

Value co-creation and innovation:

the case of Portuguese firms

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Declaração

Declaro que o presente documento é um trabalho original da minha autoria e que cumpre todos os requisitos do Código de Conduta e Boas Práticas da Universidade de Lisboa.

Declaration

I declare that this document is an original work of my own authorship and that it fulfills all the requirements of the Code of Conduct and Good Practices of the Universidade de Lisboa.

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Abstract

The central objective of this research is to study value co-creation as a key driver for innovation in the development and introduction of innovative products/services in the market, applied in Portuguese firms. It is also intended to perceive which of the co-creation procedures are more significant, as well as the propensity of the firms to obtain competitive advantage, once they adopt co-creation procedures within their innovation process.

Companies evolved into non-linear models of innovation; however, information management remained producer-centered, lacking the ability to carry out an adequate collection of the specific needs of users. Co-creation addresses the previous by having a customer-centered information management. Being a descendant of open innovation, it has a firm driven strategy. Also, co-creation includes user innovation within its procedures to co-create, being the most holistic perspective in terms of value creation with customer, as its procedures encompass all type of users.

To feed the empirical research, it was used secondary data from Community Innovation Survey (CIS), particularly from 2016 Portuguese edition. CIS is conducted periodically every two years since 1992, mostly in European Union countries, to provide information on innovation topics per type of sector, by collecting firms' responses.

To test the data, in accordance with the research hypotheses formulated, it were created five logit models. Between expected and unexpected results according to the literature review, ultimately, co-creation reveals itself as a stimulant key driver for innovation, which consequently unlocks paths to leverage competitive advantages, by its application within the companies' innovation process.

Keywords

Innovation; Open Innovation; User Innovation; Co-Creation; Development of innovative products / services; CIS.

Resumo

O objetivo desta investigação é estudar a cocriação de valor como um determinante para a inovação, no desenvolvimento e introdução de produtos/serviços inovadores no mercado, aplicado nas empresas portuguesas. Pretende-se também perceber quais os procedimentos de cocriação mais significantes, bem como a propensão das empresas em obter vantagem competitiva, ao adotarem procedimentos de cocriação dentro do seu processo de inovação.

As empresas evoluíram para modelos não lineares de inovação, contudo a gestão de informação continuou centrada na empresa, incapacitando a recolha adequada das necessidades dos clientes. A cocriação soluciona tal problema ao ter uma gestão da informação centrada no cliente. Sendo descendente da inovação aberta, tem uma estratégia orientada pela empresa. Além disso, a cocriação inclui a inovação pelo utilizador como um dos seus procedimentos para cocriar, sendo assim a perspetiva mais holística em termos de criação de valor com o cliente, abrangendo todos os tipos de utilizadores.

A investigação empírica foi conduzida com dados secundários do *Community Innovation Survey* (CIS), edição portuguesa de 2016. O CIS é realizado a cada dois anos desde 1992, maioritariamente em países da União Europeia, providenciando informações sobre tópicos de inovação por tipo de setor, através da recolha de respostas das empresas.

Para testar os dados, de acordo com as hipóteses de investigação, foram criados cinco modelos logit. Entre resultados esperados e inesperados relativamente à revisão da literatura, a cocriação revela-se como um determinante para a inovação que, consequentemente, abre caminhos para alavancar vantagens competitivas, pela sua aplicação no processo de inovação das empresas.

Palavras-chave

Inovação; Inovação aberta; Inovação pelos utilizadores; Cocriação; desenvolvimento de produtos / serviços inovadores; CIS

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List of Acronyms

API – Application Programming Interface

CAE-Rev.3 – Classificação Portuguesa de Atividades Económicas, Revisão 3

CIS – Community Innovation Survey (Inquérito Comunitário à Inovação)

DART – Dialog, Access, Risk-benefits and Transparency

DGEEC – Direção-Geral de Estatísticas da Educação e Ciência

EUROSTAT – European Statistical Office

INE – Instituto Nacional de Estatística

LE – Large enterprises

NACE-Rev.2 – Statistical classification of economic activities in the European Community, Revision 2

NPD – New Product Development

NUTS – Nomenclatura das Unidades Territoriais para Fins Estatísticos

OECD – Organization for Economic Co-operation and Development

R&D – Research and Development

SME – Small to Medium-sized Enterprises

1. Introduction

1.1. Problem context, research question and objectives

The currently very competitive market requires that companies resort to new approaches of innovation and product development in order to survive and grow. The investment in a broader range of offerings is becoming less able to guarantee differentiation (Prahalad and Ramaswamy, 2002, 2004). Furthermore, Ogawa and Piller (2006) also introduced that the company's failure in assessing and meeting its own customer's needs is one of the main reasons for unsuccessful penetration of a new product in the market.

To address this problematic issue, a solution resides in entailing the concepts of open innovation, particularly co-creation, in the New Product Development Process. According to Auh et al. (2007), Prahalad and Ramaswamy (2004), Vargo and Lusch (2004) and Martovoy and Dos Santos (2012), co-creation supports active participation of the customer jointly with the company in the innovation process.

Customers are engaging with this new form of value creation, enhanced by the Internet's consumer-centric culture, which promotes the customer empowerment through interactivity, speed, and openness to information (Prahalad and Ramaswamy, 2002).

This translates into a shift of paradigm regarding the traditional, economical and company-centric concepts to a novel consumer-centric view, where the customer is integrated as an active player of the value creation process, capable of influencing both its methods and structure, through the high quality interactions between himself and a firm, which allows both parties to co-create special experiences together. Therefore, in other words, a company can listen to customers more effectively and co-create new products with them, which will respond accurately to their specific and complex needs, providing leverage to the competitive advantage of such companies and hence, enhancing the chances to be successful (Prahalad and Ramaswamy, 2002, 2004; Hoyer et al. 2010; Papageorgiou, Efstathiades and Milikouri, 2017).

O'Hern & Rindfleisch (2010) defined a typology regarding numerous forms of customer co-creation as a collaborative New Product Development (NPD) activity, in which customers are of essence in the NPD process. Piller, Ihl and Vossen (2011) presented another typology, broader and holistic, but with same purpose. Those typologies, to be analyzed further, will be important to sustain the use of CIS (2016) secondary data to feed the research.

In the light of the above, the main research question that arises is the following: is co-creation a key driver for companies to innovate and develop new innovative products and services?

Also, the empirical research will seek to answer the following questions:

- By employing co-creation in their innovation process, will firms be more likely to successfully introduce new and innovative products and services in the market?
- If co-creation is adopted and applied within the innovation process of the company, will it allow these companies to leverage a competitive advantage over competitors?
- Which co-creation procedures are more significant to the creation and development of new innovative products and services?

Given the questions and challenges in the scope of this research, the main objective is to study value co-creation as a key driver for innovation in the development of innovative products/services, applied in Portuguese firms. In this sense, this research will take co-creation as its conceptual framework. The study's theoretical support is based on the consideration that innovation is a non-linear, evolutionary, complex, and interactive process between the company and its environment, in which the customer has a vital role within the company's innovation process. It is also the theoretical support that allows the creation of the conceptual bridge between co-creation and the CIS, with the purpose of feeding the empirical support that is intended to be built with secondary data validated by EUROSTAT, in order to study co-creation as a key driver for innovation and development of new and innovative products/services, applied in Portuguese firms.

In more detail, this research intends to study the following aspects:

- The application of co-creation within the companies' innovation process, and the propensity to innovate and introduce new and innovative products/services in the market;
- The relation between the application of co-creation and the obtainment of competitive advantage;
- The identification of the most significant co-creation procedures for creating new and innovative products and services.

These aspects are directly linked to the study of co-creation within the innovation process of firms, particularly in the Portuguese ones, as well as its influence on the development of new and innovative products/services. Moreover, in order to materialize this study, hypotheses will be formulated to be tested based on a quantitative approach using, econometric models.

1.2. Dissertation Structure

The present research, in addition to this introductory chapter, also includes chapter II, which introduces the problem definition. Chapter III, comprising the literature review on the research topic will follow, ensued by chapter IV, regarding the research methodology, which justifies the data to be used, describes the sample, presents the variables to consider, independent, dependent and the control ones, as well as the method adopted to perform the study. Chapter V will present descriptive statistics, as well as results and discussion; finally, chapter VI is referent to the conclusions. In more detail, chapters III to VI are organized as follows:

Chapter III - 1. Presents the definition and characterization of innovation, regarding the various dimensions to consider when studying this concept, as well as the definition of product innovation regarding the OECD, important to the research topic.

Chapter III - 2. Includes the theoretical approaches regarding innovation, namely the Schumpeter's theses and the linear and non-linear models of innovation. This chapter will culminate in the open innovation model, in which co-creation underlies.

Chapter III – 3. Firstly, defines the concept of user innovation and then evolves to the lead user theory and the toolkits for innovation, a required piece of information since those concepts will be integrated in Piller, Ihl, Vossen's typology for co-creation (2011), which presents a holistic view of co-creation that embraces the user innovation's lead users' theory as a particular form to co-create.

Chapter III – 4. Addresses the main topic of the present research, co-creation. In a first instance, definitions are provided. Ensuing, it is presented the rationale, which justifies the fact that co-creation is an integrant part of open innovation. The rising of this form of innovation and the role that the customer plays within the latter are also explored. A subchapter is fully dedicated to the premises that co-creation's seminal authors established, which must be fully respected, as otherwise the process of co-creation is not valid; the following two subchapters cover the summary of two typologies for customer co-creation, respectively, in order to justify the use of the Community Innovation Survey (2016) in the present research. The chapter ends with the Research Hypothesis.

Chapter IV – 1 to 4. Describes the CIS and its features, also describing the sample.

Chapter IV – 2. Refers to the Data Content. Here, the typologies analyzed in chapter III play a key role to justify which CIS (2016) section and questions can be used, without interfering with conceptual terms and premises of co-creation.

Chapter IV – 3. Provides deepen information on the dataset.

Chapter IV – 4. The characterization of the sample is performed.

Chapter IV – 5. Introduces the variables. The independent variables are represented by the variables of co-creation procedures. The dependent categorical variable is referent to the development and introduction of new or modified products on the market, which were partially or fully developed by customers and / or users of the product/services; this dimension is presented

as a dichotomous variable based on binary data. The control variables regard the firms' size and technological intensity.

Chapter IV – 6. Presents the method by which the study will be conducted, the logistic regression model that was built and the chosen software to perform the data's analysis (Stata).

Chapter V – Presents descriptive statistics, the data analysis, and the discussion of the results.

Chapter VI – Provides the conclusions, the limitations, and the future research agenda.

2. Problem Definition

In the last century, whole business systems have been driven through a company-centric view, in which the value creation rests on efficiency regarding production costs, both for the production of goods as well as for the provision of services. Furthermore, companies' investment in a broader diversity of offerings is becoming less capable of guaranteeing differentiation (Prahalad and Ramaswamy, 2002, 2004).

Currently, companies face a very competitive and complex marketplace, a kind of environment that, in order to survive and/or grow, is required to resort to new approaches regarding both innovation and product development. As a result, NPD arises as the most important process, as well as a main source to provide companies with further leverage regarding competitive advantage (Papageorgiou, Efstathiades and Milikouri, 2017).

In addition, according to Prahalad and Ramaswamy (2002, 2004), modern technological advances are imposing on companies the need to exchange the meaning of the value creation process, calling for them to shift between the traditional product/firm-centric view to the new paradigm of customer-centric view, being more responsive in terms of personalized customer experiences. The authors also acknowledged that despite the range of offerings being the widest ever observed in the market, costumers are not fully satisfied since value, as far as they are concerned, resides in the quality of the experiences that products or services may offer (Prahalad and Ramaswamy, 2004).

The traditional NPD aligned with the company-centric view, places customers as passive entities who depend on companies' offerings to meet their needs and are regarded merely as users or buyers (Simonson 2005; O'Hern and Rindfleisch, 2010).

Such a traditional view is currently being challenged by a novel approach that regards consumers as active co-creators of the offerings they use, jointly with the company, in a collaborative NPD process. The aforementioned challenge is enhancing a paradigm shift that enables companies to improve corporate growth and profitability by allowing consumers to become active players in the NPD Process (von Hippel, 2005; O'Hern and Rindfleisch, 2010).

Customers are hardly engaging with this logic of value creation: their influence has never been greater across the whole value chain, being spurred by the consumer-centric view boosted by the Internet, which enhances the interactivity, speed, and the ease of access to information (Prahalad & Ramaswamy, 2004), so that the noticeable growth regarding this approach is credited to the rise of customer empowerment.

Such empowerment is also attributed to two factors: i) current cultural developments, such as distrust of marketing communications and corporate scandals, which led to other sorts of active costumer resistance, like brand avoidance and culture jamming (Klein, Smith and John, 2004; Kozinets and Handelman, 2004; O'Hern and Rindfleisch, 2010); and ii) cognitive psychology states that intrinsic psychological needs are more likely to be satisfied through creative contributions (Csikszentmihalyi, 1996), rather than by the notion of material consumption

per se (O'Hern and Rindfleisch, 2010). Thus, as co-creators, customers may experience and gather psychological benefits that consumption, by itself, cannot offer (Pietrykowski, 2004).

In short, the increase of customer empowerment boosts customer co-creation, once it motivates the costumers to be active players within the NPD process, alongside with the firm, also developing their NPD knowledge and skills, as well as connecting them with communities of likewise proactive co-creators.

Furthermore, the new paradigm of customer co-creation (and the technologies to enable it) is considered, according to the Marketing Science Institute (2018), as a top research priority for 2018-2020, apace with the importance of exploiting and using customer-generated solutions, as evidenced by numerous leading innovation researchers and practitioners, namely, Prahalad and Ramaswamy (2004), von Hippel (2005), Evans and Wolf (2005), Seybold (2006), O'Hern and Rindfleisch (2010), among others.

For the theoretical and empirical part to be integrated, two typologies of co-creation will be considered, since both justify the use of the Community Innovation Survey (CIS) – 2016, allowing the empirical study to be performed with CIS secondary data, since that data are validated by Eurostat, providing a trustworthy means to feed the research, which is prospectively crucial for the collection of results after the analysis with econometric models and, ultimately, to sustain the research and generate answers to the problem defined in this chapter.

3. Literature Review

Chronologically, the concept of innovation has undergone considerable changes. Schumpeter firstly defined the concepts of economic development and entrepreneur as the actor responsible for innovation. In this sense, all the market entities embraced the linear and producer-centered models of innovation. In the late 70's, the rise of the interactive innovation model disrupts with the linear models, coincidentally with the foundation of the user innovation model. Further, the open innovation model also reinforces the importance of non-linear models. In spite of companies having evolved into non-linear models of innovation, the management of information still persisted producer-centered. This problem is addressed by co-creation, which significantly arose in the beginning of the XXI century, a descendant of open innovation, however with a customer-centered management of information.

3.1. Definition and characterization of innovation

In 1912, Schumpeter conceptualized innovation as a “Creative Destruction”, capable of developing new and better productive combinations. According to this point of view, an innovation can be seen as a new use of existing possibilities and components (Schumpeter, 1934). It's important to note that innovation is increasingly deemed as central to the development of a company, requiring it to innovate, not only to evolve prosperously, but also to be able to survive and persevere in the market (Cefis and Marsili, 2006; Ahlstrom, 2010).

Schumpeter (1934:66) resorted to five cases to justify and support the definition of the concept of Innovation: “(1) The introduction of a new good – that is one with which consumers are not yet familiar – or a new quality of a good. (2) The introduction of a new method of production, that is one not yet tested by experience in the branch of manufacture concerned, which need by no means be founded upon a discovery scientifically new and can also exist in a new way of handling a commodity commercially. (3) The opening of a new market that is a market into which the particular branch of manufacture of the country in question has not previously entered, whether or not this market has existed before. (4) The conquest of a new source of supply or raw materials or half-manufactured goods, again irrespective of whether this source already exists or whether it has first to be created. (5) The carrying out of the new organization of any industry, like the creation of a monopoly position (for example through trustification) or the breaking up of a monopoly position.”

According to Drucker (1997:35), “Innovation is the specific tool of entrepreneurs, the means by which they exploit change as an opportunity for a different business or a different service. It is capable of being presented as a discipline, capable of being learned, capable of being practiced.”

It was stated by the OECD (2005:46) that “an innovation is the implementation of a new or significantly improved product (good or service), or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations.”

Later, the OECD (2009:11) also asserted that “innovation is broader than R&D, firms perform both technological and non-R&D-based innovation”, namely, marketing and organizational innovation, encompasses a wide range of activities.

Therefore, one may observe that, despite the extant different definitions of innovation, it results from internal and external interactions between different agents, the sharing of ideas and information, creativity, new management practices and methods or from other externally originated factors regarding the companies.

