlean's LeanCost, also according to Hyperlean management's point of view, are aPriori[3] and Siemens Teamcenter[4]. While aPriori and Siemens are the most renowned software systems for cost estimation and cost management, it is possible to find also some other software that promote themselves as a 'plug-in' of common 3D systems (for instance Galorath Seer[5] with 3DS CATIA[6] and iDConsult METUS[7] with Siemens Teamcenter).

[3] https://www.apriori.com
[4] https://www.plm.automation.siemens.com/global/en/products/teamcenter/
[5] http://galorath.com/products
[6] https://www.3ds.com/products-services/catia/
[7] https://id-consult.com/en/metus/metusr-plug-siemens-teamcenter

It is important to describe the other technology providers by taking into account the key dimension that could influence the actors when it comes to choose which technology to adopt to perform design to cost and cost estimation operations. For this reason, the key dimensions of the analysis are ‘cost’ and ‘usability’. The information about the ‘cost’ of every software license was hypothesised by gathering information from the website, their references and their partners. The meaning of ‘usability’ is a sort of ‘trade-off’ between the user friendliness of the software and its accuracy in the results provided by the analysis. This dimension takes shape directly from factors like Library Knowledge Database, User Experience and Key features. To assess the level of every factor for every software, the information was gathered from the web, analysing case studies and reports.
These evaluations were done using the interviews with key informants of the data collection as a first source of information.

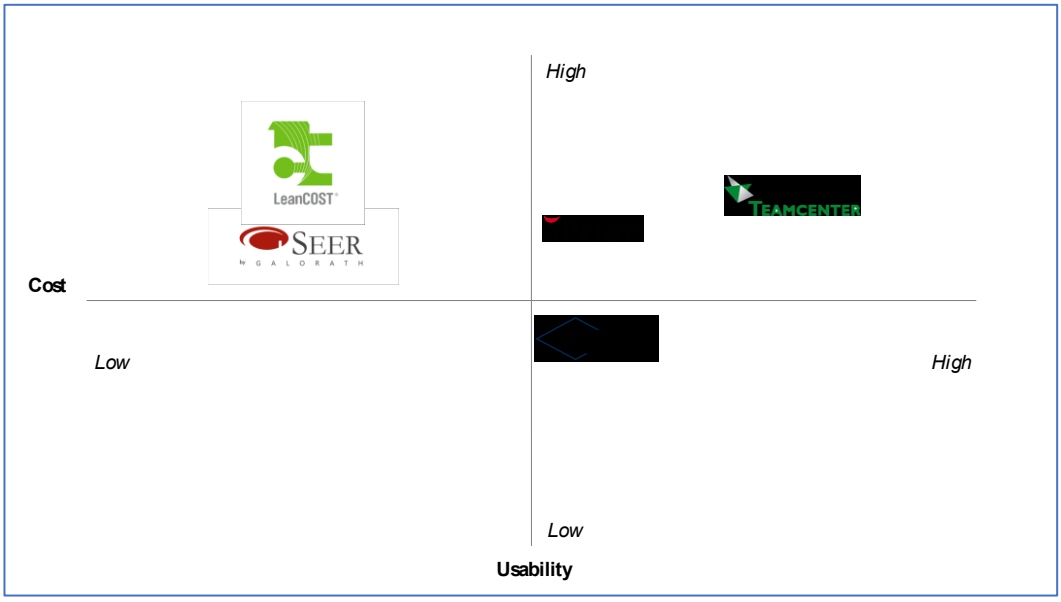

Figure 3.3.2 – Design to cost technology providers map

(Our adaptation based on the data collected)

The results of the benchmark describe what Hyperlean's founders and employees claim, i.e. That it is one of the easiest and most effective software for design-to-cost analysis, suitable to be used with the most common 3D systems (apart from some other technology providers who are directly partnering with 3D system producer). For this reason, the effort dedicated to making a smooth user interface made Hyperlean one of the easiest design-to-cost software systems to use. It is possible to find more complex software systems that could deliver more accurate results (for instance Siemens Teamcenter or aPriori), but these solutions require higher investments from rhe firms, more work and more detailed information to be operated.

While performing a brief web surf searching for other design to cost software producers, it was possible to understand that besides these few examples of software similar to LeanCost, a multitude of different software were developed for specific requirements or applications. There is a design to cost software focused only on the design and manufacturing of PCB (printed circuit board), or a design for assembly software that aims to measure the assembly efficiency of components and makes comparisons with design alternatives. These software systems could be embedded in the field of 'design for manufacture' (DFM) methodologies. These software systems aim to support engineers to quickly assess the cost of producing the new designed components and to make comparisons with other production options. In conclusion, Hyperlean positioned the software in a way that supported its purpose to be a facilitator for design-to-cost and cost estimation; thanks to the factors Hyperlean developed in LeanCost, it seems that this system is actually one of a kind for the potential customers.

3.4 - The New Product Development Process

The core part of this empirical chapter of the thesis is the description of the LeanCost development co-creation process, where it is possible to emphasise all the highlights of the processes and all the events that contributed to the creation of the product. Particularly, the purpose is to focus on the collaboration activities

between the actors of the business network in order to co-create and develop the product capabilities; thus, the ability of Hyperlean in order to exploit the business network resources. Below, the development process is divided into 4 main sections (See Table 3.4.1 below) to help the reader in the analysis of the main phases of the story. Then, the paragraph will conclude with a short summary of the development process of all the critical factors that build up LeanCost and with a view of the several actors of the business network that supported Hyperlean in the development process of its software.

YEARS	**2000-2007**	**2007-2010**	**2010-2012**	**2012-2014**	**2014-TODAY**
SECTION OF THE CASE	Origins	Validation 1 & 2	Validation 1 & 2	Re-Arranging Product Development	Further development and commercialisation
INPUT	Biesse's Needs	Idea	Mvp – Beta Version	New Customers' Feedback	New Customers' Needs
CRITICAL FACTORS	Knowledge Library Db Algorithm	Knowledge Library Db Algorithm	Knowledge Library Db Algorithm	Knhowledge Library Db	Knowledge Library Db Algorithm

INVOLVED			User Interface Applications	Algorithm Application	Application User Experience System Integration Functionality
ACTORS	Biesse	Biesse	Biesse - Omme - Bosch	Biesse - Omme - Bosch	Sacmi - General Electric - Ferrero - Cefla - Gucci - Technogym
SW VERSION	-	V.1 - V.3	V.4	V. 5	V. 6 - V.9
OUTCOME	Solutions - Idea	Beta version	Minor Updates	New Generic Software	New Yearly Updates

Table 3.4.1 - LeanCost co-creation process overview

(Our adaptation)

Origins

In the late nineties, academic researchers and firms – namely practitioners - began to be aware about life cycle costing and design-to-cost methodologies alongside the growing relevance of the studies about 'design tools and methods' and the introduction of new innovative software for CAD modelling – the purpose of which is to ease the optimisation of product design and product engineering. Soon 'design

tools and methods' became a recognised branch of mechanical engineering. Since then, researchers and professionals around the world began to work to develop a variety of different methodologies and tools to improve the capabilities of designers in cost controlling and cost estimation. The development of new CAD software tools was possible thanks to the growing 'computing power' – both in graphics and calculations – of the new microprocessor and the subsequent improvement of production technologies used among first class industries. The 'design tools and methods' subject generated interest also in the Faculty of Mechanical Engineering of the Università Politecnica delle Marche, which in 1998 created a research group focused on mechanical design, computer assisted drawing and virtual prototyping, which takes the name of 'Gruppo DT&M' (Gruppo Design Tools and Methods). Since then, the group has grown, and many changes occurred within the department. Since 2011, the DT&M Group belongs to the 'Department of Design and Methods for Industrial Engineering' (DIISM) and currently involves about 20 people between researchers, post-doc and PhD students.UNIVPM is located in Ancona, the main town of Regione Marche, and has always been involved in collaborations with local firms. UNIVPM's research activities are enhanced and supported by both academics and local entrepreneurs. Since the years of the growing interest on design-to-cost and cost-estimation methodologies, several firms started to collaborate with the DT&M Group to create a reciprocal exchange between academic knowledge and on-field experience developed by firms. One of the

collaborations that later on would be critical for the development of the theories about design tools and methods is the one with Biesse, which is still one of the biggest firms of Regione Marche. Biesse is involved in the wood and raw material machinery and plant production. The firm is very keen on innovation, which is one of its core values. The first approach between Biesse and the DT&M Group of the Faculty of Mechanical Engineering of UNIVPM occurred in the end of the nineties. In these first shy interactions between these two actors, their collaboration was based mainly on students' master theses and project works. Notably, many of the students involved in this process would be hired by Biesse or would participate in the development process of LeanCost as employees, doctoral students, researchers or external consultants. Alongside the collaboration with the students, Biesse and the DT&M Group jointly worked on small size research projects, commissioned by the first and performed by professors and researchers in the field of Life Cycle Costing and Information Management between Biesse and its supply chain. The collaboration between Biesse and the DT&M Group started around the year 2000 and continued proficiently with students' theses and small research projects until 2007.

In 2007 the opportunity came for the DT&M Group to participate, in collaboration with Biesse and other several actors, in a public funded project that had the purpose to develop and enhance new ways of collaboration in order to sustain and enhance innovation between firms and their supply chain. Since Biesse and DT&M Group

gained mutual trust during the years, when this opportunity arose, they agreed to start this project together. The aforementioned project was called Co.Env., an acronym which stood for 'Collaborative Environments'. The aim of the project was to improve the collaboration and the information sharing among firms and their supply chain – these issues were already one of the DT&M Group's main studies commissioned by Biesse. The Co.Env. project was publicly backed by Regione Marche and the Ministry for Economic Development of the Italian Republic. Co.Env. was organised as a consortium between firms and public actors. The main actors involved in the project were Università Politecnica delle Marche, which was in charge of the scientific coordination and supervision of the project; Biesse Spa, Teuco Guzzini Spa and Indesit Company Spa as project leaders, and then the supply chains of the three project leader firms. The idea behind the Co.Env. project was to involve big firms and their supply chain of SME's in order to:

1. Experiment new ICT Tools for improving the firms' innovative capabilities
2. Establish and test new 'agile' product development methods
3. Develop a web-based tool to ease the collaboration between big firms and SME's

Subject	**Leading Company**
Methods and techniques for the 'agile' management of processes within the extended company	Biesse Spa

Study of communication mechanisms within multidisciplinary working groups and development of tools to support collaboration	Teuco Guzzini Spa
The innovation of modular products and configurable through multi-level platforms for change management	Indesit Company Spa

Table 3.4.2 - CO.ENV. assignment of subjects to leading companies

(Our adaptation)

The basic assumption of the Co.Env. project was that to improve local firms' competitiveness, one of the keys could be to improve the way these firms communicate and collaborate with their supply chains. The project was managed by a 'steering committee' composed by scientific advisors – provided by the DT&M Group and other academics – and external experts and consultants. Every subject of the project was guided by a team of task managers from the leading company, PhD students from the university and a panel of employees that made up the whole group. The project was organised in three main stages, which were: 'research', where the aim was to identify new ideas and methods; 'development', where the aim was to validate and develop the different ideas developed; and 'experimentation' which applied the tools and methodologies developed to the firms. Particularly, the Biesse subject required to involve also the main actors of its supply chain for easing the studies and the consequent application of the

innovations developed inside the consortium. Thanks to the Co.Env. Project, Biesse began to develop a new architecture for the models of cost engineering within the supply chain. During the Co.Env. initiative, with the support of the DT&M Group, Biesse started to develop the 'initial collaborative design' and 'fast budgeting' projects that soon led to test pilot projects with their suppliers.

While Biesse was developing the Co.Env. project in partnership with the DT&M Group of UNIVPM, they started to feel the need for the adoption of the tools they were discussing within the project. Biesse was looking for software tools to manage design-to-cost and cost estimation activities. The initial aim of Biesse was to improve capabilities with the purpose of reducing the time-to-market of the development of the product, to align budgeting, estimation and quote requests methodologies among designer, cost engineers and buyers within the firm. At that time, Biesse used excel spreadsheets for cost estimation activities. Said spreadsheets were developed with the use of fictitious parameters and weak methodologies that did not provide the expected results. In addition, every department of the firm used a different method, and sometimes a different spreadsheet with totally different parameters and logics, which made it almost impossible to use shared methodologies among all the employees. Before the Co.Env. project, Biesse tried to adopt a design to cost software already utilised by several big Italian corporations, for example Fiat, but it was soon realised that it was too complicated for Biesse users' requirements, and they stopped to use it at

the end of the initial trial period of six month. Anyway, thanks to the Co.Env. Project, Biesse could see that if they had used a software tool that systematised and optimised design-to-cost and cost estimation processeses, they could have reached high benefits. Biesse needed a software that could cut time-to-market activities; this could help the designers to find cost effective solutions for products under development in a faster way than they used to do, and it could create a shared set of tools and methodologies for cost estimation and budgeting among departments. The idea of the adoption of a new software that could cope with the requirements already discussed was concrete for Biesse, and for this reason they started a market analysis to identify and assess the potential supplier of design to cost software. This research was completed in almost one year, but after that Biesse did not find a suitable supplier of such technologies. For this reason, Biesse started to try to find out if there were local firms available to build up a solution. In the first attempt, Biesse started to submit their requirement to a local software house (SH), but after a short period the collaboration stopped due to the unfeasibility for the SH to develop Biesse's requests. In 2008, then, Biesse tried to submit their request to the DT&M Group with whom they were collaborating in the Co.Env. project. The DT&M Group immediately took the challenge and accepted to develop a new software on design to cost with Biesse. For Biesse, this represented an attempt to develop a software which they were willing to use; for the DT&M Group, this was a way to transfer years of research and to create a parallel way besides the academic career

for the young researchers involved in the project. This new path of development between Biesse and the DT&M Group began with the purpose to create a software from scratch. This initiative was possible thanks to the mix of knowledge about IT and engineering of the research group. The collaboration started thanks to Mr. Gaffarelli (Biesse), Mr. Pagnini (Biesse) and Prof. Germani (DT&M Group).

Validation 1 & 2

A close collaboration between Biesse and the DT&M Group had already been established, but it started to grow stronger with the participation in the Co.Env. project started in 2007. The relationship intensified and strengthened since the two organisations decided to develop a new software for design to cost and cost estimation from scratch. Since the beginning, Biesse and the DT&M Group have chosen to adopt a collaborative approach to develop the new software and thus established an inter-functional teamwork which was composed by people with different backgrounds from both organisations. The operations of the teamwork were guided by Prof. Germani with a great effort of the PhD students and the young researchers involved in the project. The plan was that the teamwork would meet every week at Biesse's headquarters to discuss, brainstorm and analyse the issues connected to the software they aimed to develop. After every weekly meeting, every member had specific tasks to accomplish for finding new information or new data, mainly derived from Biesse’s supply chain, that would be discussed on the next

meeting and that was useful for improving the data set of knowledge at the base of the software. The people from Biesse and the DT&M Group overlapped their activities between every meeting to find out as much information as they could, and which would be discussed in the following meetings; in this way, the teamwork managed to make steps forward at a considerable pace. While the teamwork was working together in building up the software, they experimented a strong exchange of experiences and knowledge between all the people involved in the project. At that time, the young researcher did not have practical skills yet, and Biesse's team invested time in transferring their knowledge to these young Phd students and researchers. At the end of this first stage of the collaboration, the outcome was a 'book of knowledge' of more than 1.000 pages that enclosed all the information about materials, processes, technologies and methodologies used to create all the product made by Biesse. With this amount of information about the requirements of Biesse's product, the team started to work on building up the new software.

After about one year of co-creation process where Biesse and the DT&M Group collaborated through formal and informal networking and teamworking to acquire all the knowledge to build up the software, in 2009 they managed to release the first minimum viable product (or beta version) of the software. The initial purpose of the software was to ease the design to cost and cost estimation activities, and for this reason the teamwork agreed to call it 'LeanCost'. This MVP, the first version of LeanCost, was the results of the fusion of the knowledge of Biesse and the

DT&M Group after years of joint work based on Biesse technical requirements. Since the first moments, all the people involved in the creation of the software thought that this new solution could be easily transferred to and used also in other firms, thus they started to think about the idea of a future commercialisation of the developed software.

While the teamwork was working on testing the software created together, they started to analise how to manage the issue of the ownership of that software. Biesse's management was firm in declaring that this software did not fit with their future plans and vision because Biesse has a different mission and core business, and thus Biesse was not interested in the ownership of the newly developed software. For these reasons, Biesse agreed with the DT&M Group to find other solutions. After the initial validation of the first LeanCost version, Biesse and the DT&M Group agreed that there were encouraging circumstances to create an academic spin-off. They agreed that Biesse would provide the necessary financial backing and that the DT&M Group would be in charge of the deployment of the entrepreneurial activities. Thus, in 2010, Biesse and the DT&M Group, with the support of the Technology Transfer Office of the UNIVPM, established the new academic spin-off called Hyperlean. The initial members of the spin-off were: 6 academic people coming from the DT&M Group, Biesse and the Università Politecnica delle Marche. The first purpose of the spin-off was to protect and develop the software created; in fact, Biesse's purpose was to create a 'vehicle' to

protect its investments in the software and make sure that LeanCost's development would continue. In tandem with the purpose of 'investment protection', Hyperlean's core activities had to be devoted to starting the commercialisation activities of LeanCost towards other companies. Soon after, the people involved with Hyperlean's project – both on Biesse's and on the DT&M Group's side – started to work hard to complete the development of the ready-to-commercialise version of LeanCost.

