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METODOLOGIA PARA DESENVOLVIMENTO DE NEGÓCIOS A PARTIR DE PROGRAMAS DE TRANSFERÊNCIA DE TECNOLOGIA

Dissertação no âmbito do Mestrado em Engenharia e Gestão Industrial orientada pela Professora Doutora Aldora Gabriela Gomes Fernandes, apresentada à Faculdade de Ciências e Tecnologia da Universidade de Coimbra no Departamento de Engenharia Mecânica.

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Metodologia para desenvolvimento de negócios a partir de programas de transferência de tecnologia

Dissertação apresentada para a obtenção do grau de Mestre em Engenharia e Gestão Industrial

A methodology for developing businesses from technology transfer programs

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“Imagination will often carry us to worlds that never were.

But without it we go nowhere."

(Carl Sagan, in Cosmos, 1980)

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First, I want to thank my beloved family for all the help and support given throughout these years. It was a difficult choice to pursue bigger opportunities but I am sure that we will soon be reunited.

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Resumo

A presente dissertação resulta de um estágio curricular no Centro de Incubação de Empresas da Agência Espacial Europeia (ESABIC), sedeada pelo Instituto Pedro Nunes, em Portugal. Sendo um dos atores envolvidos no Escritório do Programa de Incubação de Negócios da ESA (TTPO), a ESABIC Portugal tem como propósito promover empreendedorismo no ecossistema de inovação Português e fomentar a transferência de tecnologia espacial para aplicações terrestres.

A inovação é um dos fatores-chave que levam ao crescimento económico e bem-estar social, e uma das formas que ocorre é através da transferência de tecnologia. Entretanto, usar patentes para promover inovação através de transferência de tecnologia é um processo complexo e cheio de incertezas, ademais, não há um conjunto bem definido de atividades que permitam aos empreendedores desenvolver modelos de negócios de base tecnológica, usando patentes disponíveis em programas de transferência de tecnologia. Deste modo, este projeto de pesquisa possui o objetivo de desenvolver uma metodologia para auxiliar empreendedores a desenvolverem negócios usando patentes disponíveis em programas de transferência de tecnologia.

A metodologia, designada por P2B, foi desenvolvida em duas etapas. Primeiramente, uma versão inicial da metodologia foi desenvolvida baseando-se em uma revisão de literatura estruturada e na análise do caso de estudo da ESABIC Portugal. Em seguida, dados coletados através de 13 entrevistas semiestruturadas com especialistas em transferência de tecnologia, gestão da tecnologia, inovação e desenvolvimento de modelos de negócios, permitiram criar a conceptualização final da metodologia P2B.

A metodologia P2B proposta pretende endereçar os desafios inerentes ao processo de desenvolvimento de negócios inovadores, específico para transferência de tecnologia, provendo um conjunto de 23 atividades, suportadas por 16 ferramentas, divididas em quatro fases: análise da tecnologia, análise do valor, modelo de negócio, e plano de negócios.

Palavras-chave: Modelo de Negócio, Inovação, Transferência de Tecnologia.

Abstract

This dissertation results from a curricular internship at the European Space Agency Business Incubation Center (ESABIC), hosted by Instituto Pedro Nunes, in Portugal. As one of the actors involved in ESA's Technology Transfer and Business Incubation Programme Office (TTPO), ESABIC Portugal has the purpose to promote entrepreneurial behavior in the Portuguese innovation ecosystem, by fomenting technology transfer of space technology for terrestrial applications.

Innovation is one of the key aspects that drive economic growth and social welfare, one of the ways that it can occur is through technology transfer. However, using a patent to innovate through technology transfer is a complex process full of uncertainties, and there is not a well-defined set of activities that enables entrepreneurs in developing business models based on patents. This research project aims to develop a methodology to support entrepreneurs in the development of businesses from patents available in technology transfer programs.

The named P2B Methodology was developed within two research steps. Firstly, the initial conceptualization of the methodology was created based on a structured literature review and the analysis of ESABIC's case study. Secondly, data collected throughout 13 semi-structured interviews with experts in technology transfer and management, innovation, and business model development, enabled the development of the final proposed P2B methodology.

The proposed P2B methodology addresses the challenges inherent in the innovative business development process, specific to the technology transfer context, by providing a set of 23 activities, supported by 16 tools, divided into four major phases: technology analysis, value analysis, business model and business plan.

Keywords Business Model, Innovation, Technology Transfer.