In this research, innovation will be considered as the result of an interactive learning process, covering both the interaction between producers and users (Lundvall, 1992), along with the interactions between companies and other knowledge providers, such as universities and higher education institutions, consultants, commercial laboratories and research and development (R&D) centers, state laboratories and governmental R&D institutes, as well as the interaction between other agents (Lundvall, 1992; Kaufmann and Tödtling, 2001; Silva et al. 2012; Srholec, 2015). Hence, innovation is perceived as the result of an interactive process between the company and its surrounding environment and results from the collaboration between many agents, both inside and outside the company (Silva and Leitão, 2009; Srholec, 2015).

The term “entrepreneurial innovative capability” was adopted by Silva (2003) to integrate the components that result from the company’s innovation process and encompasses the result of four different forms of innovation. According to the Oslo Manual (OECD, 2018), those forms may be categorized as follows: (i) product innovation, (ii) process innovation, (iii) organizational innovation and (iv) marketing innovation. For the purpose of this research, the concept of product innovation, defined as “a new or improved good or service that differs significantly from the firm’s previous goods or services and that has been introduced on the market” (OECD, 2018; 18), is also registered.

Furthermore, it is also pertinent to remark the Portuguese academic community interest with regard to the thematic of innovation. Since the early 90’s, several authors performed studies on innovation (Godinho, 1990, 1993; Fontes, 1995; Laranja, 1995; Laranja, Simões and Fontes, 1997; Simões, 1997; Godinho, Sousa and Carvalho, 1998; Baptista, 2000; Conceição and Ávila, 2001; de Faria, Lima and Santos, 2010; Baptista and Mendonça, 2010; Baptista and Preto, 2011; de Faria and Mendonça, 2011; Preto and Guerreiro, 2015; Fonseca, de Faria and Lima, 2019; Mendonça and Reis, 2020).

3.2. Theoretical Approaches regarding Innovation

With respect to the management literature, the study of innovation has evolved over time, with the goal of allowing companies to attain higher levels of performance and competitiveness.

Analyzing the innovation literature, it appears that the research focuses mainly on the study of the innovation process and dynamics (Sarkar, 2014), although there are several approaches in the literature (Baregheh et al. 2009).

At an early stage, the study focused on the relative importance of the science and market components, having latter evolved to the importance of other factors, related to the innovation process, the systemic perspective of innovation and open innovation.

3.2.1 Schumpeter's Theses

Schumpeter's theories on innovation and technological change have influenced theoretical and empirical research on innovation, since they've been conceived till the current time (Hospers, 2005; Aghion, 2017; Fagerberg, 2018).

Schumpeterian literature presents two important phases, starting in 1912 with the assumed positions in "The Theory of Economic Development", whose central focus is on the individual action of the entrepreneur. The author highlights the relevance of the innovative entrepreneur, whose core function is to innovate, hence being the agent of "creative destruction". According to this point of view, economic development is particularly motivated by innovation, through a permanent process of innovation, that generates successive imbalances in the economic system, leading it to new processes of innovation (Adler, Florida, Kind and Mellander, 2019).

The second phase took place in 1942 with the book "Capitalism, Socialism and Democracy", in which the origins of innovation continue to be attributed to the entrepreneur, not as an individual but collectively. In this regard, Schumpeter underlines the importance of R&D in technological progress as a key driver of innovation.

3.2.2 Linear Models of Innovation

Schumpeter's theses had impact on the following two approaches that emerged, in which the focus of the innovation process is centered on the relative importance of the "science" and "market" components. The two aforementioned approaches are as follows:

Technology push or science and technology push describes innovation as a linear process, driven by scientific discoveries, ensuring that innovation is based on scientific knowledge with commercial potential (Silva, 2003). Chronologically, it was the predominant approach until the mid '60s and emphasizes Research and Development (R&D) activities, where the market is not a driver of any stimulus (Silva, 2003). This linear model depicts the cause-and-effect relationship between science and technology, according to a sequential and orderly process in which, starting from scientific knowledge and through various stages, namely, applied research,

invention, development, production and innovation, a product or process which might be viable in commercial terms is marketed (Barrau, 2000; Marques and Monteiro-Barata, 2006).

Market-pull or demand-pull innovation, an approach where it is considered that demand is what creates the stimulus for innovation (Silva, 2003), takes on dominance after the mid '60s. Thus, the process arises from a market need or opportunity, detected and explored by the innovative company (Barrau, 2000). One of the main supporters of this approach was Schmookler (1966); this author highlights the role of the market in the innovation process (Marques and Monteiro-Barata, 2006; Küster and Vila, 2011).

In short, despite the existing divergences, both approaches fit in the linear conception of Innovation, a strong tendency until the emergence of a more interactive view of innovation.

The rupture with the linear model happened due to the fact that many authors found several limitations in it, namely the overemphasis on research and development; the division into isolated, sequential and ordered stages, giving the model an unidirectional nature, omitting interaction and feedback (Silva, 2003) as well as the arbitrary division of a continuous and evolutionary process (Marques and Monteiro-Barata, 2006).

3.2.3 Interactive Innovation Model

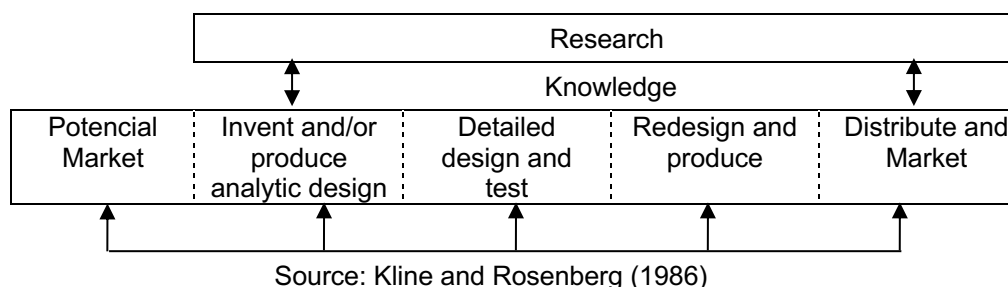
The late 1970s are defined by the rupture of the traditional and linear perspective of innovation, with the emergence of the interactive innovation model (Lundvall, 2007). Supported by authors such as Freeman (1979), Nelson and Winter (1982) and Kline and Rosenberg (1986), this view regards the scientific and technological opportunities, in combination with the emerging economic needs of the market and society, as key drivers of innovation (Silva, 2003).

Innovation as a process is seen as interactive, focused on companies, more specifically in the different phases of the production process, namely: idea generation, design and development, engineering and production, marketing, and distribution. Among the phases, several feedback processes are produced, which will interrelate with the different agents of the scientific and technological systems (Barrau, 2000).

Throughout the 1980s, studies on the development and success of new products from the Japanese business case gave rise to the first integrated models (Marques and Monteiro-Barata, 2006). At that time, with the development of systematic studies, it was possible to demonstrate that the linear model is characterized as a simplification of the process (Marques and Monteiro, 2006), which also does not reflect innovations' nature nor its different factors.

The facts mentioned above were highlighted by evolutionists who stated that: (1) there is interaction between companies' technological strategies and market selectivity mechanisms; (2) innovation is characterized as a cumulative process in which various production and usage learning mechanisms stand out, referred to as, respectively, *learning by doing* and *learning by using*; and (3) technological progress is determined by the companies' R&D effort as well as by the State. As an example of interactive innovation models, the chain-linked innovation model of Kline and Rosenberg (1986) is presented in figure 1:

Figure 1 - Chain-linked Innovation Model



This model relates two different types of interaction: the first refers to the internal process of the company, known as the Value Chain; the second one regards the relationships established between companies and the science and technology system, in addition to other companies, like suppliers, customers and competitors (Marques and Monteiro-Barata, 2006). Thus, innovation is characterized by this model according to the interactive learning processes that usually occurs within the company's boundary, in the Research and Development department, and also between it and the upstream activities, regarding the suppliers or, downstream activities, in terms of the marketing and distribution, industrial customers and end consumers (Silva, 2003).

The model takes into account some external factors that contemplate the innovation process, having the limitation of not deepening them, a situation that was addressed by the Systemic Approach, which emerges in the late 80s, that will be presented as it follows.

3.2.4 Systemic Approach of Innovation

In the mid 80's the development of the systemic perspective of innovation took place, with the intervention of authors such as Nelson and Winter (1982), Freeman (1987), Lundvall (1992), Nelson and Rosenberg (1993), Edquist (1999), Cooke et al. (1997), Mytelka (2000) and Kaufmann and Tödtling (2001), who added multiple factors regarding the analysis of innovation, namely institutional organization, history, and culture (Silva, 2003). According to these authors, the systemic approach points to innovative capacity as a result of the process of interaction between companies and their surrounding environment, highlighting the learning synergies intrinsic to the economic system and the stimulus of the innovation support institutions (Silva et al. 2008).

The theoretical foundations of the Systemic Approach to Innovation were, according to Lundvall (1992), influenced by different theories of innovation, especially the structuralist-evolutionary theory and the theory of interactive learning. Both theories point out four key elements in innovation activities: (1) bilateral process, with feedback and interactions at different stages; (2) systemic nature, dependent on the participation of other agents/actors; (3) the company's positioning in the innovation network is essential to its performance; (4) there are systemic differences regarding geography (Maggioni et al. 2007; Fitjar and Rodríguez-Pose, 2013).

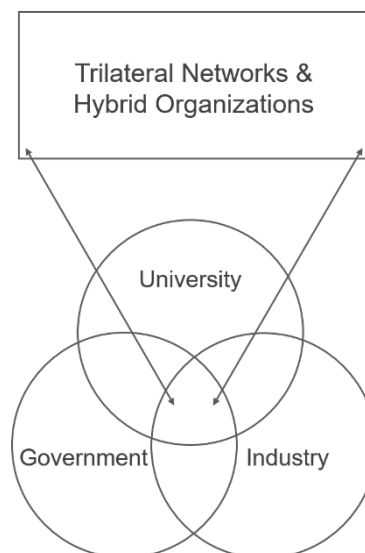
The Innovation System is characterized as a network of economic agents, alongside with the institutions and policies that influence their innovative behavior and, consequently, their performance (Lundvall, 1992, Nelson and Rosenberg, 1993, Mytelka, 2000, Hu et al. 2014).

According to Mytelka (2000), the behavior of local actors in the innovation process is analyzed by the Innovation System approach through: (1) relationships; (2) investments; (3) learning. The author further outlines that, within the system, we have suppliers, customers, R&D institutions and financial institutions, which interact and are part of a complex system at a national and international level. The key role that entities such as universities, information offices, training centers, banks and other financial institutions play in innovation is, therefore, noteworthy (Carvalho et al. 2015).

On the other hand, Kaufman and Tödtling (2001) consider that there is not one and only one specific Innovation System, but multiple social systems regarding actors, rules and objectives that are part of the innovation process; the authors claim that there are at least three different social systems: (i) the business system, which is profit-oriented and communicates via the price mechanism; (ii) the science system, that aims at the production of knowledge and communicates via publications; and (iii) the political system: the role of the regulator, widespread by legislation.

Henry Etzkowitz and Loet Leydesdorff introduced, in 1996, the Triple Helix Model (figure 2); this explicitly represents the aforementioned systems and their inherent functioning, taking into account the relationships, links and synergies between three distinct types of actors: University, Government and Industry.

Figure 2 - Triple Helix Model



Source: Adapted from Etzkowitz e Leydesdorff (2000:111).

The analysis of the previous figure establishes the existence of a knowledge infrastructure that originates hybrid organizations at their intersections.

The Triple Helix Model demonstrates not only the relationships between university, government, and industry, but also the internal transformations that occur within the various spheres (Etzkowitz and Leydesdorff, 2000). Through this model, the importance of bringing together these three distinct actors in economic activities to promote national or even regional development was studied, in which University plays a central role in the context of a knowledge-based economy (Etzkowitz and Leydesdorff, 2000; Marques et al. 2006), although, in some cases, there is evidence of the role of companies, especially the foreign direct investment (Strand and Leydesdorff, 2013).

The identification and recognition of different types of systems and their differences between countries, in terms of economic structure, institutional specificities and knowledge base (Kaufman and Tödtling, 2001), led to the employment of the concept in different dimensions or levels. Regarding their scope, systems can be characterized as national, regional, technological innovation systems and sectoral innovation systems (Carlsson et al., 2002; Marques and Monteiro-Barata, 2006). These conceptualized subdivisions lead to some issues regarding the analysis of the literature, related to the search for the appropriate level to the study and to the delimitation of the geographical, sectoral or time period (Carlsson et al., 2002).

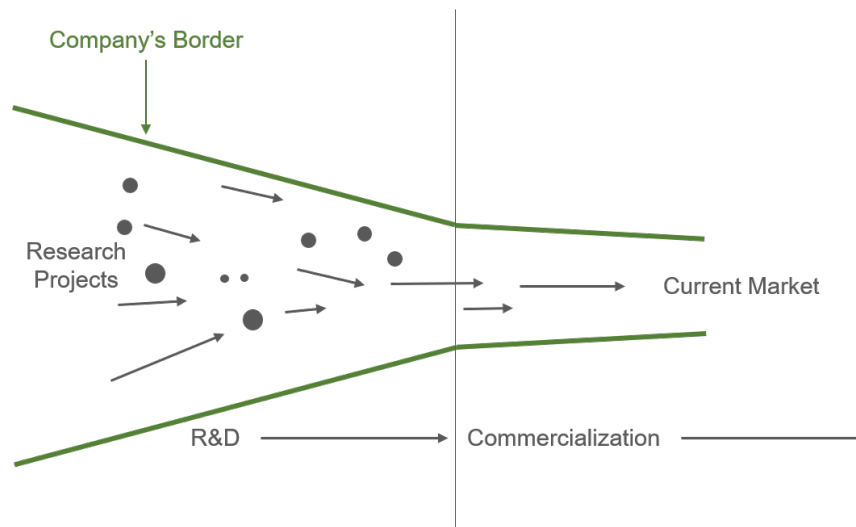
Over time, there has been a gradual increase in the importance of the systemic characteristics of innovation, focusing on levels beyond the aforementioned, which consequently gave rise to other alternatives regarding their type of analysis. In the present research, those would not be explored, since the open innovation model presented later, fits as the appropriate model to support co-creation.

3.2.5 Open Innovation Model

As presented in Chesbrough's definition (2003: xxiv), the "Open Innovation" model differs from the Closed Innovation model (figure 3), by focusing on in-house research, as well as in internal knowledge development. The innovation processes, namely, generation, development, and commercialization of ideas, are controlled internally by the company (Chesbrough, 2003; Chesbrough et al. 2006; Chesbrough, 2007; Vrande, et al. 2009; Gassmann et al. 2010).

According to OECD (2008:24), "the innovation literature has long recognized that companies do not innovate in isolation but co-operate with external partners throughout the innovation process". In addition, "the novelty of the concept of "open innovation" lies within the fact that it emphasizes not only the importance of knowledge sourcing but also to the exploration of internal innovation together with external partners (the so-called inside-out process)" (OECD, 2008:24).

Figure 3 - Closed Innovation model



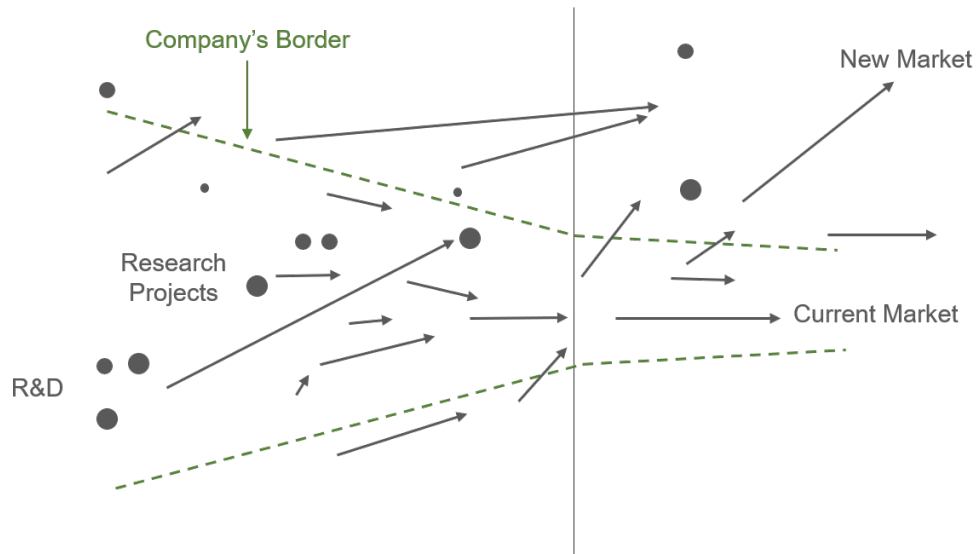
Source: Own elaboration based on Chesbrough (2003:35).