At the end of 2010, LeanCost was still a work-in-progress software, slightly more than a beta version which at that time was composed of the integration between a Microsoft Access 'Knowledge library Database' of information about materials, processes and technologies (tuned on the basis of Biesse's requirements) and a Microsoft Excel spreadsheet that played both the role of logics to perform estimation and user interface for data inputs. In some ways, Biesse's users validated the first concept of LeanCost since the beginning of 2010, then, by the end of the same year, Biesse started to massively adopt the software, updating more than 30 workstations with LeanCost.

Although LeanCost software was officially launched at the Bi.Mu.[8] exhibition held in Milan in 2012, they had established other remarkable relationships in the previous 2 years with local customers. In 2011, after the first marketing activities

[8] http://www.bimu.it/

with local firms, Hyperlean started to collaborate with the first customers, one of which was in this case a small local firm, OMME Gears, whose core business is the production of toothed gears. With OMME, Hyperlean developed all the technical files specific to their requirements. In fact, the material, processes and technologies used by OMME were totally different from the ones used by Biesse, thus Hyperelean's technicians had to work together with OMME's technicians to develop the knowledge library database and to adapt the algorithm and the costing logics of the software. In the meantime, thanks to the relevant academic research publications on the subject of design-to-cost and costing that represented also LeanCost, Hyperlean established a relationship with Bosch aimed at exploring the possibility to cooperate with Hyperlean. Their relationship was close, and Hyperlean learned a lot from Bosch (See chapter 4.2 for more details). The interest towards LeanCost by Bosch was growing, thus in 2012 Hyperlean arranged a meeting at Biesse's headquarters for a demonstration of the performance of the software with Biesse users. Bosch was impressed, but not enough to buy the license of the software. By the way, Hyperlean could learn a lot from the relationship with Bosch, also because while in the relationship, Bosch's technicians created a 'list of requirements' that they suggested to Hyperlean for the improvement of LeanCost. Bosch would not become a Hyperlean customer, but they gave Hyperlean's technicians several good pieces of advice for developing the configuration of the software.

While Hyperlean was deploying commercial operations and meeting prospects, its management realised that the software they were proposing to potential customers was excessively focused on Biesse's specifications, and consequently it difficult to apply to the requirements of firms that use different technology, materials and different production processes compared to Biesse.

Re-arranging product development

In 2012, while Hyperlean was continuing to work with Biesse, OMME and having informal networking with Bosch, Hyperlean's management recognised a possible emerging issue. Alongside the first positive feedback received from potential customers and technical users, when Hyperlean started to intensify the engagement with new potential customers asking them to buy LeanCost, they found that according to the feedback of these people, the software had a considerable number of critical issues, and for these reasons LeanCost was not already suitable to be adopted by these firms. Hyperlean's initial marketing activities were focused on exploiting the relationship that the DT&M Group had built over time with local SME's thanks to the existing connection with the university, and with them they commenced to test and validate the software already in use at Biesse. The issue that made new potential customers unwilling to adopt LeanCost mainly came from the fact that LeanCost was excessively customised on Biesse's specifications in terms of technical requirements and technologies. These potential customers particularly

highlighted 3 dimensions of the software: the range of capabilities useful to support everyday tasks, which are connected to the Library Knowledge Database; the reliability of the data which is connected to the algorithm, and the availability of useful features focused on the needs of specific applications.

At that time, Hyperlean began to realise that the only way to improve the software was probably to involve since the beginning potential customers with developed technical knowledge and to cooperate to develop all the critical elements of the software. Prior to involving new partners, Hyperlean analysed the feedback received to recognise where the major issues of the software were, and they tried to come up with a solution to these problems. Hyperlean used to work closely with their customers firstly for the assessment of their requirements in terms of ‘desires’, and then for improving the software capabilities and making it more suitable for a ‘general’ firm. The role of the customers could be substantially addressed to these aspects: reporting on their needs while using the software; contribution on knowledge library database development; support for the development of new applications and support for the development of new features of the Software. After realising the generalisation issues of LeanCost, Hyperlean recognised that if it wanted to grasp a vast customer exposure, it had to work on developing a software more suitable for a generic professional use.

Hyperlean's management learned from the feedback about the product capabilities, in terms of critical factors development, provided by the first customers and

potential prospects (OMME, Bosch, Casagrande, Magneti Marelli) and it took the chance to improve LeanCost. In order to achieve new customer relationships, Hyperlean's management realised that they needed to upgrade LeanCost.

The starting point of the 'revolution' program was to create a more general-purpose base of the software, in terms of all the critical factors, to facilitate the adaptation and the customisation that arose from the specific requirements of every firm. To reach this target, they commenced to involve directly the active customer relationships at that time, to gather new points of view and feedback on the software capabilities. Hyperlean was convinced that one of the best ways to create a successful new software release was to collaborate with potential customers to shape LeanCost on their requirements. Hyperlean's development team had two main goals: 1) to make LeanCost good enough to be adapted to general purpose, making it suitable for a considerable number of different firms; 2) to improve the critical factors that are the essence of LeanCost: library knowledge database, algorithm, user experience, applications, software integrations and functionalities.

Particularly, the feedback of the customer was very important when it came to upgrade the Knowledge Library Database and the Algorithm. For this reason, in the first step of this strategy for upgrading the software, Hyperlean was committed to accurately select their new partners for development. Hyperlean understood that finding big companies with a relevant know-how and which were willing to invest for sharing their knowledge with a 'small academic spin-off' was not easy, and thus

realised that they had to find something to give back to these firms. Hyperlean's marketing and sales activities were very intense in that period: since the beginning, Hyperlean involved a huge number of firms by attending exhibitions, seminars and through developing a network of relationships. Hyperlean had to review also their sales strategy in order to involve the right customers that could be interested in providing their knowledge to develop the software: in the first stages of the strategy, they offered a 'pilot project' with the software license for free and they were charging only the days in which they were supporting the customers with training for the software adoption and for consultancy about design-to-cost and cost-estimation activities. The elements that made it possible to involve different customers were many, but for sure it is possible to account for the willingness of all these firms to utilise a software that would ease and support their design-to-cost and cost-activities, which could bring huge benefits in terms of money and time saving. These relationships gave Hyperlean the opportunity to make testing and bug fixing activities with real users in a real working environment that could validate data that would constitute the basis for the upgrades of the software. After two years following this development strategy, Hyperlean managed to obtain a more general-purpose version of the software. To translate all the feedback in a new LeanCost release, many parts of the software were readjusted manually by Hyperlean, and for many other components of the software, the code was rewritten from scratch.

In this period of parallel development with several customers, Hyperlean's team was facing two different kinds of organisational difficulties: overlapping all the activities required to develop the new version of the software in a short time and hiring new people to substitute the founders in the management of the daily routine activities. The main part of the job with customers was organised as 'bug & improvement' activities, where the customers commenced to use a beta version of the software and then they sent suggestions for improvement or bug fixing. Since Hyperlean created a considerable number of new customer relationships with the aim of developing and upgrading LeanCost, the collaboration with Biesse lost intensity. One of the reasons is that Biesse, as a founder, was not interested in investing in a software company. The second reason, as highlighted by Hyperlean, was that Hyperlean needed new customers to collaborate to develop the software beside Biesse. However, Hyperlean maintained the specification given by Biesse, but with other feedback the aim was to develop a more general Knowledge Library and Algorithm that could allow to start the collaboration with a wider range of different firms. Thanks to the collaboration with different customers, Hyperlean also managed to develop new features like for example a suite of LeanCost dedicated to buyers and salesmen and a new model for price management.

In summary, the new software update that was released in 2014 was the version 5.0 of LeanCost, and the major improvement consisted in a higher suitability for adapting the system to different industries and applications instead of the previous

more ‘static’ versions. Thanks to these developments, the software was easier to use and to adopt; for these reason Hyperlean was able to reach a considerable number of new customers thanks to these updates. Furthermore, the tight collaboration with various firms supported Hyperlean on the validations of all the new upgrades in terms of Knowledge Library and Algorithm, with the purpose to reach a high level of reliability of the data and the results delivered by the software. The validation comes from new customers such as SACMI, Prima Industrie, Magneti Marelli, General Electric - Baker Huges Italia, OMME, Casagrande and Italian distributors such as Alfa.

The rationale of the achievements of this strategy, according to the thoughts of Hyperlean’s management, was due to the fact that customers use a broad range of different technologies in terms of machines, processes, technologies, and materials that could be dealt with only with the creation of shared knowledge in the form of a database, shaped respecting the requirements of the specific industries of application. In addition, customers carried different backgrounds and experiences within the relationship with Hyperlean that facilitated the development activities, creating a satisfactory user experience. Hyperlean paid attention to the needs of different customers by developing and frequently updating the recent releases of LeanCost with a considerable number of new functionalities with the purpose to ease and advantage the design to cost and cost estimation activities of the users.

Further developments and commercialisation

Since 2014, Hyperlean achieved the pursued ‘minimum level’ of generalisation with the release of LeanCost v4.0, an achievement that gave Hyperlean the chance to cope with other development issues. The starting point of this ‘new course’ of Hyperlean's development strategy was mainly connected with the cooperation with customers on the development and improvement of the software and its critical factors. The activities required to upgrade and maintain the software were numerous and critical. One of the most demanding and critical activity to perform was, and still is, the Knowledge Library Database update and maintenance. Hyperlean knew that in order to be useful to customers, it had to create a complete set of reliable data and information. Then, it seemed clear that this task could be done only in collaboration with customers. Raw material specifications, production processes and technologies evolve and change over time with a continuous pace, and thus updating all this information is one of the most demanding tasks for Hyperlean, which was accomplished thanks to the close cooperation of the customers. The driver for the development of LeanCost was, and still is, the creation of new collaborative relationships with the purpose of supporting the improvement of the capabilities of LeanCost in its critical elements. In these days, the purpose of Hyperlean is to develop and ‘map’ inside the software as much technology as possible to make LeanCost suitable for a ‘generic firm’ in the shortest time possible; now Hyperlean is investing in this task, and its goal is to collect and update the

Knowledge Library Database with all the information about the needs of all the applications of interest by 2020. Then, in order to validate all the information of the Knowledge Library Database and the results of the analysis – and thus the Algorithm – Hyperlean utilised the users' feedback to understand if the assumptions made to build the software were right, accurate and reliable. This collaboration process supported Hyperlean also in the customer relationships development, because potential customers' choices rely on the reference of other firms' feedback about the results of the analysis performed by LeanCost. Collaborative creation of new software improvements in interaction with customers quickly became also a 'marketing tool': since 2015, Hyperlean commenced 'to sell' to customers the option to collaborate for developing new parts or new features of the software that did not exist yet; in some ways, Hyperlean commenced to exploit their ability to co-create and develop a new specific service to offer to new customers.

Since 2012, Hyperlean grew at a relentless pace in terms of new customer relationships, revenues and new version releases – since 2013, Hyperlean has been releasing one new version of the software per year until the last release (v9.0) in 2017 – with the subsequent increasing need to perform a considerable number of concurrent tasks in several different activities. This considerable growth of tasks to accomplish demanded on Hyperlean's behalf a consistent growth also in terms of the personnel employed and the establishment of a more organised company structure, and thus the creation of different internal departments in charge of their

own assignments: for example, marketing and sales department, IT department and technical development department. Also the role of the Università Politecnica delle Marche, from which Hyperlean comes, was important in this period, both in terms of the chance to gather freshly graduated brilliant students to hire and in terms of students that were involved for their thesis or post-graduate internship with Hyperlean in developing projects with its customers: for example, several students had been involved as 'insider engineer' in Hyperlean's customer firms with the purpose to help these customers to introduce and adopt LeanCost; this happened with Ferrero, Magneti Marelli and a few others. In other words, Hyperlean provided to its customers a resource that would follow the adoption of the software and that managed the information exchange between the customer and Hyperlean's headquarters.

The collaboration on the co-creation of new features and software improvements between Hyperlean and its customers usually starts with the definition of all the requirements of the specific application fields of the customer that are needed to update the Knowledge Library Database – in terms of new raw materials, processes and technologies specifications – and the Algorithm – in terms of rules and logics. For Hyperlean, the customers' collaboration also had the purpose to make it possible to gather all the inputs – in terms of information and specifications - required to adapt the software. This process consisted of gathering data directly from customers, and it had many benefits for Hyperlean, but the most evident is that all

this information is already validated by everyday use from these firms, and thus is easily transferable to other customers or generalisable for software updates.

The firm's choice to develop the software with validated data allowed Hyperlean to obtain 'good field results' with relevant early adopters of LeanCost. Thanks to these remarkable achievements, Hyperlean managed to establish a considerable number of further relationships with new customers. The collaboration between Hyperlean and its customers went beyond the new product development process; many of these customers gave a positive feedback in terms of reference – namely word of mouth - to engage with new prospects, and some allowed Hyperlean to show and try the software directly at the customers' headquarters, giving to the prospects the chance to have a real preview of the effect of the adoption of LeanCost.

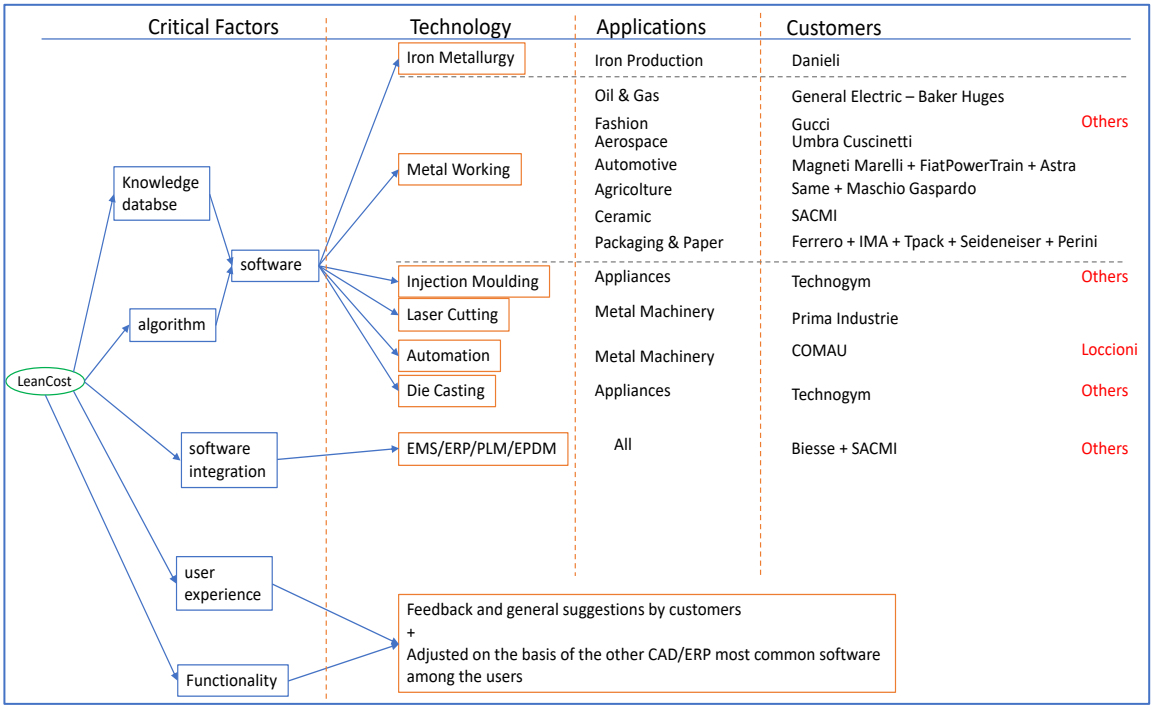

Figure 3.4.1 – Critical Factors co-creation summary

(Our adaptation) The green circle is LeanCost, blue boxes describe the critical factors, orange boxes are the technologies. Others, written in red, means that other actors followed since the first collaboration with the customers identified in the picture.

Several customers collaborated with Hyperlean since 2014 to develop and improve LeanCost in many ways; in the previous Figure 3.4.1, it is possible to find the relevant relationships that supported Hyperlean in the development of LeanCost and to reach its targets in terms of critical factors development. One of the most important collaboration was the one with **Biesse**; not only for the initial investments

and collaboration, but also for the support that Hyperlean received by the Biesse to establish new customer relationships. In fact, since 2014 Biesse hosted several 'LeanCost presentations' with relevant potential customers in partnership with Hyperlean. SACMI is a metalworking company that produces machines for ceramics, beverages, packaging, food and plastic processes (in 2016 they had more than 4,300 employees and 1,3 billion € in revenues). With SACMI, that is still one of Hyperlean's 'best customers', the development tasks were focused on the improvement of the software in two assignments: the first was on the process mapping and the process elaboration for metalworking applications for the technologies and processes used by SACMI; the second assignment was to create an efficient user interface and developing the integration between LeanCost and the main ERP (enterprise resource planning), PLM (product lifecycle management) and EPDM software (enterprise product data management) that could create a satisfactory user experience for the users. The collaboration focused on the development of the 'Metal Working' application – in some ways SACMI has replaced Biesse for the development of this application – and then supported Hyperlean on making the software better suited for 'general purpose'. Since the SACMI collaboration, Hyperlean focused its efforts on the 'metal working' technology, that at first was developed with Biesse in the application for Wood Machinery and then with SACMI in the Ceramic Machinery. Hyperlean exploited the knowledge in 'metal working' technologies by commencing several

collaborations with a considerable number of different firms involved in different industries.