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LIST OF ACRONYMS

APQ – Activity Pitch Questionnaire

B2B – Business to Business

BMC – Business Model Canvas

CBMIP – Cambridge Business Model Innovation Process

CI – Closed Innovation

DA – Documental Analysis

ECSS – European Cooperation for Space Standardization

ESA – European Space Agency

ESABIC – European Space Agency Business Incubation Center

FCT – Foundation for Science and Technology

FCTUC – Faculty of Science and Technology of University of Coimbra

IP – Intellectual Property

IMP – Intellectual Property Management

IPN – Pedro Nunes Institute

IOI – Inbound Open Innovation

IPM – Intellectual Property Management

LOI – Local Open Innovation

LR – Literature Review

NDA – Non-Disclosure Agreements

NTTI – National Technology Transfer Institute

OECD – Organization for Economic Co-operation and Development

OI – Open Innovation

OOI – Outbound Open Innovation

POC – Proof of Concept

R&D – Research and Development

RLA – Research Licensing Agreements

SA – System Architecture

SME – Small and Medium-sized Enterprises.

TAM-SAM-SOM – Total Available Market, Serviceable Available Market, and Serviceable Obtainable Market

TTPO – Technology Transfer Promoting Office

TPM – Technology, Product and Market

TTP – Technology Transfer Program

TRL – Technology Readiness Level

1. INTRODUCTION

1.1. Motivation and Concepts

The economic crisis that struck the European continent in the early 2000s forced countries to impose several budget restrictions on governmental space agencies, thus, reducing their innovation capacity. However, organizations such as the European Space Agency (ESA) resorted to Open Innovation (OI) practices to sustain innovation in a way that not only would they benefit from technology derived from other industries but also, amplify the usage of space technology on terrestrial applications (van Burg et al., 2017).

These practices vary according to the type of company that is studied, as an example, Moellers et al. (2020) point out that multi-national enterprises that run various business units commonly use the combination of five OI practices being: Gather knowledge from outside of the company; Opening to end users the possibility to join the project as sponsors or evaluators; Innovations developed to one business unit may be applied to other business units to reduce the time between innovation cycles; Promote innovation by sharing projects with employees with an internal crowdsourcing system; Document and communicate successful business model implementations.

In the case of the European space sector, van Burg et al. (2017) expose the following practices: Cooperation agreements and alliances within the supply chain, where ESA is the end customer, the member state's agencies mediate the flows of a large array of suppliers that are on the level below; increase the involvement of startups in new projects and collaborations due to their flexibility and the fact that they are not yet embedded in pre-existing innovation networks; Combine knowledge and competences by the establishment of joint ventures to develop new technology and consequently, create value.

As Chesbrough (2003) explains, open innovation is the multi-lateral flow of knowledge and resources to promote the creation of multiple paths to market for a certain technology, in a way that the management of Intellectual Property (IP) should not be exclusive, but instead, benefit from external capabilities to profit from its broad usage and market applications.

Amongst several other paths for open innovation, such as joint ventures or research contracts, the technology transfer stands out, being the most common form of collaboration between public and private entities (Min et al., 2020). Although it is a complex process, which depends on lots of variables to succeed, it is also a reliable way to create, develop and apply the results of research in various kinds of industries (Heinzl et al., 2013).

Technology transfer can be defined as a process in which technology derived from a scientific entity, such as universities and other higher education institutes, is transferred to an industrial entity, that can be represented by large companies or startups, to develop new products, services or processes and thus, commercialize the technology (Heinzl et al., 2013). Following this line of thought, this dissertation assumes technology transfer as a process, establishing the European Space Agency (ESA) as the scientific entity and the industrial entity is represented by the entrepreneur that aims to adapt one patent to develop new products or services and thus, create a new business.

In the same way that the technology transfer is perceived as a process, innovation can also be seen as a process, Tidd and Bessant (2015) proposed a four-step process model for innovation that has a sequence of activities that allows entrepreneurs or enterprises to exploit new ideas and benefit from them. The process begins with the recognition of trigger signals and the identification of subsequent opportunities. The second step strategically identifies, manages, and mobilizes the resources needed to pursue the chosen opportunity. The third step is where the idea starts to being built and adapted into a business model which once it is supported by tests and validations with stakeholders, eventually will be launched in the market. The fourth and last step is related to value capture, collect the rewards of the risks and more important, managing several aspects of the business to guarantee its longevity (Tidd & Bessant, 2015).