The closed innovation model reveals a strong isolation of the institution regarding its surrounding environment.

Chesbrough (2003) presents an antagonistic model, called the open innovation model. According to its perspective, the author defines the concept stating that “open innovation is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to markets, as the firms look to advance their technology. Open innovation combines internal and external ideas into architectures and systems whose requirements are defined by a business model” (Chesbrough, 2003: xxiv).

According to Gassmann (2006), the open innovation model seeks to highlight the fact that companies are increasingly relying on outsourcing of R&D for the development of new products and services and from outsourcing R&D companies, such as technical service providers like engineering firms and high-tech institutions.

Figure 4 - Open Innovation model



Source: Own elaboration based on Chesbrough (2003:37).

Thus, it is appropriate to introduce, according to table 1, the main differences between the two innovation models presented by Chesbrough.

Table 1 – Closed vs Open Innovation model

Closed Innovation Model	Open Innovation Model
The intelligent individuals in our area of expertise work for us.	Not all intelligent people work for us; therefore, we must find and explore brilliant external individuals regarding knowledge and expertise.
To profit from R&D, we must discover, develop, and commercialize for ourselves.	External R&D can create significant value; Internal R&D is required to demand part of that amount.
If we discover it ourselves, we will get it to the market first.	We don't have the source of research in order to profit from it.
If we are the first to commercialize an innovation, we will win.	Building a good business model is better than being the first to hit the market.
If we create more and better ideas in the market, we will win.	If we make better internal and external use of ideas, we will win.
We must control our intellectual property so that our opponents do not win with our ideas.	We must benefit from others who use our intellectual property, as well as buy intellectual property from others, whenever it promotes our business model.

Source: Adapted from Chesbrough (2003:38)

Open innovation allows organizations to create conditions in order to adapt to the surrounding environment, have access to new markets, develop new knowledge, share and/or complement resources and develop greater responsiveness and flexibility, thereby enabling a healthy and sustainable competitive advantage (Bogers, Chesbrough and Moedas, 2018; Chesbrough, Lettl and Ritter, 2018). The open innovation model aims to achieve a more global perspective, as well as a more thorough perspective on innovation, both generated within and outside organizations, as to increase their innovation capacity.

3.3 User Innovation

This chapter includes two subchapters. The first one is allusive to the definition of user innovation. The other is respecting to the lead user theory and the toolkits for innovation, both from user innovation. Information on these concepts is important, once they will be latter integrated in the typologies for co-creation, particularly in Piller, Ihl and Vossen's one (2011). This typology considers user innovation as a particular procedure to perform co-creation, between the lead users and the firms, through the toolkits for user innovation.

3.3.1 User Innovation definition

As was depicted previously in the present research, in the beginning, ever since Schumpeter's conceptualized the economic development and the entrepreneur as the agent responsible for Innovation, all the entities comprised by the market in general, like the State, business managers and even economists, faced innovation adopting the linear models, which were producer-centered (Baldwin and von Hippel, 2011). The rupture with those linear models arose in late 70's, with the emergence of the Interactive Innovation model, also being coincident, chronologically, with the beginning of von Hippel's theory on innovation.

Likewise, the Open Innovation model (Chesbrough, 2003, 2006), von Hippel's study regarding User Innovation (1976, 1986, 2005) also challenged the traditional producer-centered linear models of Innovation (Bogers and West, 2012). While the latter was driven by the homogeneous needs of a particular market segment's customers, in order to benefit from economies of scale, aligned with the "solution" information, i.e., the information that regards the proficiency to transform needs into new offerings, user innovation positions itself differently. User innovation is driven through the users' heterogeneous and intrinsic needs, that constitutes the "need" and "sticky" information, which is complex and costly to transfer between individuals due to their different know-how, knowledge and context of usage of the information they possess (von Hippel, 1994; Lüthje, Herstatt and von Hippel, 2005; de Jong and von Hippel, 2013).

Any innovation involves both the "solution" information from the companies, as well as the "need" information from users (Nambisan, Agarwal and Tanniru, 1999). However, the "need" and "sticky" information from users is vital for an innovation to succeed. This type of information is required to accurately recognize the heterogeneous and specific needs of the users and, further, satisfy them through services or products (Cooper, 1993). In this sense, the "need" information must be gathered by the companies in order to contribute to their innovation process (Piller, Ihl and Vossen, 2011).

The research from Fredberg and Piller (2008), pointed out both the impact of user integration for enhancing the innovative performance and the different roles that users might assume within the innovation process. Moreover, von Hippel (1986), Urban and von Hippel (1998), Gruner and Homburg (2000) and others, went further stating that contributing users must have peculiar characteristics and hence, not all are suitable to intervene in the innovation process. This fact was in the origin of the emergence of von Hippel's lead user theory (1986), which

represents the central agent of user innovation, the type of user who is gifted with two unique characteristics, which allow her/him to properly contribute to the innovation process, which will be presented as follows.

3.3.2 Lead User Theory and Toolkits for User Innovation

Von Hippel (1986) defined “lead users” as an integrant part of a user population; however, they distinguish themselves from the regular user due to two distinctive characteristics: “(1) They are at the leading edge of an important market(s) trend, and so are currently experiencing needs that will later be experienced by many users in that market; (2) They anticipate relatively high benefits from obtaining a solution to their needs, and so may innovate” (von Hippel, 2005:22).

Beyond quantitatively research applied in different and several market segments, performed by Enos (1962), Freeman et al. (1968), Pavitt (1984), Urban and von Hippel (1988), that pointed out the impact that individual users and user companies have in the development of new products (von Hippel, 2005). Empirical studies of Urban and von Hippel (1988), Herstatt and von Hippel (1992), Franke and von Hippel (2003), Franke and Shah (2003), Lüthje et al. (2005), went further, uncovering that the generality of the products or product modifications and also the most attractive ones to the market, are developed by user-innovators with “lead user” characteristics (von Hippel and Katz, 2002; von Hippel, 2005).

Von Hippel (2005) also adds that the “need” information that lead users produce originates from personal needs that they experienced by themselves, non from others, as well as, lead users’ needs arises mostly from performing activities in which they are experts and highly specialized. Due to these facts, this type of user-innovators is more likely to origin information regarding technical issues, as lead users tend to develop functionally new innovations at the leading edge of markets (von Hippel, 2005), rather than non-technical or even aesthetics innovations.

User Innovation possesses a customer-centric perspective, being the lead users the producers and the sources of need information regarding a possible solution, which might be translated by them in the creation of an innovation, hence assuming the role of an innovator. Regarding this, and to companies outsource need-related innovation assignments for the users, von Hippel (2005) proposed the toolkits for user innovation and custom design. These, which must be specific and properly assigned by a company to its users, are constituted by sets of “user friendly” design tools that enable the development of new innovative products or services by users themselves (von Hippel and Katz, 2002; von Hippel, 2005), as well as the transference of those innovations from the customer to the company, in an efficient way (Piller, Ihl, Vossen, 2011).

3.4 Co-creation

This chapter holds seven subchapters with respect to the main topic of the study, co-creation. To begin with, definitions are provided. Afterwards, the rationale that sustains co-creation as an integrant part of open innovation is presented. In the third subchapter, the rising of co-creation, as well as the role that the customer assumes within this recent model of innovation are explored. The fourth subchapter regards the premises that the seminal authors of co-creation established; these are fully mandatory, in order for the process of co-creation to be valid. The fifth and sixth subchapters cover two typologies for customer co-creation, respectively, which will be vital to justify and validate the use of Community Innovation Survey (2016) in the present study. Finally, in the last subchapter, the Research Hypothesis will be presented.

3.4.1 Co-creation Definition

In the present work, in accordance with Prahalad and Ramaswamy (2004), two considerations are made: (1) the terms “customers”, “consumers” or “users” are used interchangeably, throughout; (2) the term “offering” is used to designate both products and services, once the concept of co-creation is equally applicable either to “products” or “services”, despite their conventional distinctions.

The seminal authors, Prahalad and Ramaswamy (2004:8), stated that “Co-creation is about *joint* creation of value by the company and the customer, creating an experience environment in which consumers can have active dialogue and co-construct personalized experiences; product may be the same, but customers can construct different experiences”. In other words, co-creation stands for innovating with users rather than to users, assuming their active participation in the innovation process (Auh et al. 2007; Prahalad and Ramaswamy, 2004; Vargo and Lusch, 2004; Martovoy and Dos Santos, 2012).

According to Martovoy and Dos Santos (2012), the aforementioned entails the reconsideration of the customers’ role in the development of innovation; once integrated in the latter, companies enhance their ability to listen to customers and respond to their specific needs, leveraging the competitive advantage of such companies. Prahalad and Ramaswamy (2004) also stated that the interactions between consumers and companies in order to co-create exclusive experiences, are the path to unlock novel competitive advantage's sources.

Co-creation shifts the paradigm regarding the economical concept of value. According to Prahalad and Ramaswamy (2002), the concept’s view is “consumer-centric”, being opposable to the traditional “company-centric” view. In the latter: the consumer is apart from the value creation process; the methods and structure of the process of value creation are decided by the company; there is solely one point of exchange, controlled by the company, that serves its main purpose and objective, which is to extract value in the form of money from the costumers.

In the “consumer-centric” view: the costumer plays an active and key role, being able to influence the methods as well as the structure of the value creation process; the main objective

is to create value for both parts, customer and company and, for that purpose, there are multiple points of exchange where the aforementioned parts can jointly co-create value. (Prahalad and Ramaswamy, 2002, 2004).

While, traditionally, suppliers produced offerings and customers purchased them, currently customers are able to dialog with suppliers in every step of the product design and product delivery, a kind of engagement that can be seen as an interactive process of learning for both parts (Ballantyne, 2004). The consumer and the company jointly create value through the co-produced offerings, being this co-creation of value a useful objective that a company can rely on, regarding the gathering of knowledge, since it highlights the customers' point of view, it improves the company's process of identifying customers' needs and wants (Lusch and Vargo, 2006; Payne, Storbacka, Frow, 2008).

Vargo and Lusch (2004) identified customer co-creation as a central premise regarding the marketing's new service-dominant logic, also known by the acronym S-D logic. The authors' S-D logic rests on a key assumption that resources do not own value *per se*; instead, the value is co-created with costumers when resources are used; S-D logic's value-creation process occurs when the value is co-created with the customer during interaction with and activation of a set of resources (Vargo and Lusch, 2004, 2008; Payne, Storback and Frow, 2008; Edvardsson et al. 2011). So, service-dominant logic attributes importance to the value-creating processes that involve the customer as a co-creator of value (Lusch and Vargo, 2008; Payne, Storbacka and Frow, 2008).

On that account, S-D logic regards both goods and services as the central resources to be used within the service provision, which means that the customers access the experience of goods and services regarding the value-in-context and, consequently the exchange of value is no longer solely attached to the transaction alone (Lusch and Vargo, 2008; Edvardsson, Tronvoll, Gruber, 2011). Further and according to Vargo and Lusch (2004) and O'Hern and Rindfleisch (2010), customer co-creation is considerably related with S-D logic, once the latter requires that collaboration with customers occurs, creating value both through the stimulation and enhancement of customer learning, as well as through the extraction of the service-based benefits ingrained in products.

O'Hern and Rindfleisch (2010) also state that there are several forms of customer co-creation, which they define as collaborative New Product Development activities, in which consumers are imperative in the process of NPD, assuming an active participation in terms of contribution and/or selection of the content of a new product offering. Piller, Ihl and Vossen (2011) also present a typology for customer co-creation and conclude the importance of consumers for the process of NPD.

Despite the aforementioned topic's literature being scarce, the evidence gathered so far points out that customer co-creation is positively related to many NPD metrics, namely, increased new product creativity, decreased time to market and reduced development costs (von Hippel, 2005; Grewal, Lilien, and Mallapragada, 2006; Shah 2006; O'Hern and Rindfleisch, 2010).

3.4.2 Co-creation as part of Open Innovation

Co-creation is an integrant part of the open innovation concept, so that the latter considers that the internal use of external knowledge and the external use of internal knowledge enhances a company's innovation and its market expansion (Chesbrough et al. 2006; Martovoy and Dos Santos, 2012).

Currently, we experience a very competitive and complex market, an environment where companies should present novel approaches both to innovation and product development, in order to survive and/or grow. New Product Development arises as the most important process, as well as a main source to a company leverage competitive advantage (Papageorgiou, Efstathiades and Milikouri, 2017).

NPD process *per se* is difficult to manage due to the complexity of customers' needs, as well as the difficulty in collecting and identifying those through traditional marketing methods (von Hippel, 2005). According to Ogawa and Piller (2006), the company's failure in assessing and satisfying its own customers' needs is one of the main reasons for unsuccessful penetration of a new product in the market. A solution to this problem is attaching the concept of open innovation, especially, co-creation in the NPD Process, so that new products can be co-created to meet both customers' requirements and needs, enhancing the chances of success for the company (Hoyer et al. 2010; Papageorgiou, Efstathiades and Milikouri, 2017).

Furthermore, the importance of exploring and using customer-generated solutions has been evidenced by numerous leading innovation researchers and practitioners, namely Prahalad and Ramaswamy (2004), von Hippel (2005), Seybold (2006), O'Hern and Rindfleisch (2010).

3.4.3 The rising of customer co-creation and the role of the customers

In order to succeed at NPD, two types of information are required: (1) information regarding customer needs and (2) information that allow to best fulfil the aforementioned needs (Thomke and von Hippel, 2002; von Hippel 2005, O'Hern and Rindfleisch, 2010). The most precise and detailed knowledge for the first type of information is generally owned by the costumers, while for the second type of information, the same happens to the companies (manufacturers or providers, for products and services, respectively). This disparity regarding knowledge generates a condition of information asymmetry (von Hippel, 2005).

Traditionally, companies have benefited from exploring the information asymmetry between them and the individual customer, before the rising of the costumers' empowerment, which was enhanced by technological advances which able them to be networked, active and informed (Prahalad and Ramaswamy, 2004).

Furthermore, companies tried to manage this asymmetry by resorting to numerous marketing research methods to collect accurate information regarding their customers' needs.

Von Hippel (2005) states that those methods mostly provide customers' *low fidelity* needs and/or wants, while costumers have *high fidelity* needs, which are complex and, according to Franke and Piller (2004) and Simonson (2005), idiosyncratic, being hard both to measure and properly implement. Therefore, most of new product failures are pinned on the company's inability to precisely evaluate and satisfy customer needs (Ogawa and Piller, 2006; O'Hern and Rindfleisch, 2010). In order to address the information asymmetry condition, Thomke and von Hippel (2002), von Hippel (2005) and von Hippel and Katz (2002) offered means to solve it, providing customers with tools and information that capacitate them to integrate the NPD process proactively.

The notorious growth regarding the involvement of customers in the Co-creation's logic of value creation is due to the phenomenon of costumers empowerment.

Prahalad and Ramaswamy (2002:7) exploited the latter in *The Five Powers of the Connected Consumer*: "(1) information access: with access to unprecedented amounts of information, consumers have knowledge to make much more informed decisions; (2) global view: the internet is the first single source of information that gives consumers the ability, 24h hours a day, to see what is happening around the world; (3) networking: consumers naturally coalesce around common skills, interests, and experiences. The internet amplifies this by encouraging an unparalleled ease and openness of communication of communication (...) The power of consumer networks is that they're independent and based on real consumer experience, not what the company tells them they will experience; (4) experimentation: consumers use the Internet to experiment with and develop products... The ability of consumers to experiment with each other goes beyond software and digital products; (5) activism: now consumers provide unsolicited feedback to companies and each other."

This empowerment of costumers and the growing number of customers as active players in the value creation process, in opposition to the traditional NPD paradigm and the "company-centric" view, is also being enhanced by:

(i) the recent cultural developments, such as, the users' growing distrust and skepticism regarding marketing communications, the increased news coverage of corporate scandals (e.g. Equifax, Facebook, Volkswagen, Banco Espírito Santo), documentaries of big business and anti-corporate websites, which also snowballed other active forms of costumers resistance, like brand avoidance and culture jamming (Klein, Smith and John, 2004; Kozinets and Handelman, 2004; O'Hern and Rindfleisch, 2010).

(ii) the act of consumption itself does not totally fulfill customers' needs (O'Hern and Rindfleisch, 2010) as well as, according to Prahalad and Ramaswamy (2004), customers *per se*, who are experiencing a market filled with a broader range of offerings than ever before, still feel not completely satisfied. Cognitive psychology points out that, in order to satisfy deep-rooted psychological needs, creative contributions are more effective (Csikszentmihalyi, 1996), rather than the notion of material objects *per se*. As a result, customers, as co-creators, may experience and collect psychological benefits that consumption by itself cannot offer and fulfill (Pietrykowski, 2004).