With **FPT - Fiat Power Train** and **Magneti Marelli** Hyperlean developed all the requirements for the 'metal working' technology in applications for the automotive industry; thanks to these collaborations, it was possible for Hyperlean to start several customer relationships in the same field of application. Thanks to the development in the automotive field, Hyperlean reached **Umbra Cuscinetti**, which in turn supported the spin-off in the development of LeanCost for Aerospace applications. The 'metal working' technology was developed for the Agricultural Machinery thanks to the collaboration with two relevant firms such as **Same Deutz Fahr** and **Maschio Gaspardo**, which started to support Hyperlean since 2014. The 'Metal Working' technology was exploited also in the packaging machinery application – covering more than one specific field, like: tobacco, pharmaceuticals, hygiene and food – thanks to the partnership with high-relevance firms such as **Ferrero**, **TetraPack**, **IMA**, **Fabio Perini**, **Korber**, **Seideneiser** and **Fameccanica**. Then, for the 'Metal Working' technology, Hyperlean started an important collaboration with **General Electric – Baker Huges Italia, a** specialised firm in the construction of oil and gas plant components. This relationship started through the UNIVPM network to develop all the requirements to update LeanCost for the Oil & Gas – piping and pipeline construction – applications. Hyperlean collaborated with many other customers to develop new pieces of the software for other

applications or other critical factors. For a short period, for the laser cutting technology, Hyperlean collaborated with **Prima Industrie**; for the automation and assembly line productions, Hyperlean collaborated with **Comau**; for the developing of the 'Iron Metallurgy' for the iron production, Hyperlean collaborated with **Danieli**. Another interesting collaboration relationship which started around 2015 is the one with **Technogym**, a world leading manufacturer of fitness equipment, with a € 555 million turnover and more than 2,000 employees. The firm became a customer thanks to the high level of knowledge reached by LeanCost in the 'Metal working' technology, and then supported Hyperlean in the development of all the applications dedicated to the plastic injection technology and moulding – both the construction of the moulds and the injection moulding processes – involving also its supply chain. In fact, Technogym do not produce anything in their premises, but use a wide supply chain where it outsources the production of almost all the components and production tools required. Now, Technogym and Hyperlean are planning to start a new collaboration for the development of the die casting technology.

Then, it is interesting to describe the collaboration with **OMME Gears**, one of the very first customers, that since the beginning has been collaborating with Hyperlean to develop all the requirements for the Toothed gear application, and many more that are less relevant compared to the ones briefly described there. Hyperlean's

business network is represented in Figure 3.4.2, which shows all the actors that contributed to the creation and the development of LeanCost.

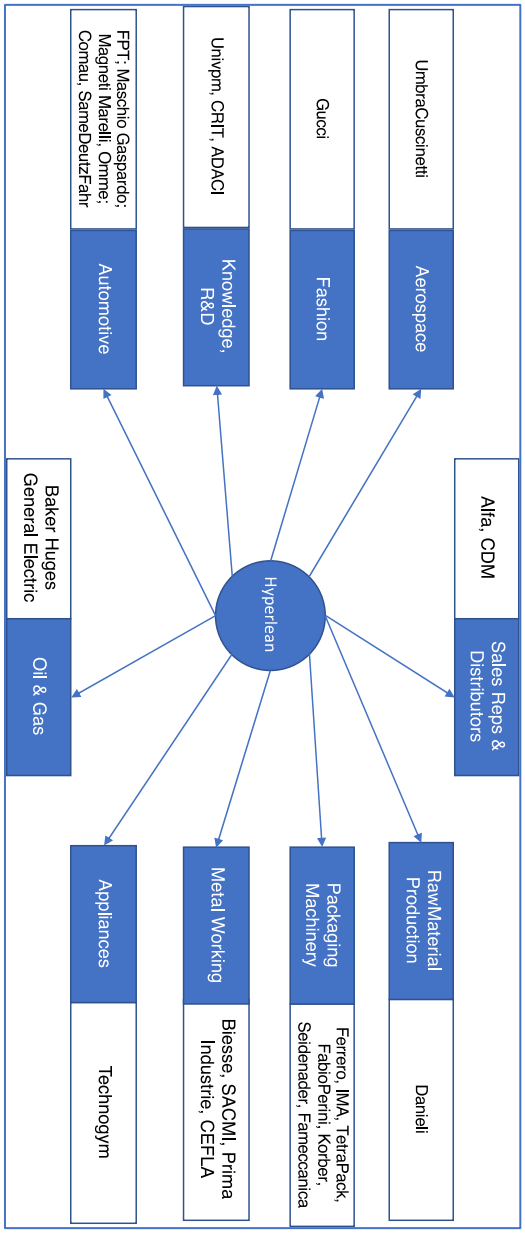

Figure 3.4.2 - Hyperlean's Business Network representation

For other critical factors such as the Software Integration, the major contributions came mainly from Biesse and Sacmi, but many improvements were driven by all the suggestions made by the users over time. As for the 'User experience' and 'Key Features', these were adjusted by Hyperlean by following the choices of the most common 3D CAD and ERP systems, taking into account at same time all the suggestions provided by the software users.

It is possible to see a summary of the critical elements' development stage in the following Table 3.4.3. Particularly, it is interesting that as for the knowledge library database, the algorithm, and the applications, the customer collaboration impact was high: this means that the collaboration between Hyperlean and the actors of the business network was crucial to develop these critical factors of LeanCost. Then, as for the user experience, the system integration and the functionality, the impact of customer collaboration was medium, or not very relevant, because Hyperlean gathered information and feedback from the network and also from other technology providers to develop these critical factors of the software.

The collaboration interactions for the development of LeanCost gave benefit to all the parts involved - both Hyperlean and its customers - but not without any dark sides in these collaborations. For the customers, the benefit consisted in the possibility to have the newly developed software at an advantageous price compared to the standard price list, and while continuing the collaboration for bug fixing and improvements with Hyperlean, the firm could benefit from several one-

to-one consulting sessions on the aspects connected with the technical specifications requested by LeanCost. This process supported the customers in developing and improving also their background knowledge in terms of cost management activities that could be adopted. Thanks to the relationship with all these customers, Hyperlean could develop also a perception that communicates to new potential customer that they were trustworthy, and that LeanCost was useful for the firm; this allowed Hyperlean to attract new customer relationships. Now Hyperlean is involved in several collaboration pipelines to develop new software capabilities; this collaborative behaviour became one of Hyperlean's strategies to establish new customer relationships and it laid the conditions for the constant growth that Hyperlean has experienced until today. The dark sides of the collaborations with the actors of the business network refer to the efforts that Hyperlean had to put in order to adapt to bigger firms and having had to re-arrange the software every time; and the customisation issues that stem from the collaboration with Biesse, that had a great impact on LeanCost's development path. One of the key elements that contributed to the LeanCost development process is the fact that the tight collaboration with customers supported and speeded up the finding of a right way of developing the software's critical factors. Now, LeanCost has reached a considerable number of users, mainly amongst big firms, which use it every day to manage in an effective way all the design to cost and cost estimation

operations. These users continue to share their precious information and feedback with Hyperlean, supporting the continuous LeanCost development.

In conclusion, according to Hyperlean's key respondents, these collaboration partnerships in product development have led also to other side benefits.

The first benefit is a deep bonding in the relationship with the customer and an increased level of satisfaction in the use of the software. The second benefit is that, using customers knowledge, it was possible to develop the software in a very lean manner, saving a high amount of resources and time. Third, and last, the achievement of this unique collaborative capability on behalf of Hyperlean's team brought a broadening of the network with efficient and meaningful customer relationships that supported the product development and made it possible to update LeanCost with an ideal fit to customer requirements. The same Hyperlean key respondents have not identified any dark sides to these collaborations, except for the initial issue with Biesse software’s customisation.

CRITICAL FACTORS	2000-2007	2007-2010	2010-2012	2012-2014	2014-TODAY	Customers Collaboration Impact
Knowledge Library Db	Build Up	Upgrades	Upgrades	Major Review - Rebuild	Upgrades & Maintenance	High
Algorithm	Build Up	Upgrades	Upgrades	Major Review - Rebuild	Upgrades	High
Application	Wood Machinery	Wood Machinery Machinery Tools	Toothed Wheel	Packaging Ceramic	Industrial Automation Automotive Oil & Gas Aerospace Agricultural Packaging & Paper	High
User Experience	Excel Interface	Fuzzy Interface	Fuzzy Interfaces	Upgrade of Interface Final Report	360° User Experience Development	Mid
System Integration	No	Only Solid Edge	All 3d Cad Systems	All 3d Cad Systems	Ems-Erp-Plm-Epdm	Mid
Functionality	No	No	No	Allowing Sales & Buyers	All	Mid

Table 3.4.3 - Summary of Critical Factors developing stages

(Our adaptation) Acronym explanation: EMS (Enterprise Management Software); ERP (Enterprise Resource Planning); PLM (Product Lifecycle Management); EPDM (Enterprise Products Data Management).

Chapter 4

FINDINGS

The data collected through observations, formal documents and interviews with key informants allow the study to attempt to answer the two research questions developed in chapter 1.4. by starting to describe the data collected from interviews. The answers are given as follows: in the first instance are discussed the pathways used by Hyperlean in order to build up the collaborations with customers; then, there will be a description of the capabilities – owned or developed – used by Hyperlean to support the co-creation NPD process.

For each pathway and capability recognised during the research process, the study was supported by the literature background and the systematic combining approach as a methodology to define the patterns for each category. Besides this reiterative process, the patterns were largely discussed with the academic tutor and the visiting supervisor.

Besides the evidence collected, a discussion of each finding will be developed according to the extant relevant literature. The discussion is the result of the combination of the empirical findings of the study and the theoretical background about NPD co-creation processes. In this preface of the chapter, it is important to highlight that what stems out from the analysis of the empirical setting, namely the

NPD co-creation pathways and the co-creation capabilities, are not something that comes from Hyperlean, for example like a Hyperlean formalised strategy already used during marketing or R&D activities. On the contrary, these elements stem out from the study's analysis of the empirical findings paired with the theoretical references through the systematic combining methodology (Dubois and Gadde, 2002). The methodology supported the conceptualisation of all the different ways to co-create products in NPD and several co-creation capabilities required within this process. All these aspects will be discussed in detail below.

4.1 - Hyperlean's new product development co-creation pathways

The co-creation pathways could be addressed to the "how" a firm, in this case Hyperlean, could create an NPD co-creation process with its customers. In the following sections, there will be the description of several pathways and their implications in NPD processes in co-creation according to data collected and presented here.

In order to perform NPD co-creation processes, Hyperlean has undertaken several different ways with the aim to involve and manage every possible individual actor of the business network in order to receive a valuable contribution for product development. The study here will focus on the discussion of the major pathways that allowed Hyperlean to reach success in NPD co-creation through the interactions with a considerable number of different actors. The study will show 8

different pathways deployed by Hyperlean in order to ease the engagement of all customers and users in order to gather their contributions for developing LeanCost. Many of these pathways are intertwined; for this reason, there were many complexities faced by Hyperlean within the NPD co-creation process. In conclusion, through these pathways, Hyperlean managed almost all the complexities that stem out from a considerable number of dyadic interactions with the actors of the business network, and the firm deployed many activities in order to manage all the knowledge and the information gathered during these interaction processes in order to develop and improve LeanCost.

4.1.1 – Engaging with someone

Engaging with universities and research centres

The close relationship with universities and research centres allowed Hyperlean to have access to a wide body of information and to the important knowledge about cutting-edge technologies and processes needed to cope with customers' requests. Furthermore, these elements supported the firm in the exploitation of extant resources in the business network and supported the development of this new venture and its products. The relationships with universities and research centres eased the creation of new, further relationships with other research centres and actors that became active customers or supported the development of the product.

It is relevant to highlight that more than one interviewee stated that the NPD process of LeanCost and its following commercialisation activities would not have been possible if this product had been created in a different context from the academic one. There are several reasons that support this statement: the first is that Hyperlean and LeanCost are the result of more than 20 years of research activities done by a considerable number of different researchers – some of them are also the founders of the spin-off – and therefore, the access to this knowledge was an essential stepping stone in order to start the NPD process. One of the former members of the spin-off described this "necessary tie" with the following sentence:

"(Hyperlean)would have never been established without the university support, also for the economic and human resources sides, as well as for the brand, that was crucial for the initial development, and it is still so".

To support this statement, another founding member of Hyperlean - who at the time of the establishment was an engineering PhD student - answered our question as follows: "Could the development of this venture have been possible outside the university context?" with this thought:

"Absolutely not. The product (LeanCost) was born within a research project".

According to another founder interviewed, the university supported the initial growth of the spin-off also in the commercialisation. By giving HyperLean its brand, the university made it possible for the firm to be perceived as a reliable company that could be accepted also by big firms.

“University also gave the brand at the beginning, that transferred to Hyperlean credibility even with big companies”.

This aspect was particularly crucial for Hyperlean because, as stated by Prof. Germani, all the customers and big firms want to deal only with reliable partners. These big companies choose their partners very carefully, because they will share with them their knowledge and confidential information about their business moves. For this reason, when talking about main differences in interaction between big and small actors, Prof. Germani said:

“The big (actor) wants to have a reliable/credible counterpart”.

Therefore, by adopting the brand and the reputation of the university, Hyperlean managed to obtain the minimum level of reliability required by new potential customers that supported the spin-off in starting new collaborations.

The role of the university was crucial also in order to create a bridge between the spin-off and actors that were already in partnership with the university; this was one of the ways Hyperlean created the first crucial customer relationships with new actors. One of the examples made by Prof. Germani is the initiation of the business relationship with Baker Huges - General Electric Italia:

“The only one who (General Electric) came towards us (Hyperlean) for our skills that they already knew thanks to their previous relationships with the university, and in that case, it started more from the academic relationships and then also to a business relationship”.

In conclusion, the role of the university was relevant also in other aspects of the business creation; in fact, as stated by one of the former board members of Hyperlean, the university supported the spin-off with facilities and other resources: ***"At the beginning, as an incubator and supplier of facilities, but also as a supplier of brains with groups of researchers".***

Engaging with the final users since the beginning

The relationship developed since the beginning between the Research Group and Biesse, both for developing together a new technology that led to the creation of the new product (LeanCost) and for starting-up the new academic spin-off (Hyperlean), was a stepping stone for the achievement of the first beta version of the software in order to meet the users' needs that created the initial idea. The Research Group and Biesse were already collaborating together within the academic context (several scientific projects and students' theses), but only in 2007 this collaboration started to gain strength with the joint-participation in the Co.Env. project. Then, in 2008, Biesse's designers recognised the immediate need for a new software that could support their operations in cost estimations and design to cost. Starting from this need, Biesse's designers started to look around, and thus deployed a market research the outcome of which revealed that no other actors in the business network were able to provide those technologies. Then, they submitted their needs to the Research Group. As stated by Prof. Germani, and according to Biesse's designers

who took part in the data collection activities, the starting up of the whole story between the Research Group and Biesse could be synthesised as follows:

"It all stems from the fact that Biesse have done in 2007 a market research to meet the specific needs of design to cost and did not find robust solutions consistent with their specifications. So, knowing of our research activities [...] decided that it could worth investing".

It is useful to highlight that before Biesse requested the research group to provide the initial studies for the development of the software, the so called "software for industrial application" of the design tools and methods were analysed by the same researchers only with academic purposes. In fact, as pointed out by Prof. Germani:

"The part of industrial application, for what concerns the development of a tool to be applied within companies, in this case Biesse, was born in 2007/2008 from a request made by the Biesse Group".

The other proof that the development of this new software was pushed from the collaboration with the users can be understood thanks to the assumption made by one of the founders of Hyperlean, who in some way confirmed that the technology was created before the academic spin-off.

"The product (LeanCost) was born before the company (Hyperlean)".

Furthermore, when discussing about the initial relationship with Biesse, the same co-founder stated that:

"Without Biesse's case history, the engineering team would not have been able to create the rules of costification".

Then, by taking the point of view of the users, i.e. Biesse and its designers, it is possible to find a confirmation about the fact that everything started with their needs. This confirmation lays on what was affirmed by one of the designers that followed all the development stages of LeanCost, and Hyperlean, since the beginning:

"The thing (LeanCost) was born as a need [of Biesse]: "do you have a need? Satisfy it" and then slowly this thing has become bigger and bigger".

Engaging with someone: discussion of the findings

When thinking about the evidence that stems from the NPD co-creation processes, the focal firm's engagement with other actors of the business network – universities, R&D centers, customers and users – can be seen as one of the common strategies in order to create value within the network. Thus, starting with the sentence given by Luzzini et al. (2015), it is widely recognised in literature that "companies rarely innovate by themselves". The importance of mobilising external resources by engaging with external actors was underlined also by Bonaccorsi and Lipparini (1994). Moreover, IMP scholars take the engagement with the actors of the business network as one of cornerstones of their industrial network approach (Håkansson, 1987; Håkansson and Snehota, 1995; La Rocca et al., 2016). Then, the

actors who became the target for the firm should be consistent with the business strategy (Lynch and O'Toole, 2003). Thus, it is possible to confirm the relevance of the actors' engagement in NPD co-creation processes. Hyperlean engaged with a great variety of actors, from universities and research centers to customers and users, in order to enhance product capabilities and to grow their business network. In particular, Van der Valk and Finstra (2005), Corry et al. (2017), Schilling and Hill (1998) and Alexa et al. (2017) highlighted the importance of the focal firm's embeddedness in universities and research centers in order to increase the innovation sensibility of the firm; in the case of Hyperlean and LeanCost, this can be defined as the direct product of the university collaboration with companies, thus the embeddedness in this "innovation context" is at a very high level. The university's embeddedness supported the engagement with key users since the earliest stage of the NPD co-creation process (Lynch, O'Toole and Biemans, 2015); moreover, the engagement with the users made it possible to identify the gap (Baraldi, 2008; Noteboom, 1999) that gave the first spark to the beginning of the NPD process. The customers' involvement is very relevant in the first stage, also because, as suggested by La Rocca et al. (2016), it helps the firm understand and discover user needs and possible solutions. Then, the engagement with the actors of the business network – namely customers and users – not only eased the adoption of the new product (La Rocca et al., 2016; Bonaccorsi and Lipparini, 1994; Woodside and Biemans, 2005), but it also supported the firm in managing and

minimising the risks of newness (Laage-Hellman, Landqvist and Lind, 2018). From the evidence, these thoughts are confirmed: the engagement of Biesse in developing the first MVP of the product supported the first sales of the product and the growth of the business network. One of the minor differences with regard to the Hyperlean case is that, despite what is possible to understand from the literature collected, previous authors usually describe the co-creation engagement as a prerogative of established firms (Snow et al., 2011). More precisely, in the Hyperlean case, at the time of the initial involvement in the NPD co-creation process, Hyperlean was not even a startup; however, the team managed to engage, involve and exploit the knowledge retained from its customers.