A business model can be defined as a structured set of organized variables that show how a company manages several aspects of its operation and integrates them internally and externally to deliver value to its customers (Zhu et al., 2019). This concept can be perceived as complementary to open innovation thus, it could bring benefits to the development of new technology, processes, or products if applied simultaneously.

According to the previous assumptions, Bogers et al. (2017) state that the organizational level aspects that are common to open innovation and entrepreneurship need further examination, by exploring both perspectives and understanding how OI can lead to entrepreneurial opportunities and innovative breakthroughs. Bogers et al. (2017) also suggest that the business model concept can allow the assessment of these opportunities, due to its ability to create value and capture it and also, establish a reliable interface with the costumers.

1.2. Research Objectives

The ESA, by the means of its Technology Transfer Promotion Office (TTPO), has an important role in sustaining a continuous downstream flow of space-related technology to terrestrial markets. To do so, the National Technology Transfer Initiative (NTTI) was created, providing support to the technology transfer process by connecting IP created in the space sector with technological demands from a member state's national industries. Furthermore, the TTPO has the responsibility of coordinating a network of Business Incubation Centers that focus mainly on promoting the development of start-ups and aid entrepreneurs that focus on transforming space technology into viable businesses.

Currently, there are some milestones that entrepreneurs must overcome to successfully transfer technology from ESA. The first is a quick assessment of the overall idea and use of space technology in the new solution, which is called the Activity Pitch Questionnaire (APQ). This questionnaire evaluates the proposal and indicates one of two paths, one is the Feasibility Study, an initial study in which the main goal is to verify if a business can be created from the adaptation of space technology for terrestrial markets and assess its feasibility. The other is called Demonstrator Project, it serves to evaluate technical aspects of the proposal, in cases where there is risk related. Either way that the proposals take, if they are accepted, it is requested the submission of an Outline Proposal, which passes through ESA’s evaluation. Also subjected to evaluation, the last milestone is the submission of the Full Proposal, which if accepted, signifies the start of the negotiations with ESA for the transfer of the technology.

A large set of tools can help entrepreneurs in their innovation journey but the steps described above can be complex and surrounded by uncertainty and risks. Moreover, there is not a standard guideline that aids entrepreneurs and enlightens the process of developing businesses using patents derived from Technology Transfer Programs (TTP). In the context of this work, TTP represents a process in which entities, that are primarily research institutes, pretend to commercialize intellectual property and promote social and economic benefits, thus, provides to entrepreneurs or start-up’s a chance to exploit the advantages of their technologies, manufacture processes, knowledge, and patents. In this process, the pledging entity is required to present a business plan to join the program and benefit from the financial and operational support that these entities provide.

And so, the present study aims to develop a methodology that guides the creation of business models that benefit from patents that are available in technology transfer programs and thus, deploy value to its customers and other stakeholders. The work displayed in this dissertation results from a curricular internship at ESABIC Portugal, which is hosted by Pedro Nunes Institute (IPN), located in Coimbra, Portugal, as an entity embedded in the NTTI.

The main research question that the present study address is: *"How can businesses be developed based on patents derived from technology transfer programs?"*. To obtain an answer to this question, a series of objectives were proposed:

- Analyze ESABIC Portugal's standards, requirements, and guidelines to develop businesses based on TTP;
- Create an initial conceptualization of the P2B methodology based on a structured literature review and the analysis of the ESABIC case study;
- Develop the final proposed P2B Methodology, using the data collected from interviewing experts in innovation and technology transfer.

In summary, an initial conceptualization of the methodology is created, based on the combination of the knowledge obtained through a structured literature review over the research topics and information gathered through documental analysis from ESABIC's standards, requirements, and guidelines. Then, resorting to data and knowledge collected over semi-structured interviews with experts in innovation and technology transfer, enhance the methodology in a sense that, by subjecting it to external and sometimes, divergent opinions over the same topics, can bring different insights and thus making it more complete.

1.3. Methodology

The research model proposed by Saunders et al. (2019) guides the execution of this project. An interpretivist philosophy with an inductive approach was chosen to instantiate an entrepreneur's perspective on the process of innovation that occurs when there is a problem that requires a solution and a technology transfer opportunity presents itself. Furthermore, this dissertation can be classified as an exploratory study, since the interviews with experts in the subject were conducted to gather knowledge on the research topics and the used to create a methodology.