In conclusion, the increase of customer empowerment enhances customer co-creation since it motivates the costumers to play an active role in the NPD process jointly with the company, also developing their NPD knowledge and skills, in addition to connecting them with proactive communities of likewise customers and co-creators.

3.4.4 Building Blocks of Interactions for Co-creation of Value

Prahalad and Ramaswamy (2004) proposed a system for co-creation of value, based on building blocks of interactions that occur between the company and the costumers, in order to facilitate the co-creation experiences. The building blocks entail four elements: *dialog*, *access*, *risk-benefits* and *transparency*, which form the acronym DART.

Dialog infers interactivity and engagement in order to enable an active two-way equally connection, with the goal of developing a joint solution between problem solvers, the company and the costumer. Rules of engagement must be defined, *access* and *transparency* to information in both sides must be preserved, being essential to a meaningful dialogue, as well as mandatory, so that information asymmetry can be surpassed as well as, enabling the jointly process of value creation and making it trustworthy, beyond the traditional view. In addition, dialog, access, and transparency can clearly grant the costumer the ability to perform a risk-benefit analysis on the duality of action and decision they incur. As consumers become more involved with firms in the co-creating experience they jointly develop, and once the firms reveal more information regarding the risks related to their offerings, the costumers may be keen to deal with more responsibility regarding their own, inherent, exposition to the risk. (Prahalad and Ramaswamy, 2002).

Furthermore, by assessing the four dimensions of DART, companies can evaluate their institutional promptness, like whether their policies and structures allow them to perform activities towards strategic and successful value co-creation, jointly with their customers (Mazur and Zaborek, 2014; Taghizadeh, Jayaraman, Ismail and Rahman, 2016; Albinsson, Perera and Sautter, 2016).

According to Prahalad & Ramaswamy (2002), DART's premises should be respected in full, so that the co-creation experience for the creation of value, in the form of offerings, is valid. It is important to address this information, since both the typologies of customer co-creation presented as follows, however different, respect that.

3.4.5 Typology of customer Co-Creation (4 types)

According to O'Hern and Rindfleisch (2010:89) regarding the typology of customer co-creation, it is suggested that, at the early stages of developing a new product, two main distinct activities are required: "(1) the *contribution* of novel concepts and ideas, and (2) the *selection* of which specific concepts and ideas should be pursued."

Firms can co-create value with the customers, giving them space to both perform contributions to the NPD process, as well as for the selection of those contributions. With this in mind, the customers' degree of empowerment and autonomy throughout these two activities forms the conceptual basis of the typology.

O'Hern and Rindfleisch (2010) suggest that the way and procedure used by customers to input contributions for the New Product Development process, can vary from being totally fixed and predefined by the company, to being totally open. The selection process regarding those contributions can be defined either by the company or by the consumers themselves. When organized throughout two dimensions, the processes of contribution and selection origin four different types of customer co-creation (figure 5), namely: (1) *Collaborating*, (2) *Tinkering*, (3) *Co-designing* and (4) *Submitting*. These will be briefly explained below:

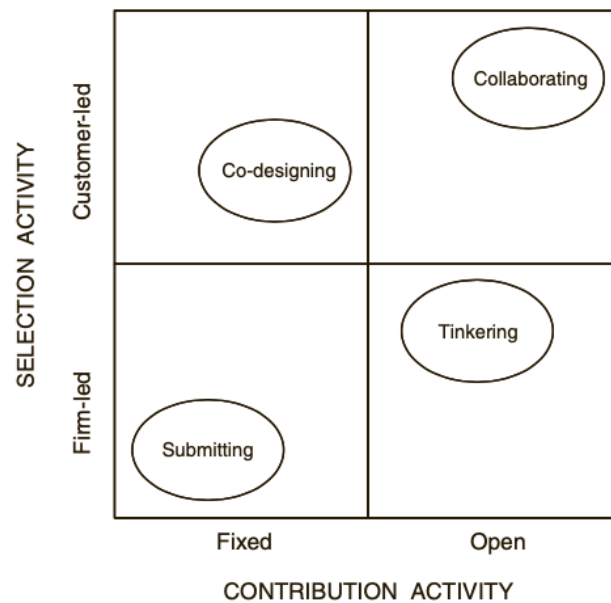
(1) *Collaborating*: open contribution and customer-lead selection; the users have the freedom to jointly develop and improve a new offering's core components and its subjacent structure (e.g., open software initiatives, namely, Linux, Firefox, Apache).

(2) *Tinkering*: open contribution and firm-lead selection; the users can make changes to a commercially available product and some of those will be incorporated into subsequent product releases (e.g. gaming industry, information-based products, open access to APIs).

(3) *Co-designing*: fixed contribution and customer-lead selection; a niche of users provides a company with new offering content or designs, while a larger group of consumers select which content or design should be adopted by the company (e.g., clothing manufacturer Threadless.com; online services and television, such as, Digg.com and Current TV, respectively).

(4) *Submitting*: fixed contribution and firm-lead selection; users send their ideas for the development of new products/services to a company. It is different from a traditional inquiry, in what concerns the customer's effort and the nature of the input provided to the company (e.g., companies' contests of design: Electrolux, Ducati Motors; brokers like InnoCentive, which posts companies' problems via website and allows users to submit solutions).

Figure 5 – Four types of customer co-creation



Source: O'Hern and Rindfleisch (2010:91).

This typology presents a solution for typifying the activities of co-creation with respect to the New Product Development, establishing a bridge between conceptual terms and the applicability of the CIS's questionnaire (CIS, 2016), in order to study co-creation as a key driver for innovation in the development of innovative offerings.

Analyzing CIS survey (CIS, 2016), regarding section H: "Participation of users in innovation activities and in the production of innovative products" (CIS, 2016:13-14), in particular the questions 10.1, 11.1 and 11.2, one may observe the compatibility between the "ways of including customers and/or users in innovation activities and the production of innovative products or services" (CIS, 2016:13-14) and the typology of co-creation presented. The only exception resides on the "information on users and customers, and developing understandings on their needs" (CIS, 2016:13), once that information was not necessarily used to the co-creation of innovative products or services, nor do the methods to gather that information from the users respect DART (Prahalad and Ramaswamy, 2002, 2004)

However, this topic will be further developed in chapter 3.4.7 "Value co-creation as a key driver for innovation in the development of innovative products/services", as well as in the chapter 4.2, referent to "Data Content: bridge between co-creation typologies and CIS".

It is also important to acknowledge that there are noticeably contrasting approaches regarding the qualification of users for co-creation: Kristensson et al. (2004), states that ordinary users are more able to generate original and valuable ideas, while Urban and von Hippel (1988), and Skiba and Herstatt (2009) suggest that the integration of lead users is more reasonable, as their ideas and efforts may lead to radical innovation. Despite that, for this typology, O'Hern and Rindfleisch (2010) did not consider lead users as a specific form of co-creation; however, they attest that lead users have an important role in specific types of co-creation.

3.4.6 Typology of customer Co-Creation (8 types)

According to the authors of this typology, there are three major extant approaches to gathering information from the customers for the purpose of the Innovation Process, which are different from each other, considering the degree of customer involvement. They are: (1) *“Listen into” the customer domain*, (2) *“Ask” customers* and (3) *“Build” with customers* (Piller, Ihl and Vossen, 2011:37).

The authors characterize the first and the second approaches as conventional, due to the use of traditional methods to identify customer information, such as feedback systems, market research and inquiries. Unlike the first two approaches, in which consumers still remain apart from companies in the innovation process, the third approach promotes an active consumer's involvement in the development of innovative products and services, jointly with the company.

Piller, Ihl and Vossen (2011:39) refer to *“Build” with customers* as the genus of Co-creation, defining the latter as the activities performed between the company and the customers, in which they assume an active role in the designing of offerings (Tseng, Kjellberg and Lu, 2003; Piller 2004; O'Hern and Rindfleisch, 2010; Piller and Ihl 2009).

Furthermore, customer co-creation is regarded as the junction of the customer centric perspective concerning the innovation process, sustained within a firm-driven strategy. The company is responsible both for promoting the interaction and providing the proper tools to customers, so they are provided with the conditions to co-create innovative offerings with the firm. Here, the position of those firms diverges from the firms that innovate under User Innovation, which merely assume the task of identifying and capturing lead user's innovations, being user centered, even strategically. Besides, and since Piller, Ihl and Vossen (2011) goals are also related to the enlargement of the information pool regarding need, authors recognized the importance that lead users, as per von Hippel's lead user theory (1986), have, due to their special characteristics, in the innovation process, including them in it for the sake of the need information they possess.

Therefore, Piller, Ihl and Vossen (2011) present a holistic typology sustained in co-creation as a multidimensional approach, a new point of view of open innovation. This approach is set on the collaborative ways of participation that customers can assume in the innovation process, which is promoted by an explicit firm strategy concerning open innovation.

This research acknowledges that, since this typology's terms are very specific and, in order to make it more perceptible and clearer, it will be summarized but explained according to Piller, Ihl, Vossen (2011:40-50):

The typology is *“Build”* under “three characteristics that form the conceptual dimensions of possible settings for co-creation with customers” (Piller, Ihl and Vossen, 2011:40), namely:

- I. *Stage in the innovation process*: “refers to the time when customer input from co-creation activities enters the NPD development, i.e., whether customer input enters early in the front end stages of the process (idea generation and concept development) (figure 6) or whether it enters later in the back-end (product design and testing) (figure 7).”
- II. *Degree of collaboration*: “refers to the structure of the underlying relationship in an open innovation setting, i.e., whether there is a dyadic collaboration between a firm and one customer at a time or whether there exist networks of customers who collaborate among themselves more or less independent from the firm”
- III. *Degrees of freedom*: “refers to the nature of the task that has been assigned to customers, i.e., whether it is a narrow and predefined task with only a few degrees of freedom or whether it is an open and creative task for which a solution is hardly foreseeable because of many degrees of freedom.”

Those three dimensions form eight types of customer co-creation, specifically:

Dyadic, single customer, co-creation at the front end, includes:

1. *Idea contest*: firms looking for information on innovation, requests to a population of independent users to submit solutions or designs for a given assignment, within a given deadline.

Stage in the innovation process: front end

Degree of collaboration: dyadic

Degrees of freedom: high

2. *Idea screening and evaluation*: users are responsible for the selection of ideas as well as for pointing out those that are more attractive.

Stage in the innovation process: front end

Degree of collaboration: dyadic

Degrees of freedom: low

Network, community, based co-creation at front end, includes:

3. *Product-related discussion forums*: users discuss their experiences regarding the use of a product and then assist other users (in the use of the same product)

Stage in the innovation process: front end

Degree of collaboration: network

Degrees of freedom: low

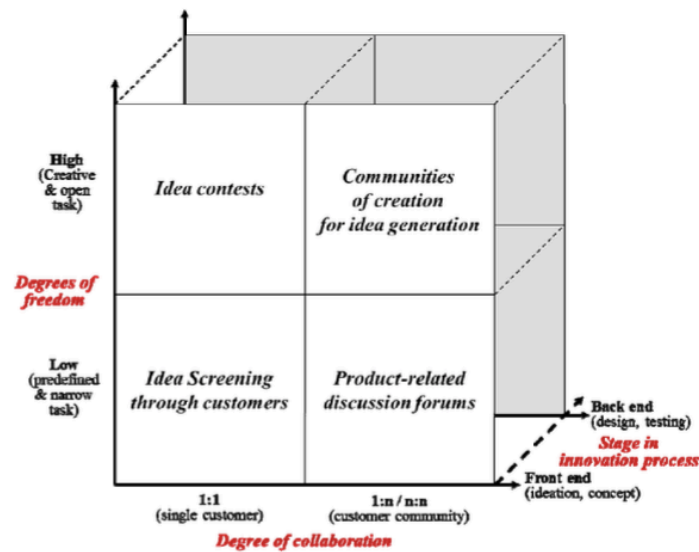
4. *Communities of creation for idea generation*: generate new ideas and concepts

Stage in the innovation process: front end

Degree of collaboration: network

Degrees of freedom: high

Figure 6 – Typology of customer innovation at the front end (4 out of 8 types)



Source: Pillar, Ihl and Vossen (2011:11).

Dyadic, single customer, co-creation at the back end, includes:

5. *Toolkits for user innovation*: their solution space is mostly unlimited. Toolkit users both assemble companies' standard modules to get a best offering for themselves, as well as invest their resources to get innovative and unknown solutions for their specific needs. Those are the so-called Lead Users.

Stage in the innovation process: back end

Degree of collaboration: dyadic

Degrees of freedom: high

6. *Toolkits for customer co-design (configuration in mass customization setting)*: they intervene in customization or even in the development of offerings' variants, rather than intervene in the development of new products/services.

Stage in the innovation process: back end

Degree of collaboration: dyadic

Degrees of freedom: low

Network, community, based co-creation at front end, includes:

7. *Communities of creation for concept development and technical problem solving*: are focused in the idea and concept generation, but also cover the final stages of the innovation process of a given offering.

Stage in the innovation process: back end

Degree of collaboration: network

Degrees of freedom: high

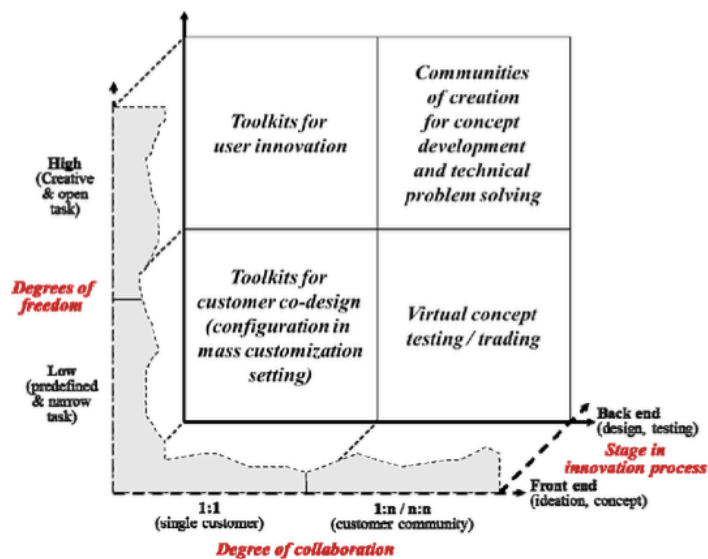
8. *Virtual concept testing and trading*: the user communities themselves test the products and/or services developed by communities of creation.

Stage in the innovation process: back end

Degree of collaboration: network

Degrees of freedom: low

Figure 7 – Typology of customer innovation at the back end (4 out of 8 types)



Source: Piller, Ihl and Vossen (2011:15).

The presented typology offers another solution for typifying the activities and procedures of co-creation with respect to the New Product Development. Since this typology is built around three characteristics, instead of two like the previous depicted typology of O'Hern and Rindfleisch (2010), it presents the double of the types of co-creation, eight in total. Another difference between typologies is the inclusion of lead users as a form of co-creation with the toolkits for user innovation, whereas in the first typology presented, the lead user did not represent a specific form of co-creation, performing just a role within particular types of it.

Despite the differences, the typologies are equal in terms of the bridge they establish between conceptual terms and the applicability of the CIS questionnaire (CIS, 2016), in order to study co-creation as a key driver for innovation in the development of innovative offerings.

Both the compatibility between the “ways of including customers and/or users in innovation activities and the production of innovative products or services” (CIS, 2016:13-14) and the typology of co-creation presented are noticeable, as well as the exception with regard to the “information on users and customers, and developing understandings on their needs” (CIS, 2016:13), concerning the DART's (Prahalad and Ramaswamy, 2002, 2004) not being respected, and also, the approaches to collect the information from the user being considered conventional by Piller, Ihl and Vossen (2011), and, therefore, not appropriate for co-creation.

However, and as for the first typology, this topic will be further delved into in the chapter 3.4.7 “Value co-creation as a key driver for innovation in the development of innovative products/services”, as well as in the chapter 4.2, referent to “Data Content: bridge between co-creation typologies and CIS”.

3.4.7 Value co-creation as a key driver for innovation in the development of innovative products/services

Both typologies of customer co-creation, 4 types and 8 types, presented a solution for typifying the activities of co-creation, with respect to the NPD. Despite their differences, concerning the partition of the activities within the respectively types of co-creation they propose, as well as the different role that the lead user from user innovation plays inside the typologies, the latter also present similarities.

The procedures inherent to these typologies, by which the interactions with the customers are made, as well as the procedures that the typologies themselves exclude as forms of co-creation, are coincident, even literally, with the ones presented in the CIS (2016) survey's section H, particularly in question 10.1 and question 11.1, which will reveal two major findings.