4.1.2 - Establishing formalised collaborations with actors

The initial formalisation of the interactions with customers allowed the research group to create a tie between the people involved from all the counterparts so that they could work together to develop the new software. This was a crucial milestone, because this pathway enhanced the commitment from the actors in participating and sharing their knowledge in order to improve and develop the software. The establishment of these formalised collaborations supported Hyperlean also in the acquisition of the necessary knowledge and feedback from the users. The support that Hyperlean received from the customers was useful for product development, and went in 2 different directions: bug & improvement and joint work for

developing the critical factors of the software. Thus, as stated by one of Hyperlean's founders:

"The technical contribution was important, in two levels: reporting needs; substantial contribution to growth with data, knowledge, expertise and functionality. In particular, the mutual exchange of knowledge and solutions".

Usually, the formalisation of the relationship between Hyperlean and its customers was mandatory, because - as revealed by the sales rep of Hyperlean - there were many cases of customers who had purchased a "work in progress part" of the software or agreed to work together for improving the critical factors of LeanCost. In particular, she explains this phenomenon with the following statement:

"There are companies that buy something (potential new LeanCost capabilities) that does not yet exist: the purchase is configured as a financial backing for the development of a new component (LeanCost capabilities). This is one of the most common types of collaboration with Hyperlean. [...] Start from scratch and develop the product with him (the customer)".

Although all the collaborations with the actors of the business network started only after the formalisation of the agreement with Hyperlean, the relationship was usually managed via informal communications amongst all the people involved, with the purpose to ease the relationship, to improve the information and knowledge sharing and the development of LeanCost. This is remarked by one of Biesse's

designers, who, when talking about the limit of formalising the collaboration with Hyperlean, argued:

"You can do the same (about using certain approach on product development) because everything is up to people, just call and get along".

In this manner, he wanted to clarify that, in the very end, people can decide to do something in order to be useful for the development of the software also if it goes beyond the boundaries of the agreement.

The relationships with all the actors of the business network were crucial also for finding all the information required for the development of the software. Prof. Germani thought that LeanCost could outgrowth other academic spin-offs only thanks to the customers' support, and that the software could be improved in the future only with their support:

"The system grows in terms of technology and contents thanks to the customer".

Establishing formalised collaborations: discussion of the findings

While the firm is engaged with several actors of the business network, formalising all the several collaborations with every actor could be very useful in order to plan and execute a considerable number of different activities with wide horizons. This approach is widely confirmed by the literature, mainly by describing the positive effect that is possible to gain when firms formalise their collaboration with the actors of the business network. First of all, according to Snow et al. (2011), who

suggested that knowledge sharing through commons is often highly efficient and effective, this tactic allows the focal firm also to minimise what they call “sunk networking costs”, which can be attributed to networking inefficiencies and hidden relationship development costs. In addition, the same authors (Snow et al., 2011) pointed out that the other benefits of collaboration formalisation can be addressed to trust fostering amongst the actors of the business network and to their openness in terms of knowledge sharing through dyadic relationships within the business network. The effects described have had a crucial role in the LeanCost NPD co-creation process: through the formalisation of collaborations and projects with their customers, Hyperlean managed to develop several parts of the software that were not already built at the time. As suggested, the relationships’ formalisation allowed Hyperlean to gain the right trust and thus the chance to focus on building up long term relationships with their customers. Formalising the collaborations supported Hyperlean’s knowledge and information exchange with the other actors of the business network, a prerequisite for the development of the software between. The formalisation of the collaboration supported Hyperlean also for the establishment of the cross-functional teamwork with its customers, and moreover for starting several internships for UNIVPM master's students with Hyperlean or within the organisations of Hyperlean’s customers which will be involved with LeanCost’s adoption process.

While analysing formalised collaborations, it is possible to observe that the relationships' formalisation later represented also a sort of barrier to the collaboration's openness with the actors. In fact, with the growth of the focal firm, the formalisation of the several collaborations with customers had become increasingly rigid, to the point that some of the initial partners started complaining that in the recent stages, Hyperlean followed excessively strict formal guidelines rather than promoting communication and collaboration between people as they used to do before (See Biesse's complaint about the progression over time of the NPD process, following section 4.2.8).

4.1.3 - Cross-Functional Teamworking

Since the beginning of the first collaboration with Biesse, all the people who managed the research and development activities and worked within the Research Group (which later became Hyperlean) understood that, in order to create the right environment for adapting and easing the adoption of the software for the end-users, it was required that people from both counterparts collaborated together. To reach this form of collaboration, Hyperlean has used since the beginning the creation of a cross-functional team which mixed people from Hyperlean and people from the customers' organisations working together with a shared goal to achieve. The

adoption of this methodology was supported also by the formalisation of the collaboration with all the counterparts.

The evidence of the adoption of this tactic comes from what was stated by one of Biesse's designers, who said:

"(The relationship between Biesse and Hyperlean is) starting with a team work that consist of systematic meetings".

The systematic scheduling of meetings supported the development of the team in organising the operations required and also in following the designed path. In some cases, the team was set up with the aim of involving also the university, and thus young researchers or graduates, who could carry out the role of *trait d'union* between Hyperlean and the customers. This process is well explained by Hyperlean's sales rep, in the following statement:

"They activated a university internship with Magneti Marelli because at the moment Magneti Marelli had no resources to deploy for the adoption of the new software. So, they (Hyperlean) involved a university student and created a team for the adoption and the development of LeanCost based on specific requests by Magneti Marelli".

Cross-functional teamworking: discussion of the findings

NPD co-creation processes are permeated by teamwork activities (Keszey and Biemans, 2016). Thus, it is quite strange that, according to Barczak (2012), few

scholars until now have investigated with empirical cases the role of these cross-functional teams in NPD and co-creation processes. Team effect can be understood in terms of the actors' advantages for what is created within the relationship (Håkansson and Snehota, 1995). First of all, in establishing cross-functional teamwork collaboration, it is important that every team structure is paired with the type of project under development (Schilling and Hill, 1998). The creation of cross-functional teamwork with people from different firms supports the creation of a shared vision towards shared goals (Lynch and O'Toole, 2003). Hyperlean developed several different teamwork, by involving a plethora of several different internal and external subjects according to every single NPD co-creation process. In particular, this collaboration method deployed by Hyperlean since the very beginning of the development path of LeanCost, thus since the initial collaboration with Biesse, allowed them to be well suited for enhancing cross-company collaborations (Müller et al., 2012). The reason why this method could be very useful in innovation processes basically comes from the fact that multidisciplinary activities – just like the NPD processes of high technology software – could require different expertise and experiences from various fields which should be combined through cross-functional teams (Serrano and Fischer, 2007). In the Hyperlean case, this methodology, used for managing users' collaboration, was established with almost all the customers in order to develop new parts of LeanCost and in order to enhance and improve the software's capabilities over time.

For the several reasons described before, it is partly obvious to say that, also thanks to cross-functional teamwork adoption, Hyperlean reached product development and user satisfaction (Schilling and Hill, 1998).

4.1.4 - Interact with the customers' business network

The interactions with the customers' business network allowed Hyperlean to have access to useful information and knowledge. These resources were collected from their suppliers and other actors that were connected with their customers' business network. This tactic of Hyperlean, deriving from its previous experiences in the Co.Env. project, was suitable for interacting with the customers' supply chain and then to develop LeanCost's critical factor capabilities. The reasons of the importance of interacting with the customers' business network laid on the evidence that almost all these firms do not produce themselves all the components of their products, outsourcing many of the productions' activities of their supply chain instead. Thus, the only way to obtain useful information was to engage with the customer's supply chain.

The interaction with the customers' supply chain started since the initial collaboration with Biesse. From the first meeting with the cross-functional team, according to Biesse's designer, the research group/Hyperlean people started to interact with the suppliers:

"From a meeting where things were not clear, and we did not have enough information or experience in the database in order to answer, the following days were dedicated to the research through suppliers, through fairs and/or machine tool manufacturers, in order to be able to tap into information and then give a feedback to those guys [Research Group / Hyperlean] or simply to have data to discuss in subsequent meetings".

The interaction with the customers' supply chain was very important for Hyperlean, and this is confirmed also by the same Biesse designer, who when discussing about the co-creation process with other customers suggested:

"If I have suppliers that do not use a certain type of technology, I can structure with them the involvement of the right supplier and exploit the supply chain to widen and improve the capabilities of the network".

Interacting with the customers' business networks: discussion of the findings

While developing LeanCost, one of the most important activities that Hyperlean deployed was trying to establish further collaborations with the customers' business networks. These interactions were part of the development strategy since the beginning; the first evidence can be addressed to the Co.Env. project, where Biesse involved its supply chain in order to provide all the information required by the

Research Group (Hyperlean had not been established yet). By pursuing this strategy, Hyperlean managed to build a sort of collaborative innovation network (Najafi-Tavani et al., 2018). According to the contribution of Perna, Baraldi, and Waluszewski (2015), the Collaborative Innovation Network "refers to a firm's interactions with different actors (supplier, customers, competitors, research organisation, etc) with the purpose of NPD". Thus, the customers' business network supported the NPD co-creation processes of LeanCost. Hyperlean's users/customers became committed to spreading LeanCost through their supply chain, firstly because the were willing to support Hyperlean, and then because they mostly outsourced the design and the production of a considerable number of components, therefore LeanCost could help them manage the sourcing operations. Besides the benefits that Hyperlean reached thanks to the interactions with the customers' business network in terms of NPD advancements and knowledge and information exchange between all the actors involved in the process, the customers' business network involvement supported also the awareness and the adoption of LeanCost amongst other actors. Another positive effect of this pathway could be addressed to the continuous enhancement of the customers' needs fit with product specifications (Schilling and Hill, 1998). Engaging with a considerable number of different actors of the business network supported the development of a "differentiated product" which, anyhow, was linked to the specific needs of

different segments that later could permit an eased adoption of the product (Cooper, 2018).

4.1.5 - Getting customers from customers

Since the initial stages of the new product development process, the Research Group (later Hyperlean) exploited the results and the knowledge obtained from the collaboration with the actors of the business network for validating and improving the performance of LeanCost. This pathway required a high level of commitment from the customers who took part in the development process. The evidence collected highlight that several actors promoted the software developed by Hyperlean in their own business network, encouraged by the relationship established with Hyperlean; this supported directly the growth of Hyperlean's business network and enhanced its capability to attract new knowledge and new collaborations.

Thus, the contributions of several actors were important, and can be addressed to customers' reference and word of mouth. Particularly, the word of mouth process was crucial to obtain a fast development path and to ease the interaction with committed customers. The former sales rep of Hyperlean highlighted that this was also one of the effective ways to promote the software:

"Word of mouth was very important, which is the way that brings more results, because if the customers are referenced the sale is almost done".

The assumption that - with the creation of a wider business network - Hyperlean could power up the development process of LeanCost was confirmed also by one of Biesse's designers who took part in the LeanCost development process, who while describing the rapid commercialisation growth of Hyperlean suggested:

"On the other hand, the more the market opens up, the more feedback are received from processes that are developed in other companies".

The word of mouth process within the business network of the actors who interacted with Hyperlean for new product development grew over time. At the same time, also the number of Hyperlean's customer relationships grew. As stated by Mrs. Peruzzini, one of the founders and former sales managers of Hyperlean:

"Now that we have hundreds of customers, there is a kind of word of mouth, there is a huge interest in this tool (LeanCost), we have done a lot of demo (product demonstration) in recent years, but it is always difficult to achieve complex negotiations".

Getting customers from customers: discussion of the findings

Linked to the customers' business network interaction, here is described another pathway that Hyperlean used to reach new customers. By continuously involving customers/users' business networks, Hyperlean happened to literally get customers from customers (Håkansson and Snehota, 1995). Here there is a reference to the possibility that customers participation in NPD co-creation processes can bring

benefits not only to product development activities (knowledge and information gathering, product testing, etc. as seen for customers' business network interaction), but also for collecting new sales opportunities and, thus, in order to widen the possibilities for commercialisation, strengthening the customers' loyalty and receiving accurate feedback from the actors (Coviello and Joseph, 2012). The process of customers' references occurred through word of mouth, and the development of customer case studies supported the sales strategies of Hyperlean and allowed it to develop a wider customer portfolio. What seems to be missing is the customer selection at the beginning of the NPD co-creation process, an activity that was suggested by Aarikka-Stenroos and Sandberg (2012) in order to reach a substantially good level of efficiency in the NPD co-creation process. But, analyzing the case more carefully, it is possible to understand that Hyperlean had developed this "selection process" before engaging with these actors, primarily by exploiting already known contacts or by targeting top class companies with approximately the same requirements of the firms that were already customers. While discussing the co-creation capability of Hyperlean, the study will later describe also how they managed to engage all these actors in an active cooperation through bringing unique insight on technology and development choices (Aarikka-Stenroos and Sandberg, 2012).

4.1.6 - Rewarding the engagement and the feedback provided by the customers

In order to get the most from any interaction with every customer who supported the development of LeanCost, Hyperlean adopted a pathway that aimed at rewarding the efforts of every actor in order to increase their involvement on the project and their commitment to contribute. In most cases, the prizes were free licenses of the software developed together or a consulting support with private sessions where an Hyperlean specialist supported the technical department of the customers.

Moreover, it is possible to argue that this exchange process, where Hyperlean tried to "give back" some of its know-how to the customers who supported the NPD co-creation process of Hyperlean, created also a knowledge spillover that involved the university context. This can be seen as a further collateral benefit obtained by all the customers involved in the NPD co-creation process of LeanCost.

Practically, when developing together new parts of the software, or when improving the critical factors of LeanCost, the strategy adopted by Hyperlean was to give the actors that supported the development process of LeanCost a reward in terms of product utilisation. As confirmed by the sales rep of Hyperlean, the co-creation development process would usually work like this:

"Hyperlean develop the beta version, that is provided to the same customer for validation, then Hyperlean and the customer work together for bug fixing and improvement of the capabilities of the software (LeanCost), at the end the new release will be commercialised and the customer who supported Hyperlean for the development will have a free license of the product created together".

Rewarding the engagement: discussion of the findings

Within the LeanCost NPD co-creation process, the customers' engagement and especially the customers' support to contribute to Hyperlean in order to develop and improve the software assumed a crucial role over time (La Rocca et al., 2016). Moreover, customer support in co-creation can be mainly related to information & knowledge exchange and the customers' work on developing specifics parts of the software. How Hyperlean managed to boost customer engagement can be addressed also to their formal and informal reward policy, deployed in order to increase the customers' commitment to be open and to contribute to the LeanCost NPD co-creation process. The most common rewards that Hyperlean gave back to the customers that contributed to the development process of the software are high discounts and free software licenses. This kind of pathway assumed a crucial role for the LeanCost development process, because customer/user participation in the NPD co-creation process could take a long time to take off and could require great efforts on behalf of the customers. By stimulating customer engagement, on the

contrary, Hyperlean aimed to get a considerable number of benefits. These could be mainly addressed to product development enhancement since the initial stages of the NPD co-creation processes (Coviello and Joseph, 2012). However, the customers involved thanks to the engagement reward supported Hyperlean also in the commercialisation activities required over time (Coviello and Joseph, 2012).

4.1.7 - Bug & Improvement programs

While figuring out how its customers and users could support the firm in developing the product, Hyperlean deployed a Bug & Improvement program in order to involve the whole customer portfolio. In fact, while with the passive[9] actors Hyperlean established a loose collaboration in product development activities, with both active and passive actors Hyperlean created a way to push these actors to highlight any possible bug or failure of the software with the aim to improve its capabilities.

For Hyperlean, the establishment of bug & improvement programs was a sort of emergent strategy in product development that had the purpose of engaging as many new customers as possible in order to validate any part of LeanCost and to receive more feedback for improving the software directly with the requirements made by

[9] It is possible to distinguish between active and passive actors of Hyperlean's business network. The active actors are the ones who actively supported the development of the product; the passive ones are those who did not supported directly, or did not supported at all the development of the new software (Payne, Storbacka and Frow, 2008; Perks, Gruber and Edvarsson, 2012)

the customers. The sales rep of Hyperlean, described briefly how this process worked:

"We usually give a trial license, and then working (with the customer) on bug & improvement, as a way of developing and growing the system".

These Bug & improvement collaborations were developed soon after the first release of the version of the software. Their purpose was to validate the assumptions made by Hyperlean's engineers directly from customers, with the aim of reducing time and cost for these analyses. In the beginning, the collaborations with the actors were more focused on building the software (or its components) from scratch, then, as time went on, the collaboration shifted to focusing on bug fixing and on finding new software improvements. This shift in the purpose of the collaboration is well explained in the interview with one of Biesse's designers, who argued:

"Now you get the ready thing, that you just have to check[...] we now do not do more than debugging activities and try to see if there are any errors in the software analysis processes".

This can be considered clear evidence that demonstrates how the co-creation relationship between Hyperlean and its customers has shifted over time. It is possible to say that, in the beginning, Hyperlean was keener on co-creating the product with Biesse and the other active actors involved; then, up until now, they have relied more on the network intelligence and have used the single actors only

to check and find possible bugs or new suggestions with the aim to improve the software capabilities.