A single-case, holistic, and cross-sectional case study was employed consisting of a multi-method data collection and analysis using exclusively qualitative methodologies. In a first moment, documental research on ESA standards was made to gather specific information, such as ESA's Business Applications requirements for funding and guidelines offered by the agency on the tendering for Feasibility Studies or Demonstrator Projects. Subsequently, more data was collected throughout semi-structured interviews with experts in innovation, technology transfer, technology management, and business development to be used as input to further enhance the methodology.

1.4. Dissertation Structure

This document is divided into eight chapters, starting with this introductory chapter that contextualizes the work done, presents what was the motivation behind the research as well as its objectives and research methodology. The second chapter contains a description of the methodology chosen to perform the structured literature review and the discussion and analysis of its findings, assessing themes that revolve around the innovation process and technology transfer. A third chapter further explains the methodological approach of this dissertation, including the steps taken to execute the project and present a discussion over the data collection and analysis process.

The fourth chapter consists of the description of the case study, in which the context of the ESABIC's is explained and its contribution to the initial development of the methodology. The fifth chapter displays the findings of the literature review and the documental analysis and presents the initial conceptualization of the methodology, as well as a description of each one of its phases and at the end, summarizes the challenges identified. The sixth chapter is where the discussion and analysis of the themes evidenced in the data collected throughout the interviews are made, and activities and tools are evidenced. The seventh chapter consolidates all the information from the previous chapters in the final proposed P2B methodology and presents discussions about the decisions made for each phase's content and showcases the final conceptualization of the P2B methodology. Lastly, the eighth chapter presents the conclusions regarding the findings and insights obtained through the course of this project, this work's main limitations and make proposals for future studies that follow the same line of research than the present one.

2. LITERATURE REVIEW

This chapter begins by explaining the chosen methodology to perform the structured literature review, then, sets forth discussions over the literature findings and how can they contribute to the main purpose of this dissertation.

The focus of this review is to present an overview of the existing knowledge on the path that leads to innovation, by starting with the concepts of open innovation, it is possible to understand its importance and how technology transfer plays a key role in promoting the diffusion of knowledge and technology and its benefits for society. Furthermore, the topic related to how innovation occurs, and its characterization as a process is also addressed, due to its relevance on how companies and entrepreneurs exploit such technologies, supported by business model generation and value proposition tools to generate profit and promote economic growth.

Moreover, obtaining a better understanding of these topics provided means to create an initial conceptualization of the P2B methodology and support the decisions and arguments made in the next chapters.

2.1. Review Methodology

A crucial part of any research project is the literature review, serving not only to map and analyze the existing knowledge about one specific subject but also allows the identification of gaps in the body of knowledge that, throughout the assessment of a research question, further expands its frontiers (Tranfield et al., 2003).

According to Müller et al. (2014), a structured literature review needs a well-defined research method in which the main source of data is not interviews or surveys, but instead, information gathered from the available literature. Thus, this literature review was conducted using the framework proposed by Svejvig and Andersen (2015), which consists of an iterative process, containing four stages that range from defining the study’s scope to analyze included pieces of literature.

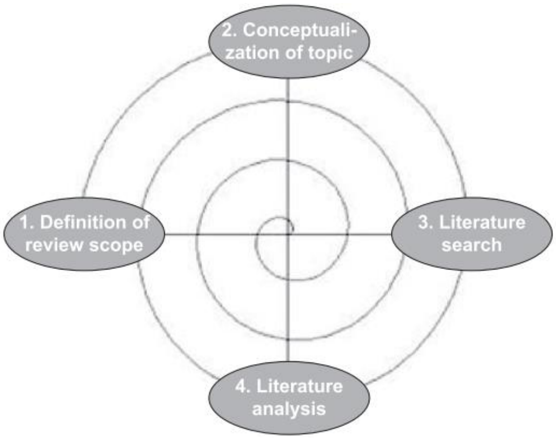

Figure 1. Framework for the structured literature review.
Retrieved from Svejvig and Andersen (2015).

As shown in Figure 1, the research begins with the definition of the review's scope, which, in the case of this dissertation, is focused on innovation processes that aim to develop businesses that uses patents derived from technology transfer programs and then, commercialize them in different markets or industries.

The second stage represents the conceptualization of the research topic. In this work, three topics were researched. First, a general review of the current innovation paradigm and the contrast between Closed Innovation (CI) and Open Innovation. The second topic explores the concept of technology transfer and the mechanisms and processes that occur to transfer technology, which is relevant since it is one way that companies or entrepreneurs can take to innovate, in complement, how these concepts are applied in the space sector and its specificity. Lastly, it is crucial to understand the path to turn opportunities and ideas into businesses, thus, not only topics related to the innovation process but also, value proposition and business model generation tools were enlightened.