The first major finding resides on CIS's question 10.1, specifically in "information on users and customers, and developing understandings on their needs" (CIS, 2016:13-14). For the latter, it is observable that:

- The information was not necessarily used to the co-creation of innovative products or services, as the procedures used for collecting information from the user do not respect DART (Prahalad and Ramaswamy, 2002, 2004); hence, the co-creation experience for the creation of value in the form of offerings could not be valid.
- Typology of Customer Co-creation (4 types), differentiates Co-creation from traditional procedures of customer inquiry, as presented in CIS's question 10.1.
- Typology of Customer Co-creation (8 types), identifies the CIS procedures to collect the information from the user, present in this part of the question 10.1, as not suitable for co-creation.

Hence, this rationale reveals the CIS's procedures that the typologies themselves exclude as procedures for co-creation, which are summarized in the Table 2, as it follows:

Table 2 – CIS's procedures that the typologies themselves exclude as forms of co-creation

Question 10.1 (CIS, 2016:13-14): During the period of 2014 to 2016, which means did your enterprise use to include customer and/or user suggestions in your enterprise's innovation activities and in the production of your innovative products and how significant the means used were?			
CIS (2016:13-14), section H, Question 10.1		Co-Creation Typology (4 Types)	Co-Creation Typology (8 Types)
Different ways of including customers and users in innovation activities and development of innovative products		Typology of procedures (ways) for customer co-creation of innovative products and services	
Information on users and customers and developing understandings on their needs	Use of customer feedback systems	Co-creation is differentiated from traditional forms of customer inquiry, namely, focus groups, satisfaction surveys and tracking studies, regarding the customer effort required and the nature of the input that customers provide to the company (O'Hern and Rindfleisch, 2010). The CIS's particular ways of including users in innovation activities and development of innovative products, presented in this table, do not respect DART (Prahalad and Ramaswamy, 2002).	Exists three different modes of using and generating customer information in NPD. They differ in their degree respectively extent of the customer activities. The first two modes are: (1) <i>Listen Into</i> , that includes feedback from salespeople, analyzing sales data, research reports, study customer by observation, namely, ethnography, netnography, etc.; (2) <i>Ask</i> , that includes surveys, qualitative interviews, focus groups, systematic analysis of feedback or complaints, etc.; In the previous modes, the users remain apart from the firm, and so they are not actively involved in the development of future offerings, as they are in mode (3) <i>Build</i> , which is the basis for the development of the typology (8 Types) for customer co-creation (Piller, Ihl, Vossen, 2011).
	Use of market studies, consumer panels, focus groups and interviews, etc.		
	User needs analysis; e.g. discovery of latent needs and user observation by means of ethnography, anthropology, need and use analyses, and contextual interviewing, etc.		

Source: Own Elaboration.

The second major finding, taking into account the CIS survey's section H: "Participation of users in innovation activities and in the production of innovative products" (CIS, 2016:13-14), specifically questions 10.1, 11.1, acknowledges that:

- in question 10.1, there is an accordance between the "different ways of including customers and users in innovation activities and development of innovative products" (CIS, 2016:13-14) and the procedures (ways) for customer co-creation of innovative products and services, regarding both typologies;
- for question 11.1: "Did your enterprise introduced new or modified products (goods and/or services) in the market between 2014 and 2016 that were partially or totally developed by customers and/or users of the product?" (CIS 2016:14), both typologies of customer co-creation include procedures for the generation of partially or totally developed products/services by the user, for a firm commercialize.

Therefore, the aforementioned information reveals the CIS's procedures that the typologies themselves include as forms of co-creation, which are summarized in Table 3, as follows:

Table 3 – CIS's procedures that the typologies themselves include as forms of co-creation

Question 10.1 (CIS, 2016:13-14): During the period of 2014 to 2016, which means did your enterprise use to include customer and/or user suggestions in your enterprise's innovation activities and in the production of your innovative products and how significant the means used were?			
CIS (2016:13-14), section H, Question 10.1		Co-Creation Typology (4 Types)	Co-Creation Typology (8 Types)
Different ways of including customers and users in innovation activities and development of innovative products		Typology of procedures (ways) for customer co-creation of innovative products and services	
Users as actors and resources in your [enterprise] innovation activities (e.g. joint brainstorming, co-development, and joint content production)	Development forums, such as platforms of development provided by the company to collect ideas from users and user communities; software and content production, crowdsourcing, etc.	All four types of customer co-creation, namely, <i>Collaborating, Tinkering, Co-designing and Submitting</i> , include by definitions, the CIS (2016) survey's ways/procedures present in this table.	All eight types of customer co-creation, namely, <i>Idea Contest, Idea Screening through customers, Communities of Creation for idea generation, Product-related Discussion Forums, Toolkits for User Innovation, Toolkit for Customer Innovation (configuration in mass customization setting), Communities of Creation for Concept and Development and Technical problem solving</i> , and also <i>Virtual Concept Testing and Trading</i> , include by definitions, the CIS (2016) survey's procedures/ways present in this table.
Utilization and commercialization of products developed or modified by users	User modified existing products, and your enterprise further developed and commercialized it		
	User developed a new product and your enterprise further developed and commercialized it		
Question 11.1 (CIS, 2016:14): Did your enterprise introduced new or modified products (goods and/or services) in the market between 2014 and 2016 that were partially or totally developed by customers and/or users of the product?			
CIS (2014:13; 2016:14), section H, Question 11.1		Co-Creation Typology (4 Types)	Co-Creation Typology (8 Types)
Question 11.1 (CIS, 2016:14) itself.		The four types of Co-creation include the procedures for the generation of partially or totally developed products/services by the user, for a firm commercialize.	The eight types of Co-creation include the procedures for the generation of partially or totally developed products/services by the user, for a firm commercialize.

Source: Own Elaboration.

This conceptual bridge between the research and the CIS, regarding the two major findings previously explored, sustains the applicability of the CIS survey (2016) to study the value co-creation as a key driver for innovation in the development of innovative products/services.

Furthermore, the two typologies for customer co-creation, 4 types and 8 types, proposed by O'Hern and Rindfleisch (2010) and Piller, Ihl and Vossen (2011) respectively, acknowledge that, regarding the typologies' procedures for co-creation, also defined as collaborative New Product Development activities, the customers are the actors that play the main role for the process of NPD.

In spite of the aforementioned topic's literature being scant, the evidence collected so far points out that customer co-creation is positively related with many NPD metrics, such as increased new product creativity, decreased time to market and reduced development costs (von Hippel, 2005; Grewal, Lilien, and Mallapragada, 2006; Shah 2006; O'Hern and Rindfleisch, 2010). Additionally, Prahalad and Ramaswamy (2004), von Hippel (2005), Evans and Wolf (2005), Seybold (2006), O'Hern and Rindfleisch (2010), Piller, Ihl and Vossen (2011), Martovoy and Dos Santos (2012), among others, reinforce the importance of exploring and using customer-generated solutions, as the path to unlock new competitive advantage's sources.

Despite the different considerations regarding the type of consumer to be used to perform customer generated solutions, the extant literature converges in the importance of exploring and using the customers within the NPD.

Customer co-creation turns out to be the most suitable innovation model to study the intention of companies to create innovative offerings jointly with the user as, since it is derived from open innovation, co-creation is customer centric in terms of the innovation process, but firm-driven in regard to the strategy; it is the most holistic perspective since it includes all the procedures of involving users in innovation activities and in the NPD, including procedures for both the lead users linked to user innovation, as well as for the regular users (non-lead users), being capable to co-create value and offerings with a company.

As a result, once it's intended to study the value co-creation as a key driver for innovation in the development of innovative products/services, applied in the Portuguese firms, this research highlights a factor that can influence companies in the development of new innovative products and services, which is:

- "Different ways of including customers and users in innovation activities and development of innovative products".

The literature review, in consonance with the accordance between the research's concepts and the CIS's survey, that grants the applicability of the survey to the present study, constitutes the rationale for the formulation of Research Hypotheses. Subsequently, these hypotheses will be tested empirically, in order to determine whether the variables included in the model have a significant influence in a company's innovation process, translated in the development of innovative products/services.

Thus, the factor Different ways of including customers and users in innovation activities and development of innovative products, encompasses the three variables:

- Users as a resource in innovation activities, joint brainstorming, co-development and joint content production;
- Utilization and commercialization of products and services modified by users;
- Utilization and commercialization of products and services developed by users.

By recalling the main research question: “is co-creation a key driver for companies to innovate and develop new innovative products and services?”, as well as based on the previous three groups of procedures, being all coincident with customer co-creation typologies’ procedures for including the users in innovation activities and development of innovative products and services, the following hypotheses are formulated:

Hypothesis 1: Users as a resource in innovation activities, joint brainstorming, co-development and joint content production is positively related to the propensity for the company to develop innovative products/services.

Hypothesis 2: Utilization and commercialization of products and services modified by users is positively related to the propensity for the company to develop innovative products/services.

Hypothesis 3: Utilization and commercialization of products and services developed by users is positively related to the propensity for the company to develop innovative products/services.

The three hypotheses presented aim to determine if the ways of including customers and users in innovation activities and development of innovative products/services influence the company's ability to develop innovative products/services. Each of the hypotheses presented in this research are related with a certain explanatory variable. The latter is summarized in Table 4, as it follows:

Table 4 – Formulation of hypotheses

Formulation of hypotheses with respect to different ways of including customers and users in innovation activities and development of innovative products or services	Explanatory variables		Response Variable
	Different ways represented by the Co-creation Typologies' procedures	CIS (2016)	
Hypothesis			
H ₁ : Users as a resource in innovation activities, joint brainstorming, co-development and joint content production is positively related to the propensity for the company to develop innovative products/services.	Users as a resource in innovation activities, joint brainstorming, co-development and joint content production	Development forums and e.g. development platforms provided by the enterprise to collect ideas from users and user communities; software and content production, crowdsourcing, etc.,	Development and introduction of innovative products/ services in the market, developed partially or totally by users
H ₂ : Utilization and commercialization of products and services modified by users is positively related to the propensity for the company to develop innovative products/services.	Utilization and commercialization of products and services modified by users	User modified existing products, and your enterprise further developed and commercialized it.	
H ₃ : Utilization and commercialization of products and services developed by users is positively related to the propensity for the company to develop innovative products/services.	Utilization and commercialization of products and services developed by users	User developed a new product and your enterprise further developed and commercialized it.	

Source: Own Elaboration.

The theoretical hypotheses presented in the previous table constitute the basis for the hypotheses to be tested further in the empirical part of this research.

4. Research Methodology

The Research Methodology consists of five main subchapters. Firstly, it is presented a description of the CIS (2016), its features and data. Secondly, in Data Content, it is depicted the rationale between the typologies analysed in chapter III with CIS 2016 section and questions to be studied, pointing out the accordance regarding conceptual terms and the premises of co-creation. Subsequently, in the third and fourth subchapters, it is presented the dataset and the characterization of the sample. Fifth subchapter accounts for the presentation of the variables. Lastly, in the sixth subchapter, the method to conduct the study, the model that was built and also the software to perform the analysis of the data are explained.

4.1. Data

In this research, the data used are secondary data, collected through a survey that consisted of a questionnaire named Community Innovation Survey (CIS 2016). CIS is a standardized questionnaire, which is conducted periodically every two years since 1992, being directed to respondents which comprise some EU member states, as well as ESS member countries. Once innovation is evolutionary, the questionnaire has been adapted and changed to capture its dimensions and trends.

CIS aims to “provide information on the innovativeness of sectors by type of enterprises, on the different types of innovation and on various aspects of the development of an innovation, such as the objectives, the sources of information, the public funding, the innovation expenditures etc”.¹

In Portugal, CIS 2016 questionnaire was conducted between June, 2017 and November, 2017, by DGEEC (Direção-Geral de Estatísticas da Educação e Ciência), in collaboration with INE (Instituto Nacional de Estatística), according to the EUROSTAT methodological specifications concerning innovation activities in Portuguese firms.

The target population on which the analysis is focused includes industrial and service firms headquartered in the Portuguese territory, with at least 10 employees and belonging to divisions 7 to 86 of the Classificação Portuguesa de Atividades Económicas (CAE-Rev.3). According to the data provided by the DGEEC relating to the firms included in the corrected sample, 6775 firms provided valid responses to the survey, which corresponds to a response rate of 75,8% (DGEEC, 2018).

Through the literature review, specific CIS questionnaire's items were selected, as suitable variables for the assessment of co-creation, as well as for its procedures' importance, which are also intended to be studied.

¹ <https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey>

4.2. Data Content: bridge between co-creation and the CIS

The objective of this research, applied to the context of the Portuguese companies, is to study the value co-creation as a key driver for innovation in the development of innovative offerings.

Also, the data that was intended to be analysed initially is the secondary data provided by the Community Innovation Survey (CIS) 2016; since this data was collected via survey and validated by Eurostat, as well as it is applied and recognized internationally, the trustworthiness of the data is granted.

In order to verify if the research purpose was in concordance with the CIS 2016, it was first performed a literature review on Innovation and its historical evolution till Open Innovation, User Innovation and Co-Creation.

That led to the accordance of the research in conceptual terms to the CIS's (2016) section H: "Participation of users in innovation activities and in the production of innovative products" (CIS, 2016:13-14), particularly with 10.1 question's "ways of including customers and/or users in innovation activities and the production of innovative products or services" (CIS, 2016:13-14), and also with question 11.1 itself "Did your enterprise introduced new or modified products (goods and/or services) in the market between 2014 and 2016 that were partially or totally developed by customers and/or users of the product?" (CIS, 2016:14).

In the CIS's (2016) question 10.1, the "ways of including customers and/or users in innovation activities and the production of innovative products or services" (CIS, 2016:13-14) are presented. In order to verify if the latter could be aligned with the procedures for co-creation of new innovative offerings, two typologies of customer co-creation were also approached in the literature review.

It was concluded that both O'Hern and Rindfleisch (2010) and Piller, Ihl and Vossen (2011) presented typologies for co-creation, albeit different, in regard to the division of the activities within the types for co-creation that they propose, the authors similarly include the procedures by which the interaction with customer is performed, to collect her/his information and develop, jointly with a company, new innovative services/products. Those procedures literally coincide with the procedures depicted within the "ways of including customers and/or users in innovation activities and the production of innovative products or services" (CIS, 2016:13-14) particularly with "users as actors and resources in your innovation activities" (CIS, 2016:13-14) and "utilization and commercialization of products developed or modified by users" (CIS, 2016:14).

Finally, one may observe the applicability of the CIS (2016) to the research, since it agrees, according to the previous rationale, with the concepts that the literature review deals with. Also, it is important to acknowledge that for the CIS's (2016), applied in Portugal, it is already known the number of responses by the firms ($n = 6775$), which is a considerable and respectable amount of data, in order to perform a proper analysis.

4.3. Dataset

In total, the CIS 2016 questionnaire conducted in Portugal presented 6775 respondents (firms). However, once the scope of this work is directed to study the context of the Portuguese firms, the dataset utilized for that purpose was firstly characterized according to the size of the companies, as SMEs and LEs, small and medium-sized and large enterprises, respectively.

Additionally, CIS (2016) questionnaire includes a field to collect answers with respect to the respondent firms' economic activity sector/division. The variable that accounts this information is "cae_div_cod", described as the coded classification of the economic activities (CAE-Rev.3), i.e., "Classificação de Atividades Económicas (CAE-Rev.3) codificada". The answers collected reported that respondents, manufacturing and service firms, belong to divisions 7 to 86 of the CAE-Rev.3.

CAE-Rev.3 was elaborated by INE in collaboration with Portuguese Public Administration, social partners and some enterprises, in a total of 200 entities. CAE-Rev.3 intended to replace the previous one, the CAE-Rev 2.1, by revising the latter, being restructured to be framed and aligned with NACE-Rev.2 (European Classification of Economic Activities). According to INE², CAE-Rev.3, which structure was published in Diário da República under the Decreto-Lei 387/2007, establishes the new framework for Portuguese economic activities, harmonized with the Statistical Nomenclature of Economic Activities in the European Community (NACE-Rev.2), under the Regulation (EC) No. 1893/2006, of the European Parliament and of the Council, of 20 December of 2006.

Furthermore, Eurostat³ presented detailed aggregations based on NACE Rev.2 and according to firms' technological intensity. As CIS 2016 collected responses on the CAE Rev.3 divisions and since CAE Rev.3 is harmonized with NACE Rev.2, the present work applied the Eurostat taxonomy to study the technological intensity of the respondent Portuguese companies.

In line with Eurostat, manufacturing firms can be aggregated according to technological intensity based on NACE Rev.2 divisions for compiling aggregates related to high-technology, medium-high-technology, medium-low-technology, and low-technology; for the service firms, the same reasoning is applicable for compiling aggregates related to less knowledge intensive services, knowledge intensive services and high-tech knowledge services. Additional sub-aggregations and more specific ones could be considered, however the present work solely made use of the previous mentioned, as they are suited to infer the technological intensity of the respondents. Given the previous, all the respondents that were properly characterized in terms of size, were also characterized according to their technological intensity.