In sum, from a creative and software creation programs with customers, Hyperlean tended to use their day-by-day software's utilisation in order to detect and fix possible bugs of the software.

Bug & Improvement programs: discussion of the findings

Alongside the NPD co-creation process, thanks to the support of customers and users, Hyperlean deployed an informal bug & improvement program within each collaboration. According to what they say, this kind of activity is fairly common for those who develop new software, be it web applications or software programs. The advantage that this kind of activity could give to the NPD co-creation process can be associated with the ability to involve also the passive actors, that usually are the less active in supporting the NPD co-creation processes (Payne, Storbacka and Frow, 2008; Perks, Gruber and Edvarsson, 2012). Moreover, these bug and improvement programs could be deployed thanks to the formalisation of the relationship between Hyperlean and its customers, which has become the meaning within which the actors could move around in order to develop and improve the product under development. The process described is in line with the built-test-feedback-revise development loop conceptualised by Cooper (2018), though Hyperlean did not formalise this process within the customer collaborations. The

evidence discussed represents another source of the advantages that NPD collaboration could give to firms while they carry out NPD processes (Ylimaki, 2014). Another effect of the "mindful trial and error" (Coviello and Joseph, 2012) capability developed by Hyperlean in order to develop the innovation can be related to their willingness to evolve during the NPD co-creation relationship with several actors of the business network. This phenomenon can be addressed also to the different roles that these actors played in order to develop the product: while at the beginning of the NPD co-creation processes, they supported Hyperlean in the NPD co-creation of the new product, Hyperlean later decided to shift the purpose of the collaboration to a focus on bug and improvement programs dedicated to the software already released.

4.2 - Which co-creation capabilities were used by Hyperlean

In order to manage and enhance the NPD co-creation processes together with the actors of the business network, Hyperlean used a wide set of different co-creation capabilities along the LeanCost development path. These capabilities stem out from the analysis of data collection and the detailed study of the case. What seems most relevant in the case could be addressed to the fact that these capabilities were developed during the process, and then changed over the years with the people that were involved by the focal firm for the development of the new product. In some ways, it is possible to say that these capabilities - either possessed or developed - supported and helped the focal firm in order to develop the product with the support of the actors of the business network. Below is a close examination of the relevant capabilities deployed by Hyperlean in order to achieve a smooth NPD co-creation processes.

In order to deploy the NPD co-creation pathways previously discussed, Hyperlean developed over time a wide set of different capabilities that were useful to attract, engage and retain customers and users of LeanCost, and, moreover, made these customers willing and committed to contribute with their knowledge & information to the NPD co-creation process of the software. According to the data collection and the Hyperlean story described in the previous chapter 3 and chapter 4, it is possible to distinguish between 8 different main co-creation capabilities that Hyperlean used to manage both the NPD co-creation process of LeanCost and every

single co-creation relationship with several actors of the business network that – actively or passively – contributed to the development of the software. Below is the description and the discussion of each of these 8 capabilities used by Hyperlean in order to develop LeanCost in co-creation with customers and users.

4.2.1 – Developing the uniqueness of the product/service

The Research Group first, and Hyperlean then, achieved the creation of a unique product mainly by answering directly to specific needs of the users. In other words, in order to be consistent, Hyperlean started the development process right from the customers' requirements. In fact, the uniqueness of the product developed can be understood in the "perfect fit" between the product's features and the customers/users' needs. In the case of Hyperlean, this process was crucial in order to reach a good level of software output reliability and high adoption rate amongst the actors of the business network. This capability can be summarised also as the creation of an interaction platform that was crucial to receive a strong support by users and customers in order to develop a software that offers a solution that was not already available. The main milestones can be depicted by the initial engaging made by Biesse, who commissioned the research group the development of a new solution, because they did not find any other similar technology available. These thoughts are confirmed by what was said by the the sales rep of Hyperlean. When talking about the origins of Hyperlean and LeanCost; she argued that:

"Everything comes from Biesse's need, thanks to the previous collaboration with the university".

This evidence about the origins of the relationship between Hyperlean and Biesse was confirmed also by the interviews with Prof. Germani and other Biesse designers who took part on the new product development process since the beginning. These can be considered evidence of the uniqueness of the product created under the specific requirements of the end users.

As stated by one of Hyperlean's founders who was interviewed, the development of the product, as a bespoke solution to the requests made by Biesse, was possible thanks to the unique background and knowledge of the researchers:

"The need of Biesse [...] (is satisfied) through a solution supported by particular technical skills. A mix of IT and engineering skills".

Moreover, also the IT Department Vice President of Biesse confirmed the uniqueness of the product by suggesting that:

"Hyperlean deal with a deeply felt issue for almost all production companies".

In some ways, the customers/users drove the LeanCost NPD process with their requirements and supported Hyperlean in translating their needs into a software. Therefore, there were many advantages also for the users who participated in this process. As suggested by one of Biesse's designers, the main advantage was achieved by taking part in the new product development process of LeanCost, and

can be addressed to the absolute ability to steer all the development choices and thus to receive a product tailored to Biesse's specific needs:

"The advantage (for Biesse) was to have a blank sheet on which to write and have a program designed on specific needs and structured on specific methods of work".

This thought was confirmed also by the sales rep of Hyperlean. Talking about Biesse's choice to begin the collaboration with the Research Group instead of using other technology suppliers, like aPriori (discussed in the previous Chapter 3), Hyperlean's sales rep argued:

"They saw aPriori, but they felt that as a larger company it was less likely to develop specific features".

This is the evidence of the uniqueness of LeanCost in comparison to other technology providers. These were addressed by Prof. Germani, who suggested how this uniqueness supported also the involvement of new customers in this way:

"Everyone was looking for a digital system to estimate product costs in less time and in the most reliable way possible, and on the market at that time, in Italy, there was no Italian or Foreign companies with established commercial channels. At that time, Hyperlean do not promote itself, but the customers contacted Hyperlean by visiting the website and other few channels like fairs".

Furthermore, while describing the uniqueness of the software developed with Biesse and the major strengths of the spin-off, Prof. Germani argued that:

"The particularity and robustness of the system, then the technical part and a credibility given by the partners included at the beginning Biesse, and however from the university world".

This statement highlights that the uniqueness of LeanCost was supported by tangible facts that eased its adoption by further actors besides Biesse.

Prof. Germani also argued that the uniqueness LeanCost was reached also thanks to the Research Group's/Hyperlean's capability to meet all the specific requests. Prof. Germani described this capability by saying:

"Our value proposition was what they (customers and other actors of the business network) were looking for that specific function, cost estimation of products".

The uniqueness of the solutions was one of the milestones that allowed Hyperlean to create in a few years a considerable number of customer relationships with relevant firms. In the opinion of Prof. Germani, the technical specificity of the software was the element that persuaded customers to believe in the initial promise made by Hyperlean. About this thought, Prof. Germani suggested that:

"The question of a technical specificity resolving a problem they did not find elsewhere convinced them to invest in that solution".

In conclusion, this could mean that the actors were interested in this solution since the beginning, and invested - in terms of resource ties - in the development of LeanCost because of its uniqueness, because at the time there were no other similar technologies that could solve their problems in design to cost operations.

developing the uniqueness of the product: discussion of the findings

The creation of a product that is perceived as unique by the customers amongst the other providers seems to remain the stepping stone of every successful NPD co-creation process. In order to develop this uniqueness, thus, in literature it is commonly recognised that NPD - prior to starting to developing a new product - has to commence with the identification of a "gap", usually understood as new – or old – perceived needs, a threat to the actual existence of need satisfaction or a shortfall of performances below the optimum levels (Noteboom, 1999). Consistent with Noteboom's (1999) suggestion, Hyperlean started the development process right from the customers' requirements. For this reason, the initial collaboration with Biesse was crucial to understand customer needs and to start developing the first beta version of the software. As stated by many interviewees, LeanCost was created from an emergent need of Biesse. The uniqueness of LeanCost was confirmed also by customers-side respondents of the data collection, strengthening the understanding of the NPD early customer involvement effectiveness in order to develop a unique and useful product (Baraldi, 2008). Then, Hyperlean managed the NPD process with the aim to continue exploiting the knowledge of its customers and software users in order to improve and enhance the software's capabilities. In this case, Hyperlean, coherently with the suggestion of Baraldi (2008), by owning specific competences and by developing many interaction interfaces, promoted a

network oriented structure and a trusted approach with a considerable number of actors of the business network. These capabilities, that will be described later, supported Hyperlean in translating the customer needs into a software ready to use. But it is important to highlight that, without the knowledge and the support of these customers also in the earliest development phases of the NPD co-creation process thanks to the idea's uniqueness, Hyperlean would probably not have been able to develop LeanCost by itself (Luzzini et al., 2015; Noteboom, 1999).

The uniqueness of the solution embedded within LeanCost triggered the interest of several actors of the business network in a mechanism that is widely renowned in marketing and NPD literature; precisely, Altun et al. (2013) suggested that the product sales performances are directly linked to the capability of the firm of understanding customer needs.

4.2.2 – Background and Culture of the 'focal firm'

The establishment of the initial collaborative relationships with the first customers would not have been possible without the unique background and culture developed by the Research Group within the academic context, which were then transferred to their new venture Hyperlean. Background and culture of the focal firm led to the creation of a 'collaboration model' that has been replicated by Hyperlean until today (2018). In particular, the highly skilled technical background of Hyperlean made it possible to achieve a smooth adaptation process with several customers by

combining their field experiences background information in order to create generalised rules and logics that would be embedded in the software.

The centricity of the academic background's role in Hyperlean's story was remarked also by Prof. Germani, who thought since the beginning that showing the ties between Hyperlean and the academic research context on the subject related to design to cost and cost estimation could be a way to strengthen the reliability Hyperlean and LeanCost. In particular, Prof. Germani argued that:

"That (academic) background transmitted to the big company, however, give a certain robustness to the (image and perception) company that It offers".

Nonetheless, also the IT Department Vice President of Biesse, when discussing about the role of the university context and knowledge background in the collaboration with Hyperlean, suggested that:

"The role of university's skills has been central. Hyperlean then used the Biesse know-how to develop the model and the software (LeanCost)".

During the interview with Biesse's designer, he made a relevant observation about one of the main reasons that persuaded Biesse to collaborate with the Research Group, later Hyperlean. Particularly, he pointed that this choice was motivated by 3 main reasons: the extant relationship with the research group; the chance to develop a software under their specific requirements; and the economical convenience of the whole operation. Here follow Biesse's designer thoughts in his words:

"They (Biesse) have chosen to collaborate with the university for three main reasons: the first is the malleability of the university and the good relations already existing with them; the second was due to the fact that Biesse could have developed the software according to its specific needs; and third that the relationship with the university from an economic and fiscal point of view was very convenient for Biesse".

Background and culture of the focal firm: discussion of the findings

The creation of a formalised collaboration model allowed Hyperlean to manage a smooth adaptation process with its customers in order to achieve a high level of collaboration for the new product development (Baraldi, 2008). The customers collaborations' nurturing capability can be addressed also to an issue of competitiveness (Müller et al. 2012), but in order to get the most from its partners, it is crucial for the focal firm to develop mutual trust with the aim to obtain higher benefits from network's relationships (O'Toole and McGrath; 2018). Mutual trust, as already described, played a crucial role also when it came to gather and exchange information and knowledge between customers and users in order to develop the software (Håkansson and Snehota, 1995). Lynch and O'Toole (2003) described cultural compatibility as one of the strategic issues that could arise when two or more firms collaborate together for developing new products. In the case of Hyperlean, in order to achieve a higher level of collaboration from customers and users, the academic background played a crucial role, both in strengthening the

perceived reliability of the firm and in giving relevance to the importance of the competence and knowledge that the firm developed within the academic context (Baraldi, 2008).

In the case of the NPD co-creation relationships between focal firm and their customers, the focal firm had to focus on the development of the capabilities needed to access, co-shape and exploit the resource set already available on the business network. This process is related also to the firm's capability of understanding the potential of every customer relationship (McGrath, Medlin and O'Toole; 2018).

The academic background, according to the interviewees, influenced also the perception of the evolution of the relationship and facilitated the collaboration with customers that looked for a product that would be in line with their requirements.

In conclusion, this could be seen as the evidence that customer collaboration in NPD can be directly influenced by both the firm's culture in sharing and developing their resources whilst collaborating in NPD process (Leonard-Barton, 1992) and that firms can enhance their co-creation capabilities by promoting a network-oriented culture for a trusted and long term approach amongst the actors of the business network (Baraldi, 2008).

4.2.3 – Network Capability

Since the beginning, the Research Group and then Hyperlean put a lot of effort to establish close collaborations with the customers/users, and then to strengthen the

ties with several other actors of the business network, with the purpose of improving and developing the software performance.

How Hyperlean managed to manage these several collaborations at the same time and how they managed to involve a considerable number of customers can be summarised in their network capabilities, which are coordinating multiple resources, activities and actors towards one target: the development of LeanCost.

Hyperlean succeeded at making the customers so involved that most of them were so keen to support the development of LeanCost that they started to cooperate also with other actors of their business network with the aim to create new knowledge that could be used by Hyperlean in LeanCost. All of these efforts were made by customers/users in order to improve the capabilities of the software that they wanted to use soon. One of the best examples that could well describe Hyperlean's customers' willingness to establish concrete and valuable collaborations with the focal company can be synthesised with the thought of Biesse's designer, who suggested the following about the cooperation with other actors:

"Call us, we will sit there, we listen if we can give our contribution, we give it or we come with the maximum (information) that we can find inside our workshop or within our supply chain with the testimony or experience of one of my suppliers that deals only with that, and knows like nobody about it, Sacmi (one of the customers involved by Hyperlean to develop the same requirements of Biesse) will

bring his technologists as well as their skills, and together we can develop, implement and grow".

Network capability: discussion of the findings

Hyperlean's ability to access a wide set of critical resources through collaborations with several actors of the business network can be described in the extant literature as "network competence" (Aarikka-Stenroos and Sandberg; 2012). McGrath and O'Toole (2018) made further improvement on their "given" definition of network capability by describing this concept as "the early stage development of the understanding, willingness and ability of the new venture to purposefully engage its business network of relationships to begin to gain access to, and mobilise, resources with other network actors". Thus, by exploiting this capability, Hyperlean managed to involve a considerable number of different actors of the business network in order to make them collaborate to the NPD co-creation process. Its aim was to develop the software by acquiring information and knowledge from customers and users in order to be consistent with their requirements. The high level of network capabilities owned by Hyperlean were decisive to receiving a lot of contributions from the targeted counterparts and, moreover, to receive from these also a very high level of effort for the development of their software (McGrath and O'Toole, 2018). This capability was crucial also to manage the different actors that were interested in the same features of the software; Hyperlean had to manage this

critical issue in order to make all the collaboration smooth and useful for the development of LeanCost. Network capability can be associated also to the capability to mobilise customer communities (Prahald and Ramaswamy, 2000). The integration of several sources of knowledge, information and users' insight allowed Hyperlean to shape a new software that could be later recognised as a useful innovation by its users and customers. In our study, innovation capability, together with network capabilities, can be "recognised as one of the most important internal resources that can result in superior firm performance" (Perna, Baraldi and Waluszewski, 2015; Najafi-Tavani et al., 2018). This kind of performance, in addition, can be addressed also to Hyperlean's network management capability in managing all the information and relationships amongst the actors of the business network who led to the creation of the software.

4.2.4 – Knowledge complementarity

Knowledge complementarity was a critical capability for the establishment of a fruitful and open collaboration with customers and users in order to develop the software.

In fact, the knowledge provided by customers for product development was not a duplicate of Hyperlean's knowledge, but indeed, it was complementary with the users' problems and their point of view in a way that made it possible for Hyperlean to reach a new awareness and to consequently develop a deep understanding of

customer/user utilisation about design to cost and suitable costing methodologies. Summarising, the complementarity was between the academic background of Hyperlean and the practical field background of the users and the actors involved. Biesse's IT Department's Vice President, while discussing about the main strengths of the collaboration between Hyperlean and Biesse, suggested that:

"Cooperation between two subjects with complementary skills through which to develop products (LeanCost) that allow you to have a competitive advantage".

Then, as stated by one of the designers of Biesse, a firm which co-founded Hyperlean, all the users involved in the NPD co-creation process somehow provided Hyperlean with their specific field experiences which could improve the capabilities of LeanCost:

"That was our experience gained in the field, gained in the daily work over the years, we have made that aware to these guys [Research Group /Hyperlean]".

Then, knowledge complementarity capability was well explained from a further thought of the designer mentioned before, who during one of the interviews described how these actors - Biesse and the Research Group/Hyperlean - organised their work and the way they achieved the creation of a new software.

"They [Research Group / Hyperlean] have elaborated [the information], we have given a lot of information, then slowly when they got this information they started to metabolise this way to structure the activities and the analysis in terms of what it consisted and of what was needed and how to make a quote. They [Research

Group / Hyperlean] developed the software from our knowledge, we went daily on topics, and we touched on a topic like carpentry and it was all about the technological and production processes with regard to the carpentry, starting from laser cutting, what can be cut and then from there we have generated together the logics that are at the base of the software so then the algorithms [...] and at the end we have collected everything and the thing has evolved up to the development of a software".

The perfect matching between different know-how provided by the several actors involved in the NPD co-creation process to Hyperlean are the unique conditions at the basis of the software development. This aspect strengthens the capabilities of Hyperlean to simultaneously manage relationships and to create mutual benefits for all the actors involved, moreover in the initial relationship with Biesse. This is highlighted by Biesse's designer:

"The approach to the development of the software was constructive for everyone, we (Biesse) we were young then also from our point of view of addressing topics in the methods, we were not ready [...] and we needed their (Hyperlean) coordination and then this starting stage was for us the most relevant".

Knowledge complementarity: discussion of the findings

In order to build up an efficient NPD co-creation process and not to run into useless activities, the knowledge complementarity between Hyperlean and its

customers/users was one of the relevant phenomena that stemmed from the analysis of the case study. For the NPD co-creation process deployment, Hyperlean needed customers' and users' insights in order to develop the software features and expected performances according to customer requirements. Therefore, thanks to the NPD co-creation process with customers and users, Hyperlean was able to develop also a deep understanding of the customers' requirements for software utilisation and their expectations while using a design to cost software. Then, in association with the strong academic background of Hyperlean, customers and users provided the focal firms with all their field experiences, which were critical for the development of specific single technologies or single fields of application required by the software. As already suggested, this "perfect matching" between different knowledge and points of view could be one of the success factors at the basis of the software development collaborations with customers and users. The knowledge complementarity supported the entire ongoing processes of information and knowledge sharing and exchanging between all the dyadic relationships within the business network (Håkansson and Snehota, 1995). Knowledge complementarity positively affected and enhanced also the capability of the focal firm to attract new customers and new users in order to be supported along the NPD process (Baraldi, 2008). In fact, specific owned competences eased the knowledge complementarity amongst several different actors of the business network (Baraldi, 2008). In other words, the strategy followed by Hyperlean was the establishment of a constellation

of strategic alliances with several of the most relevant actors of the business network (in terms of knowledge and experiences in a specific field or technology), in order to gain direct access to relevant assets and/or knowledge (i.e. enabling technologies or resources) needed for the development of the software which the firm did not possess (Schilling and Hill, 1998).

4.2.5 – Knowledge and Information Sharing

The several recurrent interactions between Hyperlean and its customers supported the establishment of a smooth sharing process of knowledge and information within the business network. These exchanges were bigger with the active actors, who supported the development of the product with great efforts. The reliability of Hyperlean's development team comes from their "academic perception" and all the references made by the satisfied customers. These elements supported Hyperlean in achieving complete openness by the actors involved in the NPD co-creation process, and it eased the information and knowledge sharing with them in order to make substantial advancements in the software's development.

As discussed in the previous subsection, since the beginning, Biesse's designers provided Hyperlean's engineers with their background and knowledge in terms of field experiences and practical skills. Specifically, it is possible to highlight how the sharing process and the joint work in the development of a tool that was needed

by the users was eased also by the complementarity of the knowledge of the actors involved.

In fact, in the beginning, the relationship between Biesse and the Research Group only consisted in them sharing their knowledge in order to create the basis for the development of the new software that Biesse wanted to use. This evidence comes from what stated by one of Biesse's desginers:

"The initial work, we speak simply of the writing of the book, the book of the foundations of the software, that have been written by me, and other 2 or 3 colleagues; on the Research Group / Hyperlean side there were the co-founder Finaurini, Mandolini and two other persons".

The knowledge sharing capability could be seen, as suggested by Biesse's designer, also like a sort of marketing activity, used by Hyperlean to create new relationships and engagement with the actors of the business network.

"The sharing of information is, if you want, some sort of higher marketing".

The second Biesse designer interviewed confirmed that Hyperlean's capability to combine knowledge coming from the practical field experience background of Biesse and the academic background was critical in order to develop the initial versions of LeanCost:

"On a technical level, the main interactions were: to understand the production processes of the details (we did not speak the same language between operational and academic). Translating and transferring one's knowledge to a purely

theoretical staff has been a somewhat complicated initial hurdle. Then the Hyperlean staff formed and this thing was solved".

The same Biesse designer, while talking about the knowledge sharing capabilities of Hyperlean, exposed some of the possible threats that the actors could face by being too open with others in sharing sensitive information, by arguing:

"Perhaps, there could be some kind of fear that the Knowledge of the company that was transferred could also be given to other companies".

These knowledge sharing capabilities supported also the further validation of the software development. By analysing the development process of LeanCost, it is possible to recognise what is possible to term the "automatic mechanism of data validation" made by the users over time. This process was explained by the former sales rep of Hyperlean, who argued that:

"The data are accurate because they are validated by all the customers and partners".

The co-creation relationships between Hyperlean and the customers usually start with the development of a precise set of critical factors of the software, usually directly related with the specific application field of the customer. The developments of these critical factors are connected with the information and knowledge exchange between the users and Hyperlean. This is confirmed by the Hyperlean's sales rep, who suggested:

"The zero point of the collaboration is the development of the software dedicated to the application. The input, the sector data, is the change that requires software to develop '[...] Collaboration in the development of the algorithm is maximum. Sometimes algorithms developed by the client can also be used in the LeanCost algorithm".

The importance of knowledge sharing is highlighted also by another thought of Biesse's Designer, who was slightly disappointed about the new relationship's settings strategy adopted by Hyperlean, which then chose to involve other partners instead of Biesse to develop certain areas of the software. He argued:

"But maybe let us participate, let us participate in these tables, even just to listen, because it's all knowledge that we need to bring forward our work better and to catch possibility to grow for the company [...] all this knowledge will be coming back".

Knowledge & Information Sharing: discussion of the findings

The information and knowledge sharing between Hyperlean and the actors of the business network was supported by the recurrent interactions, the formalisation of their relationship and the cross-functional teamwork established within every single actor's interaction (Håkansson and Snehota, 1995; Snow et al., 2011; Keszey and

Biemans, 2016). Amongst every dyadic relationship, it is useful to distinguish between relationships with active actors and relationships with passive actors (Payne, Storbacka and Frow, 2008; Perks, Gruber and Edvarsson, 2012). The ones with active actors were deeper and gave more support to the development of the software. The ones with passive actors were useful for bug and improvement processes.

The sharing process between the actors involved and the focal firm was possible also thanks to the NPD pathways discussed in the previous section 4.1; for example, actors' and people's engagement, the formalisation of the collaboration, the creation of cross-functional teamwork, the interaction with the actors' business network and the development of bug & improvement programs. All these pathways were deployed by Hyperlean in order to develop LeanCost in co-creation with the actors of the business network; this process can be understood as "collaborative innovation" according to the definition given by Wanga and Hu (2018) who describe this process as "knowledge sharing" and "joint work to plan and execute R&D". The ongoing resource sharing process can be understood, as suggested by the vision of Håkansson and Snehota (1995) as a never ending process between all the actors that participate in the NPD process of LeanCost. Then, Hyperlean's capability to translate and mix-up all the resources gathered in terms of information and knowledge made it possible to reach the full development of the software through time. The background of Hyperlean and the relationship created with their

customers supported the openness of the actors in fully sharing their knowledge without feeling threatened by Hyperlean. The sharing process started with the ideation of the software, but it then supported all the NPD phases (Cooper, 2008, 2018; Schilling and Hill, 1998) faced by Hyperlean for the development of LeanCost. In the end, the information and knowledge sharing processes became something very valuable also for the customers, as stated by some of the interviewees. Therefore, in the NPD co-creation process analysed, it is possible to understand the information and knowledge exchange (Ylimaki, 2014) and the resource sharing between the focal firm and the other actors of the business network as a process of collaborative innovation (Håkansson and Snehota, 1995; La Rocca et al., 2016; Leonard-Barton, 1992).

4.2.6 – People Engagement

Hyperlean's major ability can be addressed to their ease of engaging – and to be engaged – by the customers' employers and management, and thus to generate high commitment on behalf of all the people (who were also users of the software) who were involved in the adoption of LeanCost. This created the right conditions for Hyperlean to generate high commitment among all the firms involved for the development of the critical factors of the software, and it eased the achievement of high satisfaction in the use of the results provided by LeanCost. The development activities that occurred between the Research Group and Biesse had very positive

results, a clear indication of the relationship's good quality. As stated by one of Biesse's designers who participated in the development process since the beginning:

"I remember very well all the moments we shared, that is, being at the table thinking about the logic, it was a moment of training, I think maybe unique, maybe I do not know now, but at the time I had much less experience than now and that opportunity was an great to go to study and ask what you did not know and so it was a time of growth [...] very important".

The customers' management engagement in the project is summarised by the efforts of these actors in the development and improvement process of LeanCost. The evidence comes from the interview with Biesse's designer, who said:

"One of the companies, but I do not speak of companies, I speak of people, who has always seen my time dedicated to the development of this software (LeanCost) and as my time dedicated to support for Hyperlean is Intermac (Biesse) [...] they have always said "more things you learn, the more you can bring back to the company".

To confirm the statement of Biesse's designer, it is useful to show what another Biesse designer said about this issue during further interviews:

"Biesse is one of the major promoters of the implementation of the program".

The importance of the engagement of the users and the management of the new customers was crucial for the development process of LeanCost. This is highlighted

also by Prof. Germani, who said that when he, or his team, fail at creating the right relationship bond with the customer, then it could be very difficult for Hyperlean to overcome other technology providers. Prof. Germani's thought was:

"In cases where a human relationship is not established, but a more aseptic relationship (with the client), without the possibility of making demos, it is obvious that in those cases it is easier that will win the biggest brand (with the same technology provided)".

People engagement: discussion of the findings

In the NPD co-creation process, the engagement of the actors was crucial for Hyperlean in order to obtain the development of its product; moreover, for Hyperlean it was crucial to involve in the business network people within the other firms (Håkansson and Snehota, 1995; La Rocca et al., 2016). Identifying and motivating the right people was conceptualised by Lynch and O'Toole (2003) as one of the relevant activities to deploy in order to manage customer involvement within the business network. People engagement contributed to the creation of the right conditions to obtain commitment in order to receive feedback and suggestions about the software's functioning and about possible further improvements. This engagement started with the management of the firms, and then they involved all the employees that face difficulties every day in design-to-cost and product costing activities. The real evidence of this capability relies on its contrary: as stated by one

of the interviewees, when Hyperlean fails to establish an initial strong relationship bond (Håkansson and Snehota, 1995) with the other actor's referent, usually the project will fail and the chance to collaborate together vanishes. In this case, it is possible to understand this process as "acceptance", as described by Woodside and Biemans (2005), which is what allows the focal firm to obtain the commitment from its business partners. Of course, this acceptance represents the result of a co-creation process, which is supported by NPD pathways – among all cross-functional teamworking – and other capabilities. In other words, it is possible to understand people engagement capabilities as a meaning of the relational quality deployed by Hyperlean and its people towards the actors of the business network. In fact, according to Marshall (2004), relational quality can be understood as a variable that challenges all the actors of the business network to learn from each other's dyadic interactions. Relational quality will gradually affect also the level of trust and intimacy between the actors of the business network and the focal company (Marshall, 2004).

4.2.7 – Creation of an Engagement Platform

The cross-functional teamwork initially created with Biesse was then replicated also in the other co-creation relationships, sometimes with the ease and support of the university (in terms of students or internships involved in each project) and other times with the direct involvement of the users within the firm. To reach the required

level of quality and validation of the software, there was a continuous need for a certain degree of variety among the resource providers and users developing relationships which could be problematic to maintain over time because of the stability in resource ties to a certain set of others (Håkansson and Snehota, 1995). The software creates and advantage for this aspect; in fact, LeanCost works like an engagement platform to involve the actors of the business network and to mix their knowledge in a tool that then everyone can use. One of the unique capabilities of LeanCost (and Hyperlean) that it can be seen as "something" that can create new relationship between customers. As pointed by Biesse's designer, participating in the development process could be useful for Biesse for two major reasons:

"For an information and knowledge exchange, but above all to relate companies that build technologies that other companies use every day, the important thing for me is to capture these possibilities".

One of the other ways to create engagement that Hyperlean used since the beginning was the collaboration with universities and research centers. These actors supported Hyperlean to spread their idea and to make their partners aware of this new solution for cost management. Prof. Germani said:

"We have conveyed the system on their members through training activities [...] towards the end users of the technologies. These (the partners) have been the trait d'union between suppliers of new technologies and end users".

Creation of an Engagement Platform: discussion of the findings

In the previous sections, some of the most relevant NPD pathways and capabilities were described in order to depict their role within the LeanCost NPD co-creation process. Moreover, it could be useful to depict Hyperlean's capability to develop a considerable number of engagement platforms (Baraldi, 2008) in order to ease the involvement of the actors of the business network and to satisfy their needs according to the requirements exposed. These engagement platforms deployed by Hyperlean took the role of interaction interfaces between the focal company and the actors of the business network (Baraldi, 2008). One of the main reasons Hyperlean created many engagement platforms (Snow et al., 2011) was also due to the necessity of managing the high degree of variety of its customers and to ease its access to customers and users' knowledge (Håkansson and Snehota, 1995; La Rocca et al., 2016). These platforms also assumed the roles of marketing - R&D interfaces, supporting the management of the commercialisation activities according to R&D activities (Lynch and O'Toole, 2003). Amongst all the NPD pathways and capabilities already described, the particularity of the case can be addressed to the possibility of understanding LeanCost itself as an engagement platform that supported its customers'/users' commitment to contribute to LeanCost development. It is relevant to highlight that after the first steps in the NPD co-creation process with Hyperlean, customers have seen LeanCost also as a "tool" that, besides its technical design to cost capabilities, permits a "cultural exchange" amongst different actors, that could then share their point of view on certain

technical aspects related to the software. Another aspect that contributed to the creation of an effective engagement platform was the role of the university as a research center, where Hyperlean collaborated with their customers to develop cutting edge innovations. Thus, in the study it is possible to accommodate the thoughts of Prahalad and Ramaswamy (2000) who assume customers/users as providers and links to a wider set of different resources within the business network.

4.2.8 - Progression of the development capability over time

While analysing the case, it seems that there is an establishment of a dependency relationship between the customers/users (who have benefitted from using the software) and the developer/Hyperlean (who has benefits from developing and selling the software). This phenomenon could be well described by the evidence gathered about the progression ofthe growth of Hyperlean's capabilities during the new product development process.

The Biesse designer who was in charge of following the development of the software since the beginning gave us his point of view on the evolution of the relationship between Biesse and the Research Group/Hyperlean:

"The first 5 years were the most collaborative, then slowly in 2013 things changed, it is not that the collaboration has failed, but we miss a little that kind of feeling and complicity".

Thus, the relationships with a growing number of customers required more formalisation over time. All these relationships were formalised since the beginning to create a shield to protect the users who share their sensitive information. However, the formalisation of these relationships were useful for Hyperlean also to manage all the tasks that these relationships require from both parts at the same time. On this subject, one of Biesse's designers argued that:

"Today the relationship is more structured (formalised) [...] The information is exchanged on fairly defined and formal channels".

To describe the growing formalisation of Hyperlean's customer relationships with the actors of the business network, the same Biesse designer suggested that:

"Perhaps, now there is a more commercial relationship than was at the beginning, that was more for research and development, in which the role of the university was relevant […] This thing has been mounting from product development to commercial development, passing more and more by defined channels".

From these interviews, it seems clear that with the consequences of time, the needs of Hyperlean, in terms of knowledge and information required in order to develop LeanCost, have changed. At the moment, Hyperlean mostly needs to interact with and absorb the information and knowledge of different actors to broaden the boundaries of the software capabilities. That was clear also for Biesse's designer who said, talking about Hyperlean's actual relationships:

"It is clear that they (Hyperlean) live on their priorities [...] maybe for them it is more important to prioritise the development of other things within the software, or the improvements of other processes, this is the difficulty we encounter".

Being perceived as co-creation focal actors and while dealing with the development of the co-creation capabilities already described, Hyperlean started to ask the customers to submit new development proposals. One of the newest cases that is possible to describe can be addressed to what happened with Biesse when they started to approach 3D printing technology. In this case, Biesse immediately involved Hyperlean to work together since the beginning in order to improve the software's critical factors and to analyse this kind of technology. As stated by one of Biesse's designers we have interviewed:

"We have brought to the attention of Andrea (Finaurini, one of the co-founders), and therefore Hyperlean, the fact that we have bought the 3D printing machine [...] and then said come, we show you the machine, make training and we provide all the data, you begin to reason with the goal to develop it as soon as possible because we would like to use it into LeanCost".

This could be another confirmation of the great work done by Hyperlean in creating a network of actors who are willing to support its activities and the development of its product LeanCost.

Progression over time: discussion of the findings

The collaboration between Hyperlean and its customers and users became stronger and closer over time. But, as suggested by Håkansson and Snehota (1995) and Marshall (2004), the relationship between Hyperlean and the actors of the business network evolve through time and through interactions. Thus, for the first 5 years the collaboration was very close with Biesse, in order to develop the first version of the software and to later establish the spin-off. In the following years, Hyperlean focused on building specific partnerships with actors that could support Hyperlean's NPD co-creation strategies by bringing valuable knowledge and information. In order to understand the evolution of the relationships with the actors of the business network, it can be useful to define two main dimensions of the progression of the co-creation capability over time: vertical, along the supply chain and between different disciplines; and horizontal, or alongside the whole NPD process (Müller et al., 2012). Looking at the vertical dimension, the growing number of dyadic relationships required a growing level of formalisation in order to manage all the relationships. Several frictions happened between Hyperlean and its customers as a side effect of the progression over time of the NPD co-creation process, mainly because as the development needs of LeanCost shifted, Hyperlean had to engage different partners in order to develop different "pieces" of the software. But despite these frictions between companies, as a sign of the great

relational quality (Marshall, 2004) established between people who collaborated together, many of the interviewees declared they were a bit disappointed by the choice of Hyperlean's management, but they were still willing to collaborate with Hyperlean's people to enhance software capability and to grow in the field of design to cost and cost management.

In conclusion, it is possible to say that, in the case of Hyperlean, the business network took shape from the necessities of the NPD process needs in order to develop and enhance the product capabilities and performances.