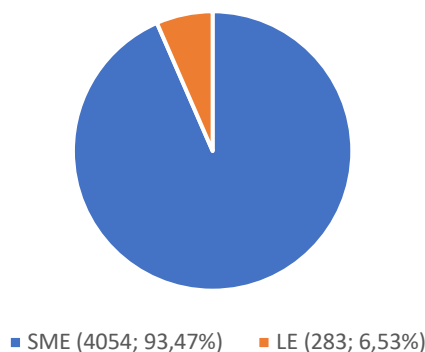
The objective of the present research is to study value co-creation as a key driver for innovation, by its application within the companies' innovation process for the development and introduction of innovative products/services in the market, as well as the most significant co-creation procedures to materialize the prior. Regarding the before mentioned, explained in detail

² https://www.ine.pt/ine_novidades/semin/cae/CAE_REV_3.pdf

³ https://ec.europa.eu/eurostat/cache/metadata/Annexes/htec_esms_an3.pdf

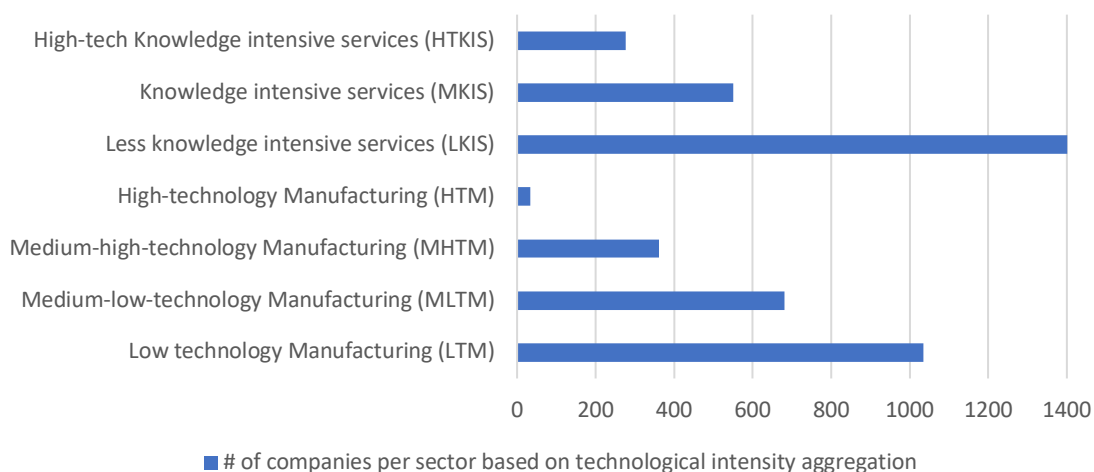
in subchapters 3.4.7 and 4.2., of the initial 6775 respondent firms, there were 4337 which were properly classified in terms of size (Figure 8) and technological intensity (Figure 9) and answered to question 10.1 (Figure 10).

Figure 8 – Number of companies per size (SME or LE)



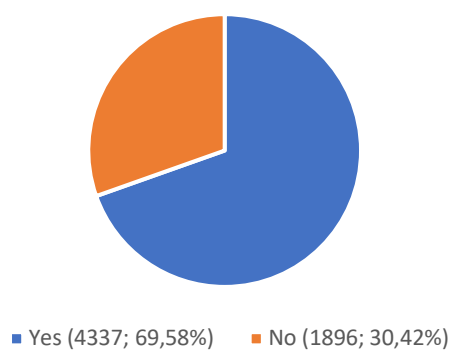
Source: Own elaboration.

Figure 9 – Number of companies per sector based on technological intensity aggregation



Source: Own elaboration.

Figure 10 - Distribution of firms that have attributed importance to co-creation procedures



Source: Own elaboration.

4.4. Sample characterization

This section presents the description of the co-creation procedures that can be derived from the CIS (2016) questionnaire. In the chapter 3.4.7 “Value co-creation as a key driver for innovation in the development of innovative products/services”, as well as the chapter 4.2, referent to “Data Content: bridge between co-creation typologies and CIS”, it was presented the rationale that granted the accordance between the present research’s conceptual terminology with CIS 2016, as the literature review points out two Co-Creation Typologies, whose procedures by which the companies interact with customers are the same ones depicted in the CIS (2016) survey; the information is collected in CIS (2016) through three variables, namely clufor, cluada and cludev, designated in this study as co-creation variables, which represent three different groups of procedures to co-create, respectively. The previous is summarized in Table 5.

Table 5 – Summary of the independent variables and their accordance with co-creation typologies

CIS (2016:13-14), section H, Question 10.1		Co-Creation Typology (4 Types)	Co-Creation Typology (8 Types)
Different ways of including customers and users in innovation activities and development of innovative products	CIS (2016) Variable	Typology of procedures (ways) for customer co-creation of innovative products and services	
Development forums, such as platforms of development provided by the company to collect ideas from users and user communities; software and content production, crowdsourcing, etc.	clufor	All four types of customer co-creation, namely, <i>Collaborating, Tinkering, Co-designing</i> and <i>Submitting</i> , include by definitions, the CIS (2016) survey’s ways/procedures present in this table.	All 8 types of customer co-creation, namely, <i>Idea Contest, Idea Screening through customers, Communities of Creation for idea generation, Product-related Discussion Forums, Toolkits for User Innovation, Toolkit for Customer Innovation (configuration in mass customization setting), Communities of Creation for Concept and Development and Technical problem solving</i> , and also <i>Virtual Concept Testing and Trading</i> , include by definitions, the CIS (2016) survey’s procedures / ways present in this table.
User modified existing products, and your enterprise further developed and commercialized it	cluada		
User developed a new product and your enterprise further developed and commercialized it	cludev		

Source: Own elaboration.

A Cronbach’s alpha analysis of the variables was performed (Table 6) to verify the reliability. According to Hair et al. (2006), for few items, a value near of 0.6 can be accepted. Once the values are all over 0.6, the reliability was attested.

Table 6 – Cronbach’s alpha analysis

Item	Alpha
clufor	0.8957
cluada	0.6306
cludev	0.6377

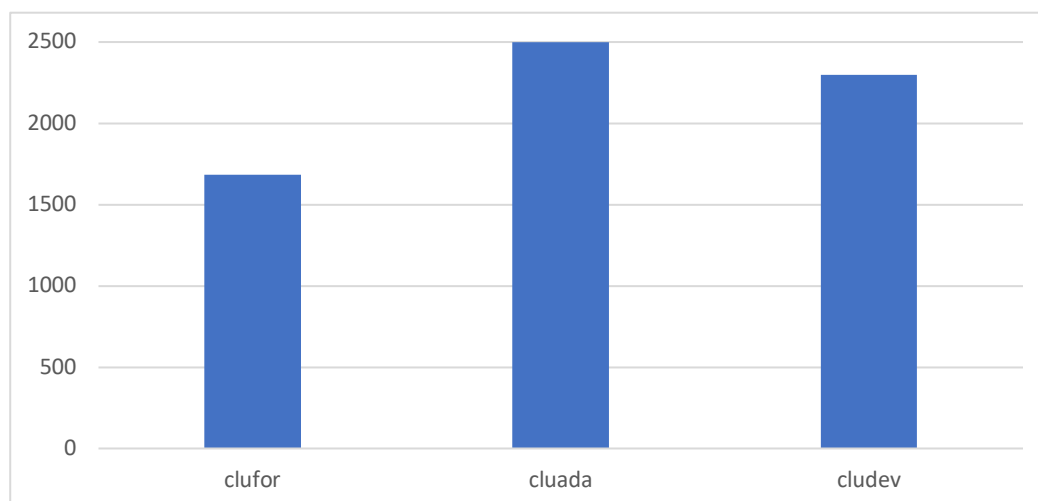
Source: Own elaboration.

From the 4337 innovative companies that have performed co-creation procedures:

- 1682 (38.8%) answered positively to clufor, from which it could be inferred that they consider important the procedures that include “development forums, such as platforms of development provided by the company to collect ideas from users and user communities; software and content production, crowdsourcing, etc.” (CIS, 2016:13).
- 2498 (57,6%) answered positively to cluada, from which it could be inferred that they consider important the procedures that allowed the user to modify the firm’s existing offerings.
- 2300 (53%) answered positively to cludev, from which it could be inferred that they consider important the procedures that allowed the user to develop new products and services.

The previous findings are shown in Figure 11, as follows:

Figure 11 - Importance of each co-creation procedures, according to the sample (n=4337 firms)



Source: Own elaboration.

One can observe that procedures which allowed the user to modify existing offerings or to develop new products / services, inherent to cluada and cludev, respectively, are similarly preferred, as well as preferred over the ones relative to clufor.

4.5. Variables

4.5.1. Independent variables

The independent variables are represented by the variables of co-creation. To this key driver, one may add three variables, presented as a scale comprising the following results, in accordance with the degree of importance: irrelevant/not used = 0; low = 1; medium = 2; and high = 3. There are three "different ways of including customers and users in innovation activities and development of innovative products or services" (CIS, 2016:13-14). This information was obtained from the answers to question 10.1 of the CIS 2016, through the variables "clufor", "cluada" and "cludev", which represent different procedures to perform co-creation. The variables are presented as follows (Table 7):

Table 7 – Independent variables summary

Variable	Description CIS (2016)	Different ways represented by the Co-creation Typologies' procedures	Possible answers
clufor	Importance of the ways used to include suggestions from customers / users - development forums; user communities; software and content production, crowdsourcing.	Users as a resource in innovation activities, joint brainstorming, co-development and joint content production	0 = not used 1 = low 2 = medium 3 = high
cluada	Importance of the ways used to include suggestions from customers / users - adaptation of existing goods or services by customers and / or users; and development, production and introduction of these goods or services on the market by the company.	Utilization and commercialization of products and services modified by users	0 = not used 1 = low 2 = medium 3 = high
cludev	Importance of the ways used to include suggestions from customers / users - development of new goods or services by customers and / or users and which the company produced and introduced to the market.	Utilization and commercialization of products and services developed by users	0 = not used 1 = low 2 = medium 3 = high

Source: Own elaboration.

4.5.2. Dependent variables

The firms in the sample are considered to be innovative in terms of products and/or services based on whether they introduced in the market new or modified products and services during the period of time between 2014 and 2016, which were partially or totally developed by users, and so, in this study, the dependent variable, represented in Table 8, is measured using the collected information at the level of introduction of innovative products and services in the market, which were developed or partially developed by user / clients. This dimension is presented as a dichotomous variable based on binary data; it is set to 1 for firms that introduced in the market innovate offerings developed totally or partially by users and 0, otherwise.

Information on this variable regarding the CIS 2016 will be considered, by taking into account the answers to question 11.1: “Did your enterprise introduced new or modified products (goods and/or services) in the market between 2014 and 2016 that were partially or totally developed by customers and/or users of the product?” (CIS 2016:14), referent to the section H: “Participation of users in innovation activities and in the production of innovative products”.

Table 8 – Dependent variable summary

Variable	Description CIS (2016)	Possible answers
inclu	Introduction of new or modified products on the market between 2014 and 2016 that were partially or fully developed by customers and / or users of the product/services	1 = yes 0 = no

Source: Own elaboration.

4.5.3. Control variables

The present research aims to study co-creation as a key driver for innovation, when applied within the companies' innovation process for the development and introduction of innovative products/services in the market, as well as the most significant co-creation procedures to materialize the prior. Although there is a lack of empirical evidence with regard to the specific objective of this study, it was added control variables based on literature on co-creation. Following the study of Markovic & Bagherzadeh (2018), the following controls variables were included, as follows (Table 9):

Table 9 – Control variables summary

Variable	Description/Definition	Values
firm_size	Size of the firm	0, if the firm is a SME or 1, if the firm is a LE
Tech_intensity	Technological intensity of the firm according to Eurostat's aggregation of firms based on NACE Rev.2.	1 = Low technology Manufacturing (LTM) 2 = Medium-low-technology Manufacturing (MLTM) 3 = Medium-high-technology Manufacturing (MHTM) 4 = High-technology Manufacturing (HTM) 5 = Less knowledge intensive services (LKIS) 6 = Knowledge intensive services (MKIS) 7 = High-tech Knowledge intensive services (HTKIS)
fin_supp_num	Public financial support for innovation.	0 = Other supports 1 = No support 2 = Only EU support 3 = Only governmental support 4 = Governmental and EU support 5 = Only local support 6 = Local and EU support 7 = Local and governmental support 8 = Local, governmental and EU support
Int_Orientation	Companies' presence in foreign markets, besides its home market.	1, the firm having sold to foreign markets 0, otherwise
inpdgd	Firm introduced new or improved products in the market (just functional improvements)	1, if the firm had introduced 0, otherwise
inpdsv	Firm introduced new or improved services in the market	1, if the firm had introduced 0, otherwise
mktdgp	Firm introduced new or improved products in the market (only aesthetic improvements, not functional)	1, if the firm had introduced 0, otherwise

Source: Own elaboration.

Having the variables defined, the method will be presented as follows.

4.6. Method

In the present research it is intended to study the value co-creation as a key driver for innovation in the development of innovative products/services, applied to the Portuguese firms.

Thus, data that allows the characterization of firms, specifically data to obtain results associated with the innovation of firms on the national level will be considered. It is, therefore, a quantitative method for data collection, leading to an empirical basis that allows the analysis of the importance of the variables about user participation in innovation activities and production of innovative products in Portuguese firms, using the available data from the CIS 2016 and the application of statistical patterns through logistic regression models.

Regarding the inquiry of the CIS 2016 (CIS, 2016), this research took into account question 10.1, concerning the variables associated with co-creation (CIS, 2016:13-14). If the answer for a variable of co-creation is “no”, that will mean that there is no influence of co-creation in the innovation and development of innovative products/services; otherwise, there is inferred an effect of co-creation in the company’s ability to develop innovative products/services, that entails a certain importance level associated to one of the remaining possible answers for the variable, namely, “high importance”, “average importance” or “low importance”.

Taking into account the inquiry of the CIS 2016 (CIS, 2016), this study considered question 11.1, regarding product innovation (CIS, 2016:14). Hence, we have a dependent dichotomous variable. According to what has been previously defined, the variable is binary, with a value equal to 1, if the firm developed new innovative products or services, or a value equal to 0, if the firm have not developed new innovative products or services. The binary data are very common among the several types of categorical data and their modelling is part of the linear regression models category (McCullagh and Nelder, 1989).

The logistic regression model is the most common one (Silva, 2003), in terms of how it facilitates the substantive interpretation of parameters. Thus, logit regression is an approach used in studies of innovation capability factors (Kaufmann and Tödtling, 2001; Silva et al. 2008 and Parrilli e Heras, 2016). In this sense, a logistic regression model is proposed.

As dependent variables, this research used the CIS (2016) variable inclu, represented by the letter “A”, which is referent to the firm development and introduction of innovative products / services in the market, developed partially or totally by users. The independent variables related to co-creation procedures were denoted in the model by the letter “C”. The control variables with respect are represented by letter “D” to “J”. ε_i represents the residual term. Equation (1) presents the logistic regression model that was built:

$$A_i = \beta_0 + \beta_1 C_1 + \beta_2 C_2 + \beta_3 C_3 + \beta_4 D + \beta_5 E + \beta_6 F + \beta_7 G + \beta_8 H + \beta_9 I + \beta_{10} J + \varepsilon_i \quad \text{Equation 1}$$

Where: A_i = innovation (product/services) introduced in the market; β = coefficient, C_i = co-creation procedures, D = technological intensity, E = public financial support, F = size of the firm, G = international orientation of the firm, H = functionally new/improved products introduced, I = new/improved services introduced, J = aesthetically new/improved products introduced and ε_i = residuum; index i represents the unit of analysis: the firm.

The analysis was performed in 5 stages: in the first stage it were only included in the model the control variables (Model I); from the second to the fourth stage, it were included the controls and a just a co-creation variable at a time, respectively (Model II to IV). Finally, it were included the control variables and all the independent variables with respect to the three co-creation variables (Model V).

There are several statistical techniques that allow measuring the results of categorical variables, such as the dependent variable under study, for this study it was chosen the logit model. Logit model, developed in the mid-1960s and widely applied in innovation and economics studies (Cabrera, 1994), allows to capture the relationship between dependent, independent and control variables, for two main assumptions underlying its use: the first is related to the type of distribution that is associated with the nature of the dependent variables; secondly, the model allows to define the relationship between the categorical dependent variable and the independent and control variables, being the latter categorical. (Cabrera, 1994).

Taking into account the first assumption, the binary dependent variable regarding the development and introduction of innovative products / services in the market, developed partially or totally by users, can only assume values 0 or 1. These values correspond to the expected probability that varies depending on the value of each independent variable. The previous is expressed according to Equation (2):

$$E = \left[Y_i = \frac{1}{X} = x \right] = P(Y_i = 1) \quad \text{Equation 2}$$

Where: $P(Y_i = 1)$ represents the probability of observing the condition of success for each contribution value of X ; it is assumed that the previous probabilities follow a binomial distribution. Besides the probability distribution has an overall mean with respect to P , the variance changes with regard to each independent variable considered. This latter is expressed according to Equation (3):

$$V(i) = P(Y_i = 1) \times [1 - (P_i = 1)] \quad \text{Equation 3}$$

Where: $P(Y_i = 1)$ represents the probability of observing the condition of success (the firm co-created, i.e., developed and introduced innovative products / services in the market, developed partially or totally by users); $[1-(P_i=1)]$ represents the probability of observing the condition of failure (the firm did not co-created, i.e., did not developed and introduced innovative products / services in the market, developed partially or totally by users). The previous is expressed in Equation (4), as follows:

$$Y = \begin{cases} \text{inclu} = 1, & \text{if the firm co - created} \\ \text{inclu} = 0, & \text{if the firm did not co - created} \end{cases} \quad \text{Equation 4}$$

The logit model defines the relationship between the dependent categorical variable and the independent variables, according to the Equation 5:

$$L = \ln \frac{P(Y)}{1 - P(Y)} = B_0 + B_1 X_1 \quad \text{Equation 5}$$

Where: L is designated as the logit or the natural logarithm of the odds ratio; B_0 is the constant; B_1 it's the coefficient of the variable X; $P(Y)$ represents the probability of success in Y. Equation (5), expressed in order the probability $P(Y)$, according to Equation (6):

$$P(Y) = \frac{\exp(B_0 + B_1 X_1 + \dots)}{1 + \exp(B_0 + B_1 X_1)} \quad \text{Equation 6}$$

The logit model uses logistical distribution. The latter has an "S" shape, where $P(Y)$ can take values between 0 and 1. B_0 and B_1 can take values from negative to positive infinity (Cabrera, 1994). The estimation method is based on the maximum likelihood method. The approximation of the maximum likelihood method in the regression seeks to assess the effect that the independent variable has on the objective function. This approximation is achieved through an iterative estimation process in which the estimation of the value of the constant and the coefficients of X are chosen in order to maximize the probability of the value of the probability observed in Y (Cabrera, 1994).

To estimate the models, a hierarchical estimation process was used. This process is used by some researchers, when the dependent variable is dichotomous (Cabrera, 1994). This process can be done in two ways: by adding or removing variables. In the present research, it was performed the process of adding variables, resulting in a total of five models, which will be presented in the following chapter.

The statistical software that served as the basis for the statistical analysis of the data is the Stata for Windows.

5. Results and discussion

This chapter aims to present and discuss the results obtained through the logistic regression model, comprehending the tests of the research hypotheses, previously formulated in accordance with the literature review, aligned with the model results. The first sub-chapter presents descriptive statistics, being ensued by the second one referent to the regression results; the third subchapter regards the discussion of the results.

5.1. Descriptive statistics

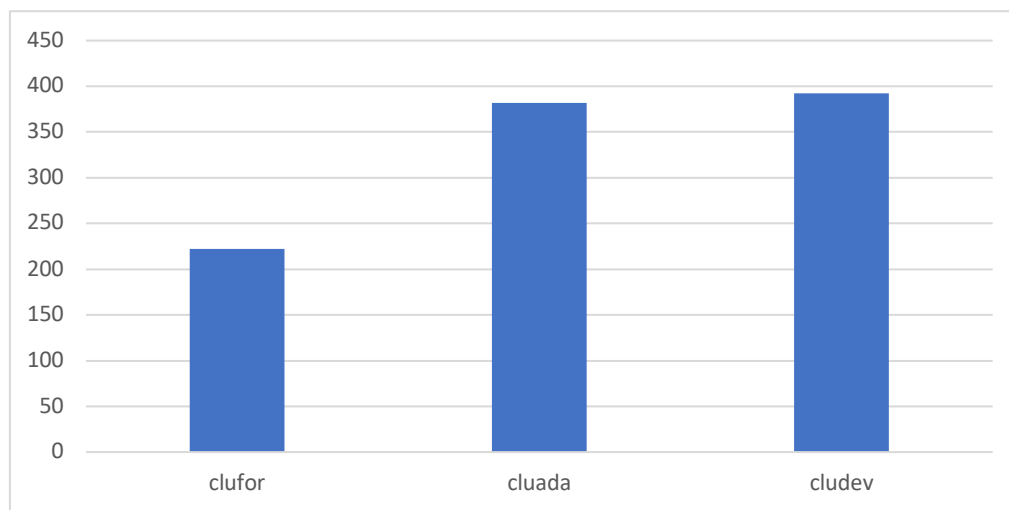
The following table provides information which characterizes the sample used in the analysis. From the 6775 respondent firms that answered the questionnaire, the ones which could not be properly classified regarding size and technological intensity were excluded, resulting in 6233 observations. Of the previous, only 4337 firms respond to question 11.1 referent to “Did your enterprise introduced new or modified products (goods and/or services) in the market between 2014 and 2016 that were partially or totally developed by customers and/or users of the product?” (CIS, 2016:14). In this sample, 10.4% of firms (450) reported to have introduced innovative products / services in the market, developed partially or totally by users (inclu).

From the 450 innovative companies that have introduced co-created products / services in the market, in terms of the co-creation procedures used:

- 222 (49.3%) answered positively to clufor, from which it could be inferred that they had co-created and introduced innovative products / services in the market, through procedures that include “development forums, such as platforms of development provided by the company to collect ideas from users and user communities; software and content production, crowdsourcing, etc.” (CIS, 2016:13).
- 382 (84,9%) answered positively to cluada, from which it could be inferred that they had co-created and introduced innovative products / services in the market, through procedures that allowed the user to modify the firm's existing offerings.
- 392 (87,1%) answered positively to cludev, from which it could be inferred that they had co-created and introduced innovative products / services in the market, through procedures that allowed the user to develop new offerings.

The previous findings are depicted graphically in Figure 12:

Figure 12 - Co-creation procedures score, according to the # of innovative co-creation firms



Source: Own elaboration.

Table 10 presents descriptive statistics for each variable:

Table 10 – Descriptive statistics for each variable

	mean	sd	min	max
Introduction of new or modified products on the market that were partially or fully developed by customers (inclu)	0.1038	0.3050	0	1
Co-creation procedures which include development forums; software and content production, crowdsourcing, etc. (clufor)	0.6255	0.8878	0	3
Co-creation procedures by which the customer partially develops a product/service (cluada)	1.1035	1.0905	0	3
Co-creation procedures by which the customer totally develops a product/service (cludev)	0.9949	1.0738	0	3
Technological Intensity (tech_intensity)	3.5517	2.0495	1	7
Public financial support (fin_supp_num)	1.0570	1.3848	0	8
Size of the firm (1=LE) (Firm_size)	0.5423	0.2265	0	1
International Orientation (Int_Orientation)	0.6443	0.4788	0	1
Firm introduced new or improved products in the market (just functional improvements) (lnpdgd)	0.3238	0.4679	0	1
Firm introduced new or improved services in the market (lnpdsv)	0.2732	0.4457	0	1
Firm introduced new or improved products in the market (only aesthetic improvements, not functional) (mktddp)	0.2227	0.4161	0	1

Number of observations: 4337. Source: Own elaboration.

A Spearman correlation matrix (Table A11) was used to investigate multicollinearity. Spithoven et al. (2013) acknowledge that values between different activities should not be over the 0,4 threshold. However, two values between the different procedures of co-creation present a value near 0,5; a third one, that regards the procedures to co-create with respect to cluada and cludev, present a correlation value slightly above 0,8. Therefore, from a strong correlation between the procedures referent to cluada and cludev, it can be inferred that the companies that co-create through cluada procedures are prone to also co-create through cludev procedures and vice-versa. The same reasoning is applicable for clufor procedures. Such possible explanation seems reasonable as the typologies for co-creation provide procedures which might serve both to co-create through cluada and/or cludev and/or clufor procedures.

This topic merits further investigation, meanwhile, to study multicollinearity in the model, it was calculated the variance inflation factors for the independent variables: clufor, cluada and cludev. The results are depicted in Table 12 for Model V (complete model), as follows:

Table 12 – VIF (Model V)

Variable	VIF
clufor	1.36
cluada	3.03
cludev	3.07
Tech_intensity	1.15
fin_supp_num	1.10
Firm_size	1.02
Int_Orientation	1.06
inpdgd	1.24
inpdsv	1.17
mktddp	1.08
Mean VIF	1.53

Source: Own elaboration.

The variance inflation factors range from 1.02 to 3.07 (Model V). “Since all scores are below the cut-off point of 10, multicollinearity is ruled out” (Spithoven et al. 2013:550).

5.2. Regression Results

The main objective is to depict the firm's development and introduction of innovative products/ services in the market, developed partially or totally by users, which constitutes the response variable. In order to be able to materialize this objective and, in accordance with the literature review, the variables of co-creation are considered regarding the co-creation role as a key driver to firms' development of new and innovative offerings. The results from the logistic regressions and marginal effects (Model I and V) are presented in Table 13 and Table 14, respectively, as follows:

Table 13 – Results regarding the logistic regression models

	Logit inclu (Model I)	Logit inclu (Model II)	Logit inclu (Model III)	Logit inclu (Model IV)	Logit inclu (Model V)
clufor (group of specific Co-creation procedures)		0.2178*** (0.0543)			-0.1303** (0.0609)
cluada (user partially developed an offering)			0.5846*** (0.0502)		-0.0873 (0.0833)
cludev (user totally developed an offering)				0.8096*** (0.0524)	0.9155*** (0.0823)
Technological intensity	-0.1277*** (0.2662)	-0.1368*** (0.0267)	-0.1252*** (0.0273)	-0.1127*** (0.0279)	-0.1041*** (0.0282)
Public financial support	0.1125*** (0.0316)	0.1050*** (0.0319)	0.1002*** (0.0330)	0.0896*** (0.0339)	0.0908*** (0.0340)
Firm size (=1, if LE)	0.1173 (0.1936)	0.0420 (0.1956)	0.1739 (0.1990)	0.2088 (0.2033)	0.2490 (0.2052)
International Orientation	0.4421*** (0.1285)	0.4467*** (0.1287)	0.3721*** (0.1308)	0.3559*** (0.1330)	0.3420*** (0.1333)
Inpdgd (introduction of functional improvements)	0.6636*** (0.1163)	0.6427*** (0.1168)	0.5678*** (0.1191)	0.4802*** (0.1214)	0.4826*** (0.1216)
Inpdsv (introduction of services)	0.4505*** (0.1080)	0.4107*** (0.1090)	0.3190*** (0.1111)	0.2701** (0.1139)	0.2905** (0.1143)
Mktdgp (introduction of aesthetical improvements)	0.3045*** (0.1056)	0.2560** (0.1067)	0.1370 (0.1091)	0.0713 (0.1112)	0.0919 (0.1117)
Observations	4337	4337	4337	4337	4337
Pseudo R²	0.0619	0.0673	0.1121	0.1557	0.1581
Chi²	178.85	194.45	324.18	450.22	457.14
Prob > Chi²	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-1355.940	-1348.138	-1283.273	-1220.253	-1216.795

Standard deviation between parentheses; p value (***) p<0.01, ** p<0.05, * p<0.1).

Table 14 – Marginal effects

	Logit inclu (Model I)	Logit inclu (Model II)	Logit inclu (Model III)	Logit inclu (Model IV)	Logit inclu (Model V)
clufor (group of specific Co-creation procedures)		0.0193*** (0.0048)			-0.0106** (0.0049)
cluada (user partially developed an offering)			0.0498*** 0.0043		-0.0071 (0.0068)
cludev (user totally developed an offering)				0.0661*** (0.0043)	0.0744*** (0.0066)
Technological intensity	-0.0114*** (0.0024)	-0.0121*** (0.0024)	-0.0107*** (0.0023)	-0.0092*** (0.0023)	-0.0085*** (0.0023)
Public financial support	0.0100*** (0.0028)	0.0093*** (0.0028)	0.0085*** (0.0028)	0.0073*** (0.0028)	0.0074*** (0.0028)
Firm size (1, if LE)	0.0104 (0.0172)	0.0037 (0.0173)	0.0148 (0.0169)	0.0171 (0.0166)	0.0203 (0.0167)
International Orientation	0.0393*** (0.0114)	0.0395*** (0.0114)	0.0317*** (0.0111)	0.0291*** (0.0109)	0.0278*** (0.0108)
Inpdgd (introduction of functional improvements)	0.0590*** (0.0104)	0.0568*** (0.0104)	0.0483*** (0.0102)	0.0392*** (0.0099)	0.0393*** (0.0099)
Inpdsv (introduction of services)	0.0400*** (0.0096)	0.0363*** (0.0097)	0.0272*** (0.0095)	0.0221** (0.0093)	0.0236** (0.0093)
Mktdgp (introduction of aesthetical improvements)	0.0271*** (0.0094)	0.0226** (0.0094)	0.0117 (0.0093)	0.0058 (0.0091)	0.0075 (0.0091)
Observations	4337	4337	4337	4337	4337
Pseudo R²	0.0619	0.0673	0.1121	0.1557	0.1581
Chi²	178.85	194.45	324.18	450.22	457.14
Prob > Chi²	0.000	0.000	0.000	0.000	0.000
Log-likelihood	-1355.940	-1348.138	-1283.273	-1220.253	-1216.795

Standard deviation between parentheses; p value (***) p<0.01, ** p<0.05, * p<0.1).

The previous logistic regressions were run in order to test the hypotheses regarding the same dependent variable and the different groups of co-creation procedures. All the regressions presented results with statistical significance. The significant and positive coefficients prove that a variable has an impact in increasing the probability of firms to develop and introduce innovative products/ services in the market, developed partially or totally by users (inclu). Whereas, a negative and significant coefficient, according to the previous rationale, will restrain inclu. Also, the marginal effects provide a dimension in terms of probability, which coefficient, once significant, can represent an increase or a decrease, if it is positive or negative, respectively.

All the models, I to V, are logit regressions. Model I just includes controls, while model II to IV analysis a particular group of procedures for co-creation, at a time. As the results are quite similar, even when one observes the results for the controls, two remarkable inferences can be

depicted: (1) when analyzed separately, each of the co-creation procedures variables appear significant and positive, as it can be perceived in table 13 and 14 regarding models II, III and IV; from here it was expected that support could be found for the three research hypotheses. (2) However, when such variables are all jointly studied, the procedures referent to development forums; software and content production, crowdsourcing, etc. (clufor) appear significant but negative; co-creation procedures by which the customer partially develops a product/service (cluada) become non-significant; solely the procedures by which the customer totally develops a product/service (cludev) remains significant, positive and somehow in accordance with the prior. As the results for Model II to IV are straightforward, from hereafter the Model V will be analyzed in depth.

When analyzing the goodness of fit of the logistic regression model, it is observable that the chi-squared statistic presents the value of 457.14, with a proof value below to 1%-level of significance. The log-likelihood statistic, with the value of -1216.795, also confirms the overall significance of the model, when compared with the null model.

Hereafter, taking into account the results, the research hypotheses will be tested and discussed, one by one. The three research hypotheses, which were formulated regarding the factor *Different ways of including customers and users in innovation activities and development of innovative products or services*, are intended to determine whether this factor influences the company's ability to develop innovative products or services.

The first hypothesis associates the company's ability to develop innovative products or services with procedures linked to the employment of users as a resource in innovation activities, joint brainstorming, co-development, and joint content production. Those procedures encompass: "Development forums and e.g., development platforms provided by the enterprise to collect ideas from users and user communities; software and content production, crowdsourcing, etc." (CIS, 2016:13). Thus, as it was presented in H_1 : *Users as a resource in innovation activities, joint brainstorming, co-development and joint content production is positively related to the propensity for the company to develop innovative products/services*. The results obtained through this model point out the estimation of the coefficient of -0.1303 (table 13) and marginal effect of -0.0106 (table 14), both significant at: 5%-level. These results present a significant and negative effect, which indicates that the specific procedures included in users as a resource in innovation activities, joint brainstorming, co-development and joint content production, restrains the propensity of the firms to develop and introduce innovative products/services in the market. This was an unexpected result, which will be explored in the discussion of the results.