Chapter 5

CONCLUSIVE REMARKS

The studies on new product development processes, and consequently on innovation, are still intriguing topics for scholars who are involved in academic research in the management field as well as for practitioners and business managers. In fact, what stems out from the extant literature on NPD and co-creation is that the competitiveness of most companies is still closely linked to their ability to create innovations within their business network (Håkansson and Snehota, 1995; Schilling and Hill, 1998). This manuscript can be understood as a journey within an interesting empirical case study of an NPD co-creation process where a small firm – Hyperlean, a newly established academic spin-off and its software – developed its new product – a software called LeanCost – with the support of a considerable number of several different important actors within its business network. The study was focused on making an attempt to explore and understand which pathways allowed this recently established academic spin-off to engage and exploit several complex co-creation interactions in order to develop and commercialise a new product, considering an obvious scarcity of resources. In addition, the study aims to explore the different capabilities that made it possible for Hyperlean to be

successful in the LeanCost NPD co-creation processes and in managing such a considerable number of several different actors. In order to understand the phenomenon under exploration, the background of the study lies in the theories developed by the "fathers" of the IMP Group Håkansson (1987) and Håkansson and Snehota (1995). Alongside, a considerable number of subsequent newer studies were taken into consideration in order to describe the IMP's Industrial Network Approach (INA) and the ARA model (Activities – Resources – Actors) that the IMP scholars still find useful to describe and analyse empirical case studies (Håkansson and Snehota, 1995; Landqvist, 2017). Then, in order to position the study in the NPD field, the background present some of the major contributions in the literature of innovation and NPD process such as Cooper (2008, 2018), Schilling and Hill (1998), Hsu (2016), Tzokas (2004), Takeuchi and Nonaka (1986), Noteboom (1999) plus many other authors cited before. These cited authors agree in defining NPD as an iterative process, where the focal company should commit the customers and product users to contribute in order to build up a product calibrated on their needs, and moreover, to be lean in the use of resources and in order to speed up the entire NPD co-creation process.

The aim of the study is to provide the readers also with a conceptualisation of the subject of co-creation, that is still a grey area for marketing and management scholars, which could be mainly addressed to the previous studies of O'Toole (Lynch and O'Toole, 2002, 2003; Lynch, O'Toole and Biemans, 2016; McGrath,

Medlin and O'Toole, 2018; McGrath and O'Toole, 2013; O'Toole and McGrath, 2018; Sutton-Brady, McGrath and O'Toole, 2011), Wanga and Hu (2018) Perks, Gruber and Edvarsson (2012), Ramaswamy (2011), Ramaswamy and Ozkan (2014, 2018); Prahalad and Ramaswamy (2000), and several other authors. In synthesis, many authors are agreeing that co-creation in NPD happens when a firm collaborates systematically with several different actors of the business network in order to develop new products (i.e. products, services or innovation in general terms). In many cases, these actors can be identified as the potential customers of the new product and they could be involved since the first stages of the NPD co-creation process (La Rocca et al., 2016; Bettiga and Ciccullo, 2018) to support the focal firm in coping with the complexities of the solutions required by customers and users, and then to engage with them with the right timing along the NPD co-creation process.

The study proposed in this manuscript could be interesting because, since then, several scholars have discussed about NPD co-creation within the marketing and business management field, but very few attempted to analyse and conceptualise these topics by using a longitudinal case study in order to explore macro and micro dynamics that can happen in such contexts between the different actors who took part in the process, thus the topic discussed in the study can be understood as relatively new in the field of business network research, with still few extant literature and empirical case studies to take as a point of reference and to compare

with. In order to achieve the aim of exploring the subjects mentioned, the study was made up of a longitudinal case study (Yin, 2014; Strauss and Corbin, 2015), where the data was collected mostly through interviews to starring actors; then, also due to the newness of the research, in order to understand the results of the data collection, systematic combining was used in order to analyse and compare theory with empirical findings (Dubois and Gadde, 2002). The case describes the NPD co-creation process of LeanCost, the design-to-cost software developed by Hyperlean, an academic spin-off of the DIISM (Industrial Engineering and Mathematics Sciences Department; former Department of Mechanical Engineering) of Università Politecnica delle Marche.

There is an old adage that says that companies rarely innovate by themselves (Luzzini et al., 2015), but NPD co-creation is still a slightly new methodology for developing innovation and new products and it iss still rather new in marketing and management literature. The main juxtaposition with the co-creation concept can be understood as the “ivory tower paradox” or “syndrome of the lone inventor”, thatcan usually affect innovation processes developed by both private firms and academics (Grandi and Grimaldi, 2004). In the case explored, the strength of Hyperlean was that it had partnered since the beginning with several actors in order to identify the gap (Baraldi, 2008; Noteboom, 1999) that constitutes the stepping stone for the development of a unique product.

Table 5.1 - Overview of the findings

Pathways
Engaging with universities and research centers
Engaging with final users since the beginning
Established formalised collaborations with actors
Cross-functional teamworking
Interacting with customers' business network
Getting customers from customers
Rewarding the engagement and the feedback provided by the customers
Bug & Improvement programs
Capabilities
Developing the uniqueness of the product/service
Background and culture of the focal firm
Network Capability
Knowledge complementarity
Knowledge and information sharing
People engagement
Creation of an engagement platform
Progression of the development capabilities over time

The good performance of the commercialisation of the new product, particularly in the first years of the development – where Hyperlean was almost an unknown firm – can be linked with the focal company's understanding of customer needs (Altun

et al., 2013). The strong link created along the relationships with several actors of the business network, where many of those were really committed to contribute since the beginning – otherwise, as suggested by Prof. Germani, new potential customers would not have participated at all in the development process – gave a reliable support to Hyperlean to avoid a lack of users and customers of the product, especially in the early stages of its commercialisation. In these stages, the main complaint made by the customers could be addressed to Hyperlean's vertical (Müller et al., 2012) shifting within the NPD process over time, that required the continuous involvement of several different actors at the detriments of previous customers' requests. The other effect of these development and of commercialisation strategies, is the pathway taken by Hyperelan in getting customers from customers. Although, this can be seen as a slightly new concept, but in the empirical case analysed, it can be addressed to the desired effects of the industrial network approach theories conceptualised by Håkansson and Snehota (1995).

The deployment of NPD co-creation strategies effectiveness in order to manage the growing complexities of developing high-technology products in etherogeneus environments, such as the industrial setting, were validated from the empirical evidence discussed with the study of the Hyperlean case (Håkansson and Snehota, 1995). Within the never-ending process of NPD co-creation (Håkansson and Snehota, 1995), a wide range of complexities emerged. A firm must cope with

these and overcome them in order to achieve customers and survive (Schilling and Hill, 1998; Cooper, 2008; Håkansson and Snehota, 1995). The knowledge and information – about products and technologies under development – represents one of the most important resource to manage. These complexities in managing knowledge and information can be referred to - as stems from the Hyperlean case - as knowledge and information gathering, knowledge and information storing and knowledge and information sharing between the actors of the business network (Lynch and O'Toole, 2003). Hyperlean's case highlighted that the technological shift required in order to develop a product that should be adapted to several different customers can be eased by a considerable number of close collaborations with the different actors of the business network. Moreover, the technology development pace required by users and customers required Hyperlean to produce an even more significant effort in order for the firm to be on the edge of innovation. To cope with these complexities and overcome them, Hyperlean leveraged the uses of business network actors' resources in order to exploit their knowledge and information and to improve the software LeanCost (Håkansson and Snehota, 1995; La Rocca et al., 2016).

In the Hyperlean case, there is an overlapping between research & development activities and commercialisation activities: the study suggest that NPD co-creation deployment may turn into commercialization, and vice versa. Hyperlean involved several different actors in order to cope with product technical needs and

development requirements, but at the same time they worked on turning R&D partners into customers in the shortest time possible, with the aim to sustain their investments and thus survive. It is possible to argue that, in the long run, this emergent and informal strategy has paid off the effort made by Hyperlean. In the case under analysis, the capability to manage the relationships with the network's actors is still relevant in order to obtain resources for developing the products and selling them to the widest possible number of different actors (McGrath, Medlin and O'Toole; 2018).

Relationships management activities helped Hyperlean engage with several customers in order to help them collaborate for a shared goal. In particular, the decision to set a shared vision and shared goals with these actors in terms of product capabilities, and then collaborating together in order to develop the product was a turning point in LeanCost's story. Thus, it is possible to argue that NPD co-creation is also a matter of relationship management; in some ways, managing a relationship can be a means of managing knowledge – needed to develop the product – and managing commercialisation activities – needed to provide financial resources to the firm for backing its investments in the new product.

The analysis of the Hyperlean case highlighted how the co-creation aspects of NPD processes can also be understood as emergent capability that should be possible and useful to use when it comes to gather relevant information and knowledge from a considerable number of different actors of the business network. First of all, these

co-creation capabilities can be useful for empowering people and sharing knowledge in order to create something shared amongst companies, and moreover, a sort of co-owned intangible asset that the focal firm could take possession of in the long run. The possession of shared knowledge could be understood in the case discussed in this manuscript as the fuel of further innovation (Lynch and O'Toole, 2003). In order to obtain this body of knowledge and information, a firm should be able to create the right interfaces in order to interact with several different actors within the business network. The reasons addressed are that the easier the interactions, the more information and knowledge a company will be able to gather (Baraldi, 2008). In addition, the evidence from the Hyperlean case suggests that good interactions mean also a faster and improved trustworthiness between the actors involved within the NPD co-creation process. As a consequence, according to what stems out from the evidence of the case, the loyalty amongst actors - i.e. customers - and the focal firm will increase over time with the increase of the effectiveness of the collaboration; for example it is possible to take as an example the case of Biesse people who are still interested in partnering with Hyperlean in order to acquire more information about new technology utilisation in the situation where Hyperlean was trying to reach new partners for the development of the software (Lynch and O'Toole, 2003). NPD co-creation processes can be understood also as interaction processes amongst the focal company and several actors of the

business network towards the realisation of an innovation, a new product or a product's improvement.

Although the study underlines the relevance of customers' collaboration in NPD, the manuscript cannot end without assessing also potential critical issues and threats. With the term critical issue, here it is possible to understand something that could be very difficult to manage within the NPD co-creation process. With the term threats, here it is possible to understand the risk of losing something (money, customers, knowledge, people, etc. in business terms) in the next future during the NPD co-creation process.

Within the analysed case study, it is possible to identify several **critical issues**, which can be mainly related to the complexities of managing a considerable number of concurrent NPD co-creation relationships with a wide number of different actors; in these business relationships, one critical issue can be addressed to *"trying to please everyone"*, and losing sight of the main goal could be a very concrete issue. This can happen where - just like in the case of Hyperlean - there is a wide number of different actors requesting a tailored solution; rather than focusing, there is the risk of trying to follow every request only to end up in a *black hole of "work in process" solutions* without solving any problems. Fortunately, Hyperlean was brave enough to avoid the pitfall, and this did not happen in their case, because since the beginning Hyperlean chose to focus only on a few relationships. Within the several co-creation relationships, another critical issue to manage for Hyperlean

was the *customers' rivalry in addressing the direction of the R&D activities* of the product: the complexity here refers to the capability (a declination of network capability already seen in chapter 5.1) of managing the major decisions and then the behaviors of a considerable number of different actors with very different specific needs. By following few relationships at a time, Hyperlean managed to create a smooth path for the improvement of the software. Although, in the very beginning, they fell into this trap because by following Biesse, they found themselves into a cul-de-sac, this meant they had to redo a lot of work in order to review the software developed since then. In addition, with the establishment of different cross-functional teamwork, Hyperlean managed to *maintain the different development pace of the several different actors involved in the NPD* co-creation processes; this arrangement supported Hyperlean in harmonising the whole development process of LeanCost. Then, the last critical issues faced within the NPD co-creation process could be addressed to the *management of the uniqueness of the product*, because it could be difficult to develop a product which should be perceived as unique without a deep understanding of the customers' needs (Noteboom, 1999), and moreover, when this technological gap is formalised, to manage the *assessments of customers needs' evolution* in order to shape the product's improvement further. By establishing bonded relationships with the major actors of the business network, Hyperlean was able to *adapt the development*

process to the emergent requirements of the customers and to the newest cutting-edge technologies related to other design to cost software.

During the NPD co-creation process, Hyperlean also faced several **threats**. The first one in order of relevance was the *risk of losing control of the overall NPD co-creation process*, and thus losing sight of the main goal and vision of the venture. This risk can be addressed to what happened with Biesse when, in the first years of the establishment of the spin-off, Hyperlean was very tightly collaborating with them, but following Biesse's requirements brought Hyperlean to a dead end within a few times. After that, in 2011, Hyperlean struggled to re-develop a software that could be adopted by a considerable number of different actors. Alongside these threats, it can be useful to mention also *the possibility that several customers may become rivals and clash* while asking the focal company to develop some specific parts of the software to the detriment of others. Hyperlean's resources were, and still are, very limited, thus it could develop only a few parts at a time; therefore, development choices could mandatorily accommodate only some actors' requests, to the detriment of the requests of someone else. As discussed, one of the best skills of Hyperlean was the ability to manage relationships and people, which allowed them to reach almost full control on the NPD co-creation process and allowed them to avoid this threat. Then, when gathering information and knowledge from customers, the *risk is to take wrong data or information to develop the software*. Thus, great effort should be put on how to assess the knowledge and information

brought by the different customers. This could have been another threat for Hyperlean, but it was avoided mainly thanks to their academic engineering background. In this case, the academic background played a crucial role by being authoritative in the fields of mechanical engineering, design to cost and costing. The last aspects connected to the various threats that could be faced during the NPD co-creation process that could be highlighted in this study can be addressed to the *potential difficulties of managing the overall process during a wide time span*, where many actors follow one another, and many new technologies were created (more than 10 years and hundreds of customers). Also in this case, it is possible to address Hyperlean's ability to adjust and adapt the co-creation development process designed to the new requirements that stem out from customers and other actors of the business network; this was possible thanks to Hyperlean's ability to understand customer needs – mainly through the direct engagement of customers - and thanks to their academic background which provided openness and a wide portfolio of different technical choices.

In terms of managerial implication, it is possible to summarise the major steps a firm should focus on, which were involved in NPD co-creation processes: first of all, after the identification of a *potential new product that could solves a specific real need for a specific target of customers*, in *formalising the collaboration*, defining a shared vision and shared goals; these elements could help the focal firm to reach an advantageous agreement when deploying the co-creation processes and

several pathways over time. Then, for the focal firm, in order to deploy the designed process without slipping into emerging issues, it could be very useful to establish since the beginning a cross-functional teamwork with the most relevant actors, in order to easily access information and knowledge to capture needs and desired requirements. Finally, the tight collaboration with these actors could bring product awareness within the actors' network, which could support the commercialisation activities of the new product.

In the very end, this manuscript about the Hyperlean case could suggest that customers' contribution to NPD processes through co-creation relationships can be very relevant in order to meet customers' expectations and R&D programs' effectiveness. Thereafter, adopting co-creation strategies in NPD processes could be relevant in order to ease commercialisation activities and to reach customers and users with less efforts.

Regarding possible future research that could stem from this study, there are many roads to travel and a lot of work to do in order to understand how firms could be more effective at reaching product development in co-creation. First, there is the chance for the conceptualisation and validation of a robust NPD co-creation framework; this can be developed by starting from the suggestions and the empirical evidence described in this manuscript in terms of NPD pathways and co-creation process development stages. Then, it could be interesting to analyse other different empirical cases to compare with the pathways and capability settings of

this thesis in order to refine the dimensions identified and described in this study. Finally, after the development and the empirical validation of a more detailed and grounded NPD co-creation framework, there is enough data for the opportunity to develop a quantitative analysis, maybe also in the shape of an online survey to managers and entrepreneurs, in order to understand if the evidence gathered from a few cases are reflected in a wider sample of firms.

Besides, it could be interesting to continue the analysis of Hyperlean's NPD co-creation activities in order to build a track record of its progression over time.

References

Aaboen L., Laage-Hellman J., Lind F., Öberg C., Shih T. (2016) "Exploring the role of university spin-offs in business networks"; Industrial Marketing Management; 59: 157-166.

Sandberg B., Aarikka-Stenroos L. (2009) "Applying network approach to commercialisation of innovations: case study on nets to create markets for innovations"; 25th IMP Conference, Marseille, France, Competitive Paper.

Aarikka-Stenroos L., Sandberg B. (2012) "From new-product development to commercialisation through networks"; Journal of Business Research; 65: 198-206.

Alchian A.A., Demsetz H. (1972) "Production, Information Costs, and Economic Organisation"; The American Economic Review; 62: 777-795,

Alexa L., Avasilcăi S., Bujor A. (2017) "Multiple stakeholders's co-creation process in new product development: an exploratory analysis"; MATEC Web Conferences, Annual Session of Scientific Papers IMT ORADEA, 1-4.

Altun K., Dereli T., Lu A.B. (2013) "Development of a framework for customer co-creation in NPD through multi-issue negotiation with issue trade-offs"; Expert systems with applications; 40: 873-880.

Aramand M. (2008) “Software products and services are high tech? New product development strategy for software products and services”; Technovation; 28: 154-160.

Baglieri E., Zamboni S. (2005) “Partnering along the demand chain: collaboration in new product development process”; 21st IMP Conference, Rotterdam, Netherlands.

Baraldi E. (2008) “Strategy in industrial network: experiences from IKEA”; California Management Review; 50: 99-126.

Baraldi E., Gregori G.L., Perna A. (2011) “Network evolution and the embedding of complex technical solutions: The case of the Leaf House network”; Industrial Marketing Management; 40: 838-852.

Baraldi, E., Brennan, R., Harrison, D., Tunisini, A. and Zolkiewski, J. (2007) “Strategic Thinking and the IMP Approach: A Comparative Analysis”; Industrial Marketing Management; 36: 879-894.

Barczak G. (2012) “The Future of NPD/Innovation Research”; Journal of Product Innovation Management; 29: 355-357.

Baum J.A.C., Calabrese T., Silverman B. (2000) “Don't Go It Alone: Alliance Network Composition and Startups' Performance in Canadian Biotechnology”; Strategic Management Journal; 21: 267-294.

Bettiga D., Ciccullo F. (2018) “Co-creation with customers and suppliers: an exploratory study”; Business Process Management Journal; in press.

Biggemann S., Kowalkowski C., Maley J., Brege S. (2013) “Development and implementation of customer solutions: A study of process dynamics and market shaping”; Industrial Marketing Management; 42: 1083-1092.

Blomqvist K., Levy J. (2006) “Collaboration capability – a focal concept in knowledge creation and collaborative innovation in networks”; International Journal of Management Concepts and Philosophy; 2: 31-48.

Bonaccorsi A., Lipparini A. (1994) “Strategic partnership in new product development: an Italian case study”; Journal of Product Innovation Management; 11: 134-145.

Boukhris A., Fritzsche A., Möslein K. (2017) “Co-creation in the early stage of product-service system development”; Procedia CIRP; 63: 27-32.

Ciabuschi F., Perna A., Snehota I. (2012) “Assembling resources when forming a new business”; Journal of Business Research; 65: 220-229.

Cooper R.G. (2008) “The stage-gate idea-to-launch process – Update, what’s new and next-gen systems”; Journal of Product Innovation Management; 25: 213-232.

Cooper R.G. (2018) “The drivers of success in new-product development”; Industrial Marketing Management; in press.

Corry E., Van der Klink M., Stoffers J., Boshuizen H. (2017) “The Co-Creation-Wheel: A four-dimensional model of collaborative, interorganisational innovation”; European Journal of Training and Development; 41: 628-646.

Coviello N.E., Joseph R.M. (2012) “Creating Major Innovations with customers: Insights from small and young technology firms”; Journal of Marketing; 76: 87-104.

Denzin N., Lincoln Y.S. (1994) Handbook of qualitative research; Sage.

Dubois A., Gadde L.E. (2002) “Systematic combining: an abductive approach to case research”; Journal of Business Research; 55: 553-560.

Edqvist C. (1997) Systems of Innovation: Technologies, Institutions and Organisations; Routledge.

Eisenhardt K. M., Graebner M. E. (2007) “Theory building from cases: opportunities and challenges”; Academy of management journal; 50: 25-32.

Eisenhardt, K. M. (1989) “Building theories from case study research”; Academy of management review; 14: 543-576.

Favi C., Germani M., Mandolini M. (2016) “Design for Manufacturing and Assembly vs. Design to Cost: Toward a Multi-objective Approach for Decision-making Strategies During Conceptual Design of Complex Products”; Procedia CIRP; 50: 275-280.

Ford D., Håkansson H. (2006) “IMP – Some things achieved: Much more to do”; European Journal of Marketing; 40: 248-258.

Frow P., Nenonen S., Payne A.; Storbacka K. (2015) “Managing Co-creation Design: A Strategic Approach to Innovation”; British Journal of Management; 26: 463-483.

Gadde L.E., Huemer L., Håkansson H. (2003) “Strategizing in Industrial Networks”; Industrial Marketing Management; 32: 357-364.

Gebert-Persson S., Mattsson L.G., Öberg C. (2014) “The network approach - a theoretical discussion”; 30th IMP Conference, Bordeaux, France.

Grandi A., Grimaldi R. (2005) “Academics’ organisational characteristics and the generation of successful business ideas”; Journal of Business Venturing: 20, 821–845.

Håkansson H. (1982) International marketing and purchasing of industrial goods; Wiley.

Håkansson H. (1987) Industrial technological development: a network approach; Routledge.

Håkansson H., Ford D., Gadde L.E., Snehota I., Waluszewski A. (2009) Business in Networks; Chirchester, John Wiley & Son.

Håkansson H., Snehota I. (1995) developing business relationship; Wiley.

Håkansson H., Waluszewski A. (2002) Managing Technological Development: IKEA, the Environment and Technology; Routledge.

Håkansson H., Waluszewski A. (2007) Knowledge and innovation in business and industry; Routledge.

Halinen A.; Törnroos J.Å. (2005) "Using case methods in the study of contemporary business networks"; Journal of business research; 58: 1285-1297.

Hallen L., Johanson J., Seyed-Mohamed N. (1989) "Relationship e exchange in international business" in "Networks of Relationships in International Industrial Marketing" Lars Hallen, Jan Johanson; Greenwich, CT Jai Press; 7-23.

Hsu Y. (2016) "A value cocreation strategy model for improving product development performance"; Journal of Business & Industrial Marketing; 31: 695-715.

Hutt M. D., Reingen P. H., Ronchetto J.R. Jr. (1988) "Tracing Emergent Processes in Market Strategy Formation"; Journal of Marketing; 52: 4-19.

Johnsen T., Ford D. (2000) "Managing collaborative innovation in complex networks: findings from exploratory interviews"; 16th IMP Conference, Bath, United Kingdom.

Johnsen T.E., Ford D. (2007) "Customer approaches to product development with suppliers"; Industrial Marketing Management; 36: 300-308.

Jones O., Holt R. (2008) “The creation and evolution of new business venture: an activity theory perspective”; Journal of Small Business and Enterprise Development; 15: 51-73.

Kaulio M. (1998) “Customer, Consumer and user involvement in product development: a framework and a review of selected models”; Total Quality Management; 9: 141-149.

Keszey T., Biemans W. (2016) “Sales–marketing encroachment effects on innovation”; Journal of Business Research; 69: 3698-3706.

Koch R.; 1997; The 80/20 principle; Nicholas Brealey Publishing; London;

La Rocca A., Ford D., Snehota I. (2013) “Initial relationship development in new business ventures”; Industrial Marketing Management; 42: 1025-1032.

La Rocca A., Moscatelli P., Perna A., Snehota I. (2016) “Customer involvement in new product development in B2B: The role of sales”; Industrial Marketing Management; 58: 45-57.

Laage-Hellman J. (1997) Business Network in Japan, Supplier-Customer interaction in product development; Routledge.

Laage-Hellman J., Landqvist M., Lind F. (2018) “Business creation in networks: how a technology-based start-up collaborates with customers in product development”; Industrial Marketing Management; in press.

Laage-Hellman J., Lind F., Perna A. (2014) “Customer Involvement in Product Development: An Industrial Network Perspective”; Journal of Business- to-Business Marketing; 21: 257-276.

Landqvist M. (2017) Start-up in business network: Resource development through interaction; Chalmers university of Technology.

Langley A. (1999) “Strategies for theorizing from process data”; Academy of Management Review; 21: 691-710.

Le Dain M.A., Calvi R., Cheriti S. (2011) “Measuring supplier performance in collaborative design: proposition of a framework”; R&D Management; 16: 77-87.

Leonard-Barton D. (1992) “Core Capabilities and Core Rigidities: A Paradox in Managing New Product Development”; Strategic Management Journal, Special Issue: Strategy Process: Managing Corporate Self-Renewal; 1: 248-266.

Luzzini D., Amann M., Caniato F., Essig M., Ronchi S. (2015) “The path of innovation: purchasing and supplier involvement into new product development”; Industrial Marketing Management; 47: 109-120.

Lynch P., O’Toole T. (2002) “Managing User Involvement in the Early Stages of New Product Development”; 18th IMP Conference, Dijon, France.

Lynch, P. and T. O'Toole (2003) "After von Hippel: the state of user involvement research in new product development"; Paper presented at 19th IMP Conference, Lugano, Switzerland.

Lynch P., O'Toole T., Biemans W. (2016) "Measuring Involvement of a Network of Customers in NPD"; Journal of Product Innovation Management; 33: 166-180.

Marshall C. (2004) "The dynamic nature of innovation partnering: a longitudinal study of collaborative interorganisational relationships"; European Journal of Innovation Management; 7: 128-140.

McGrath H., Medlin C. J., O'Toole T. (2018) "A process-based model of network capability development by a start-up firm"; Industrial Marketing Management; in press.

McGrath H., O'Toole T. (2013) "Enablers and inhibitors of the development of network capability in entrepreneurial firms: A study of the Irish micro-brewing network"; Industrial Marketing Management; 42: 1141-1153.

Mengoni M., Mandolini M., Matteucci M., Germani M. (2016) "A scalable "Design for Costing" platform: a practical case in ball valves industry"; Procedia CIRP; 50: 311-317.

Mishra A.A., Shah R. (2009) “In union lies strength: Collaborative competence in new product development and its performance effects”; Journal of Operation Management; 27: 324-338.

Mu J., Thomas E., Peng G., Di Benedetto A. (2017) “Strategic orientation and new product development performance: the role of networking capability and networking ability”; Industrial Marketing Management; 64: 187-201.

Müller P., Pasch F., Drewinski R., Bedenbender H., Hayka H., Stark R., Rivest L., Bouras A., Louhichi B. (2012) “Study on Collaborative Product Development and Digital Engineering Tools”; PLM 2012, IFIP AICT; 389-399.

Najafi-Tavani S.; Najafi-Tavani Z.; Naudè P.; Oghazi P.; Zeynaloo E. (2018) “How collaborative innovation networks affect new product performance: Product innovation capability; process innovation capability and absortive capability”; Industrial Marketing Management; 73: 193-205.

Nelson R.R., Winter G.S. (1982) An Evolutionary Theory of Economic Change; Belknap Press.

Noteboom B. (1999) “Innovation, learning and industrial organisation”; Cambridge Journal of Economics; 23: 127-150.

Noteboom B. (2000) “Learning by interactions: absorptive capacity, cognitive distance and governance”; Journal of Management and Governance; 4: 69-92.

O'Toole T., McGrath H. (2018) "Strategic patterns in the development of network capability in new ventures"; Industrial Marketing Management; in press

Payne A., Storbacka K., Frow P. (2008) "Managing the co-creation of value"; Journal of the Academy of Marketing Science; 36: 83-96.

Perks H., Gruber T., Edvardsson B. (2012) "Co-creation in Radical Service Innovation: A Systematic Analysis of Microlevel Processes"; Journal of Product Innovation Management; 29: 935-951.

Perna A., Baraldi E., Waluszewski A. (2015) "Is the value created necessarily associated with money? On the connections between an innovation process and its monetary dimension: The case of Solibro's thin-film solar cells"; Industrial Marketing Management; 46: 108-121.

Petersen K. J., Handfield R. B., Ragatz G. L. (2005) "Supplier integration into new product development: Coordinating product, process and supply chain design"; Journal of Operations Management; 23: 371-388.

Pettigrew A. M. (1992) "The character and significance of strategy process research"; Strategic Management Journal; 13: 5-16.

Prahalad C.K., Ramaswamy V. (2000) Co-opting Customer Competence; Harvard Business Review; 78: 79-87.

R. Dahl (1957) The concept of power; Behavioral Science; 2: 201-215.

Ramaswamy V. (2011) “It's about human experiences...and beyond, to co-creation”; Industrial Marketing Management; 40: 195-196.

Ramaswamy V., Ozcan K. (2014) The Co-Creation Paradigm; Stanford University Press.

Ramaswamy V., Ozcan K. (2018) “What is co-creation? An interactional creation framework and its implications for value creation”; Industrial Marketing Management; 84: 196-205.

Rasool F., Koomsap P., Costa M.C. (2017) Identifying Firm Characteristics for Successful Co-Creation - Literature Review; Transdisciplinary Engineering: A paradigm shift; 729-737.

Ratajczak-Mrozek M. (2017) The essence of network approach; Network Embeddedness, Palgrave Studies of Internationalisation in Emerging Markets.

Ries E. (2015) The Lean Startup; Penguin.

Robson C. (1997) Real World Research: a resource for social scientist and practioner-researchers; Wiley.

Rogers E.M. (1995) Diffusion of Innovations, 4th Edition; The Free Press, New York.

Schilling M.A., Hill C.W.L. (1998) “Managing the New Product Development Process: Strategic Imperatives”; The Academy of Management Executive; 12: 67-81.

Schumpeter A.J. (1943) Capitalism, Socialism and Democracy; London Unwin.

Serrano V., Fischer T. (2007) “Collaborative innovation in ubiquitous systems”; Journal of Intelligent Manufacturing; 18: 599-615.

Siggelkow N. (2007) “Persuasion with case study”; Academy of management Journal; 50: 20-24.

Singh H., Kryscynski D., Li X., Gopal R. (2016) “Pipes, pools, and filters: how collaboration networks affect innovative performance”; Strategic Management Journal; 37: 1649-1666.

Snow C.C., Fjeldstad Ø.D., Lettl C., Miles R.E. (2011) “Organizing Continuous Product Development and Commercialisation: The Collaborative Community of Firms Model”; Journal of Product Innovation Management; 28: 3-16.

Strauss A., Corbin J. (2015) “Basics of quantitative research: Grounded theory procedures and Techniques”; Newbury Park: Sage publications.

Sutton-Brady C., McGrath H., O’Toole T. (2011) “The evolution of network capability in an SME context”; 27th IMP Conference, Glasgow, Scotland.

Takeuchi H., Nonaka I. (1986) “The new product development game”; Harvard Business Review; 137-146.

Teece D. (2012) “Dynamic Capabilities: Routines versus Entrepreneurial Action”; Journal of Management Studies; 49: 1395-1401.

Tsang E.W.K., Kwan K.-M. (1999) “Replication and Theory Development in Organisational Science: A Critical Realist Perspective”; The Academy of Management Review; 24: 759-780.

Tzokas N., Hultink E.J., Hart S. (2003) “Navigating the new product development process”; Industrial Marketing Management; 33: 619-626.

Van der Valk W., Wynstra F. (2005) “Supplier involvement in new product development in the food industry”; Industrial Marketing Management; 34: 681-694.

Voss C. A., Tsikriktsis N., Frohlich M. (2002) “Case research in operations management”; International journal of Operations & Production Management; 22: 195-219.

Waluszewski A. (2004) “A competing or co-operating cluster or seven decades of combinatory resources? What’s behind a prospering biotech valley?”; Scandinavian Journal of Management; 20: 125-150.

Wanga C., Hu Q. (2018) “Knowledge sharing in supply chain networks: Effects of collaborative innovation activities and capability on innovation performance”; Technovation; in press.

Weustink I.F., Brinke E.T., Streppel A.H., Kals H.J.J. (2000) “A generic framework for cost estimation and cost control in product design”; Journal of Material Processing Technology; 103: 141-148.

Woodside A.G., Biemans W.G. (2005) “Modeling innovation, manufacturing, diffusion and adoption/rejection processes”; Journal of Business & Industrial Marketing; 20: 380-393.

Yin R. K. (2014) Case study research: Design & Methods. Newbury Park; CA; Sage.

Ylimaki J. (2014) “A dynamic model of supplier-customer product development collaboration strategies”; Industrial Marketing Management; 43: 996-1004.

Zollo M., Winter S.G. (2002) “Deliberate Learning and the Evolution of Dynamic Capabilities”; Organisation Science; 13: 339-351.

Acknowledgements

This study itself could be identified as the result of several interactions and relationships - within and outside the academia - which brought me to start the PhD course in 2015. This journey was very exciting, and, at that time, I could not even imagine that it would be so great for me.

First of all, I want to thank Andrea Perna, my supervisor and my polestar in developing all my studies, who supported my ideas and provided constructive criticism and useful insights during my training while I was still trying to become a researcher. Then, I want to thank all the people of Hyperlean, with a special mention for Prof. Germani, Prof. Mengoni, Mr. Mandolini, Mr. Finaurini and Ms. Moretti; the people from Biesse, Loccioni, Ferrero and Baker - Huges General Electric for supporting my data collection and for their availability in answering my huge number of questions. Of course, a central role in the development of my study was that of Prof. Tom O'Toole, who gave me a lot of insights and new points of view about studies on new product development during my visiting in Ireland, which was one of the best experiences of my life. I would like to express a great acknowledgement to Prof. Gregori, who is a mentor for all the marketing scholars of the Department of Management and who supported my studies by always giving me always the right suggestions and pushing me to always do my best.

I would also like to thank all the Department of Management professors and colleagues for these 3 fantastic years, with a special mention for Prof. Marasca, Prof. Chiucchi, Prof. Giuliani, Prof. Temperini, Prof. Pascucci, Prof. Manelli; here I have improved my knowledge in a very healthy and stimulating environment.

I would also like to thank the IMP Group colleagues for allowing me to participate in their seminars and workshops; for me it is still a great honour to be part of this group of leading scholars of industrial marketing cutting-edge studies.

Thanks also to all my PhD colleagues for supporting and helping each other during all the ups and downs of the PhD course.

A mention must go to all the people that in these years engaged with me and left me better than they found me: Alessio, Andrea, Luciano, Marco, Giacomo, Luigino, Luca, Martina, Federico, Marco, Andrea, Giorgio, Claudio, Danilo, Augusto, Lorenzo, Michele, Enrico, Giovanni, and many, many, many more…

A special mention to Gloria, the best companion of this long and difficult path, who managed to help me in a whopping number of difficult situations; without her I probably would not have been able to do all these things. Another special mention to Mina, my fluffy companion of my late-night working hours and joyful weekends.

Thanks to my family and friends, and to all the people who have been close to me and have supported my efforts during these studies even through hard times.

Last but not least, a special thanks to Graziano Cucchi, a mentor and a friend, because without him none of this would have happened.

At last, thanks to myself, because I am still aspiring to improve and trying to develop something valuable for our community.