The second hypothesis links the company's ability to develop innovative products or services with the utilization and commercialization of products and services modified by users. The latter is expressed by the CIS (2016:13), so that: "The user modified existing products and your enterprise further developed and commercialized it". Thus, as it was presented in H_2 , *Utilization and commercialization of products and services modified by users is positively related to the propensity for the company to develop innovative products/services*. The model's results, with respect to H_2 , have no statistical significance and, consequently, nothing can be concluded.

The third hypothesis associates the firm's ability to develop innovative products or services with the utilization and commercialization of products and services developed by users, which, according to the CIS (2016:13), is referred as: "The user developed a new product and your enterprise further developed and commercialized it". Thus, as it was presented in *H₃*: *Utilization and commercialization of products and services developed by users is positively related to the propensity for the company to develop innovative products/services*. The model's results denote the coefficient of 0.9155 (table 13) and a marginal effect of 0.0744 (table 14), both significant at: 1%-level. These results suggest that the commercialization of new products and services developed totally by users, stimulates the propensity of the firms to develop innovative products/services, which translates into a significant and positive effect.

5.3. Discussion of the results

The literature review highlighted a specific factor: Different ways (procedures) of including customers and users in innovation activities and development of innovative products.

The stratification of this factor into three research hypotheses, where the innovative contribution of the present dissertation resides, aimed to obtain empirical evidence regarding the different co-creation procedures and their influence in a firm's ability to develop and introduce new and innovative products or services in the market. Once there exists a gap in this matter, regarding both the literature and the empirical studies, a direct comparison of evidence from other authors is not allowed.

However, the literature review addresses the beforementioned fact, due to the procedures from the typologies for customer co-creation, which are also defined as collaborative New Product Development activities. In the latter, the customer plays the central role in the NPD process, performing customer generated solutions, which, Prahalad and Ramaswamy (2004), von Hippel (2005), Evans and Wolf (2005), Seybold (2006), O'Hern and Rindfleisch (2010), Piller, Ihl and Vossen (2011), Martovoy and Dos Santos (2012), among others, highlight as the path to leverage new sources of competitive advantage. Also, according to von Hippel (2005), Grewal, Lilien, and Mallapragada (2006), Shah (2006), O'Hern and Rindfleisch (2010), empirical evidence collected so far indicates that co-creation is positively associated with several NPD metrics, namely, increased new product creativity, decreased time to market and reduced development costs.

In this sense, this rationale gives the study critical mass from other authors regarding the influence that co-creation may have on the companies' development of new and innovative products and services.

Thus, according to the literature review, it was expected that previously formulated research hypotheses stimulate companies' ability to develop new products/services.

Regarding the first hypothesis, which takes into account users as a resource in innovation activities, joint brainstorming and joint content production, its model's results reflect a significant and negative effect; thus, what was expected, according to the literature, is not verifiable. In such

wise, “development forums and e.g., development platforms provided by the enterprise to collect ideas from users and user communities; software and content production, crowdsourcing, etc.” (CIS, 2016:13) are co-creation procedures that may be characterized as barriers to the firms' development and introduction of new products/services in the market.

The variable associated with the first hypothesis contains more than one co-creation procedure. The negative results might be related to the inclusion of the term ‘crowdsourcing’ on the group of procedures. Estelles Arolas and González-Ladrón-De-Guevara (2012) reported the semantic misperception of the term, as well as the literature, also referring the extant confusion between the terms crowdsourcing and crowdfunding. The literature on “crowdsourcing” (Howe, 2006), defines it as the outsourcing of a traditional job, usually performed by a firm worker, to a general large group of individuals as an internet’s open call (Schwienbacher and Larralde, 2010; Allon and Babich, 2020).

Crowdfunding is defined as a dimension of the concept of crowdsourcing, which solely focuses on the raising of financial resources from the public, known as the “crowd”, through specific online platforms (Gerber, Hui and Kuo, 2012).

According to Walthoff-Borm, Schwienbacher and Vanacker (2018), companies engage on equity crowdfunding platforms as a “last resort”, generally when the internal resources are scarce or even when they have no supplementary debt capacity. The same authors pointed out empirical evidence that denote that: companies registered on equity crowdfunding platforms are less profitable than their equivalents that are not.

Even bearing in mind the fact that companies may consider the group of all co-creation procedures concerning the first hypothesis as not favorable to their innovation process, as well as, even having knowledge of the term and procedure of crowdsourcing, they also finding it not favorable to their innovation process, the inclusion of crowdsourcing may have driven to the results obtained, by the semantic confusion with crowdfunding.

Despite the justification presented, in practical terms, the model reveals that the first hypothesis fits as a barrier to the company’s ability to develop new innovative products and services.

The second hypothesis associates the company’s ability to develop innovative products or services, with the utilization and commercialization of products and services modified by users. Regarding the latter, since its model’s results are characterized as statically not significant, no conclusions can be drawn. However, this result is configured as an important topic for future research agenda. The typologies of co-creation converge in the integration of lead user from user innovation, within their types and procedures to co-create. Although the typology proposed by O’Hern and Rindfleisch (2010) does not differentiate the lead user from the non-lead user, it embraces both, in terms of their different capacities to co-create value. However, this typology states that the type *Tinkering*, which is defined by the utilization of users that can make changes to commercially available products, which will be incorporated into subsequent product releases, includes procedures that a regular user, with lead user characteristics, would be more prone to engage. Moreover, Piller, Ihl and Vossen (2011), who consider all types of users as capable to

co-create value, included, as a type of co-creation within their typology, the *Toolkits for user innovation*. This type of co-creation includes procedures that the toolkits users, the so-called lead users, are more prone to perform.

Thusly, once co-creation includes user innovation within its types and procedures to co-create, it would be interesting to get empirical evidence on these specific co-creation procedures, more connected with the intervention of the user with lead user characteristics, within a firm's innovation process.

Collecting empirical evidence on this topic would also be important, so as to further compare the influence that non-lead users and lead-users, within their respective co-creation procedures, might have in a firm's ability to develop and introduce new and innovative products or services in the market.

With respect to the qualification of the users, that better fit to generate value jointly with a company, the literature diverges. On the one hand, Urban and von Hippel (1988), Herstatt and von Hippel (1992), Franke and von Hippel (2003), Franke and Shah (2003), Lüthje et al. (2005), Skiba and Herstatt (2009), defend that user-innovators with lead user characteristics develop the most attractive products and modifications to the market, being those users the most reasonable to embrace the company's innovation process, as their efforts can lead to radical innovation. On the other hand, Kristensson et al. (2004), claims that ordinary users are more capable to generate original and valuable ideas.

Co-creation of value turns out to be the most holistic innovation perspective, in terms of the value creation jointly with the companies, once it embraces both lead and non-lead users; however, it is still pertinent to understand the effect of each type of user on the company's ability to develop and introduce new and innovative products or services in the market.

The third hypotheses links the company's ability to develop innovative products or services with the utilization and commercialization of products and services developed by users. The respective results point out a significant and positive effect. The respective coefficient of 0.993 present a value substantially positive in regard to the stimulation of the company to develop new and innovative products and services, corroborating the studies and empirical evidence that argue that co-creation is positively related to the New Product Development metrics (von Hippel, 2005; Grewal, Lilien, and Mallapragada, 2006, Shah, 2006; O'Hern and Rindfleisch, 2010), that unlock the path to leverage competitive advantage to the companies (Prahalad and Ramaswamy, 2004; von Hippel, 2005; Evans and Wolf, 2005; Seybold, 2006; O'Hern and Rindfleisch, 2010; Piller, Ihl and Vossen, 2011; Martovoy and Dos Santos, 2012).

In practical terms, the third hypothesis represents a stimulus for companies to develop and introduce new and innovative products and services in the market, by embracing third hypothesis' inherent co-creation procedures within their innovation process.

In conclusion, a contribution of the performed research work regards the differentiation of three groups of co-creation procedures, allowing a specific analysis of how each group may stimulate or restrict the development of new products or services. Although the first two groups of co-creation procedures are a barrier and inconclusive, respectively, the third one unfolds a

positive and considerable stimulus. Since all the research hypotheses that were formulated are convenient from the same factor, overall, it may be concluded that value co-creation is a stimulant key driver for innovation which, when introduced along a firm's innovation process, it will stimulate the firm to develop and introduce new and innovative products and/or services in the market, developed partially or totally by its users.

6. Conclusions

The main objective of this research is to study value co-creation as a key driver for innovation in the development of innovative products/services, applied in the Portuguese firms.

The literature review firstly regards to the explanation of the inherent contents of this study, in respect to the concept of innovation, its historical evolution until the emergence of the open innovation approach, user innovation and co-creation. In the beginning, ever since Schumpeter defined the concepts of economic development and the entrepreneur as the actor responsible for Innovation, all the market's entities, even the Government itself, embraced the linear and producer-centered models of innovation. In the late 70's, the emergence of the Interactive Innovation model disrupts with the linear models, being coincident in time with the beginning of the user innovation model.

Later, the open innovation model also arises the importance of non-linear models, since they break the barriers between the companies and their external environment for innovation purposes. Despite companies having evolved into non-linear models of innovation, the management of information persisted producer-centered, which translates into the incapability to totally meet customers satisfaction, in regard to the lack of information on their specific and peculiar needs. Both user innovation and co-creation address this problem although, while user innovation strategy is customer driven and its management of information is customer-centered, co-creation, being an integrant part of open innovation, has a firm driven strategy, managing the information in a customer centric basis simultaneously.

Once is intended to study which companies are strategically driven themselves, towards activities related to the management of information centered in the user, for better perceive the latter intrinsic needs, in order to accurately meet them, co-creation arises has the most holistic perspective of open innovation. Co-creation is defined by the joint creation of value, between companies and users, attending to iterative interactions to better perceive users' needs, which will result in a unique experience during the process of the development of a new innovative product or service, also enclosing user innovation as a form to perform co-creation.

Additionally, the literature review points out two Co-Creation Typologies for the verification of the conceptual terminology and rationale's accordance with the CIS 2016. Despite the differences regarding the division of the activities within the types of co-creation they propose, the typologies are similar in terms of the procedures by which the interactions with customers are performed. Later, it is concluded that those procedures literally coincide with the methods described within the CIS 2016, and so, the applicability of the CIS 2016 to the study is observed.

The data that was analyzed in order to fulfil the main objective of this research was secondary data provided by the CIS 2016, which is trustworthy, once it's validated by EUROSTAT. Applied in Portugal, the CIS section that was analyzed covers 4337 national responses from firms, configuring itself as a respectable amount of data, which allowed a proper analysis, performed through econometric models.

The statistical software used to conduct the statistical analysis of the data was the Stata for Windows.

After the validation of the goodness of fit of the logistic regression model was assured, the data analysis was performed, to which ensued the discussion of the results. Taking into account the three research hypotheses, which contained different groups of co-creation procedures, the main model (model V) reported three different outcomes: the first revealed both a significant and negative effect; the second had no statistical significance; the third revealed a significant and positive effect.

It was then determined that, considering the first hypotheses, the model revealed that users as a resource in innovation activities, joint brainstorming, co-development and joint content production, restrain the firm's ability to develop new innovative products and services. The second hypothesis, which associates the firm's ability to develop innovative products or services with the utilization and commercialization of products and services modified by users, was inconclusive. Finally, with regard to the results of the third hypothesis, it was concluded that the utilization and commercialization of products and services developed by users, represents a stimulus for companies to develop new and innovative products and services.

Ultimately, the three hypotheses formulated took into account the same factor: the different ways of including customers and users in innovation activities and development of innovative products or services. The research hypotheses that were formulated allowed a decentralization of the factor, grouping the procedures of co-creation into three different groups of procedures to study. This fact is the responsible for the innovative and differentiator contribute of the present research. It also confirms that once the model's results for the third hypothesis are significant and considerably positive, they corroborate the extant literature that relates positively the co-creation to the NPD metrics, which consequently unlocks paths to leverage competitive advantages. Hence, co-creation is, in this sense, a stimulant key driver for innovation in the development of innovative products or services.

Moreover, the results from the model allow to attend both the main objective as well as the secondary objectives depicted in the introduction.

Regarding the limitations, the first one is referent to the lack of studies and the gap of empirical evidence on the main research topic, co-creation and its procedures. This limitation revealed itself harder in the discussion of the results, once it was not possible to directly relate the results from the model with empirical evidence on the procedures to perform co-creation as a whole. In addition, despite the extant typologies for co-creation, which groups procedures to co-create per type of co-creation, again there is a gap with regard to empirical evidence with respect to results on each type of procedure; thus, it was not possible to perform a direct comparison with the model's results.

Other limitation emerged from the utilization of the CIS (2016). In spite of the data being validated by EUROSTAT and, therefore, trustworthy, the questionnaire groups the co-creation types in only three groups of procedures. In this sense, and due to the performed bridge between the present research and the CIS (2016), it was possible to analyze those three groups of

procedures. However, if the survey provided a wider and more detailed co-creation section to answer, the results and conclusions could be more specific in terms of the influence and importance of each of the co-creation procedures, in the firm's ability to develop new and innovative products/services.

The third limitation presented in the present research work entails the first two limitations mentioned previously, culminating in the fact that, there is a gap in the studies and empirical evidences that regards co-creation, its types/procedures and the CIS. In this way, it was not possible to directly compare the model's results with possible results from other authors.

The suggestions proposed for future research agenda were a result of the research process performed and the limitations detected. It is considered that the following suggestions may provide new evidence on the phenomenon of customer co-creation, more specifically on the topic of the procedures that influence the firm's development of new and innovative products or services.

It is proposed a work that derives from the limitations found in the present investigation, mainly in terms of the necessity of more empirical studies on the co-creation procedures, to increase the collection of additional results, which will, consequently, enable further comparisons and deeper conclusions.

In addition, the proposed model might be developed; it is adapted according to the CIS (2016) survey, however, if other trustworthy sources of data are more detailed in terms of the co-creation procedures, the explanatory variables could be more detailed too, resulting in a model that exports results more specific, in terms of the effects of each of the co-creation procedures.

In the "Discussion of the results" of the present work, two topics are also referred for future research agenda. They are related to the results with regard to the second research hypothesis, which are statistically not significant, hence inconclusive. Nevertheless, once co-creation includes user innovation within its types and procedures to co-create, as previously depicted:

- It would be interesting to get empirical evidence on these specific co-creation procedures, related, to a greater extent, to the intervention of the user with lead user characteristics, within a firm's innovation process, to assess their influence;
- Collecting empirical evidence on this topic would be also important to the comparison of the influence that the regular users and lead-users, inserted in their respective co-creation procedures, might have in a firm's ability to develop new and innovative products or services.

Moreover, as Model II to IV presented positive and significant results for each of co-creation procedures separately but, when jointly analyzed in Model V, the results regarding the procedures to co-create do not remained aligned, more research in this specific topic is required, to understand the impact of the procedures separated and combined as well.

Another proposed research is to repeat the empirical research carried out in this investigation with the CIS (2014) and the CIS (2018), in order to obtain information that promotes

the evaluation of the past and the evolutionary trends. In this perspective, it is considered that the repetition of this research in other countries that responded to the same or to a similar CIS could also enrich the study of the phenomenon of co-creation. At an academic level, this study also aims to open doors for future studies, through parallel analysis or complementary studies that analyze the subject more broadly. It was intended to extend the knowledge on co-creation as a key driver for innovation and development of new and innovative products and services.

Finally, the researcher's work should not be limited to the elaboration of explanatory and inferential models alone; it is her/his responsibility to contribute to the evolution of scientific research, as well as to take action to foster innovation. Only then will it be possible to move from understanding a phenomenon/concept to proposing possible initiatives, aiming at improving the innovative capacity of companies and, consequently, improving the competitive capacity of Portuguese companies.

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Appendix

Table A11 – Spearman's Correlation Matrix

	inclu	clufor	cluada	cludev	tech_inten sity	fin_supp_n um	firm_size	Int_Orienta tion	inpdgd	inpdsv	mktddp
inclu	1										
clufor	0.0812*	1									
cluada	0.2195*	0.4871*	1								
cludev	0.2875*	0.4898*	0.8189*	1							
tech_intensity	-0.0829*	0.0933*	-0.0272	-0.0630*	1						
fin_supp_num	0.1171*	0.1000*	0.1261*	0.1394*	-0.0851*	1					
firm_size	0	0.0739*	0	0	0.0416*	0.1202*	1				
Int_Orientation	0.0835*	0	0.0825*	0.0934*	-0.1233*	0.1427*	0.0278	1			
inpdgd	0.1540*	0.0913*	0.1564*	0.1866*	-0.1845*	0.3264*	0.0305*	0.1668*	1		
inpdsv	0.0841*	0.1356*	0.1516*	0.1493*	0.2101*	0.2090*	0	-0.0258	0.2325*	1	
mktddp	0.0810*	0.1380*	0.1674*	0.1806*	0	0.0740*	0	0.0658*	0.2053*	0.1103*	1