From that point, the third stage represents the search for relevant literature about the research topics. This review was performed by searching in the ScienceDirect database for journal publications such as review and research articles, and also, articles that were indexed in SCOPUS and Web of Science.

Table 1. Search strings and search results from the literature review.

Databases	Search String	Search Results
ScienceDirect	"Technology Transfer" AND "Open Innovation" AND "Innovation Process" AND "Business Model*"	118
Scopus	(TITLE-ABS-KEY ("Technology Transfer") AND TITLE-ABS-KEY ("Open Innovation") AND TITLE-ABS-KEY ("Innovation Process"))	26
Web of Science	("Technology Transfer" AND "Open Innovation" AND "Innovation Process")	17

Table 1 summarizes the search strings used as well as the results of the search process from each database, and a total of 161 publications were found. Although the findings contained publications with the terms described above, it also presented articles related to subjects that diverge from the review's scope. Furthermore, the titles and abstracts of those publications were examined, then, they were either included or excluded from the review, based on the criteria discussed below.

The publications included in this review: provide general knowledge over the relation between open innovation practices and the innovation process; based on the work of Chesbrough (2003), analyze inbound and outbound open innovation and its challenges and advantages in various industries; explore the use of IP management and technology transfer opportunities as a mean to sustain innovation or demonstrate the use of technology transfer within the space sector context; addresses tools and methods for value creation and business modeling.

In addition to the previously selected literature, there was a need to include other publications. The work of Chesbrough and Crowther (2006) which explores open innovation in various industries beyond high-tech companies, the study made by Bozeman (2000) that display knowledge on the technology transfer process, the contributions of Osterwalder and Pigneur (2010) for the business model concept, the Business Model Innovation Process developed by Geissdoerfer et al. (2017) and the concepts for Innovation Process proposed by Bessant and Tidd (2015) are solid examples of publications that did not appear in the initial search results but represent important knowledge that cannot be forgotten when assessing the research topics.

Although the search indeed revealed several contributions to the literature encompassed with the research topics, some of them are not relevant to the focus of the research thus, were excluded from the analysis, a few examples are papers that: analyze organizational dynamics that dictate the openness level of companies in certain kinds of industries; studies that present techniques, procedures, challenges or advantages obtained from the implementation or creation of technological hubs, innovation arena or ecosystem; addresses the usage of open innovation in the renewable energy sector, although they tackle applications of OI concepts, the market specificities of this industry is not quite relevant for this work; measures the performance or efficiency of the several actors involved in open innovation and technology transfer process.

The results of the research process are shown in Figure 2 below. Articles that overlapped between databases were identified and removed from the count on Table 1, then, from the initial research, 25 pieces of literature, from all the databases researched, were included in this review based on the criteria discussed previously. Furthermore, 22 other publications were also included since they represent relevant knowledge to the execution of this work, consolidating a total of 47 selected.

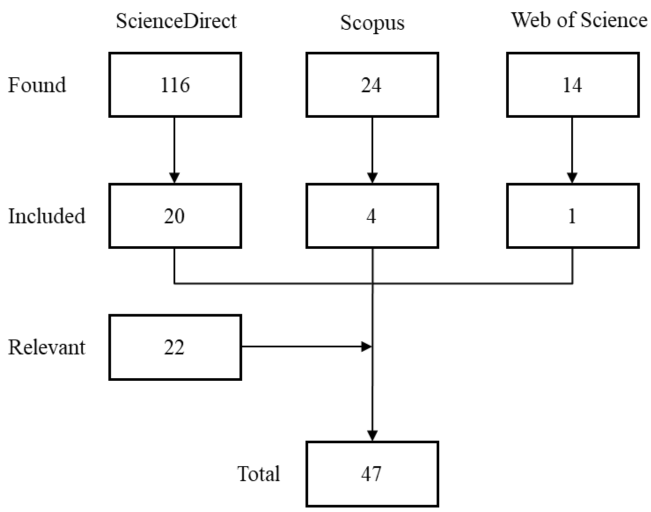

Figure 2. Literature selection scheme.

The fourth and last stage of the review consists of the analysis of the research findings. It starts assessing innovation and the current paradigm exposed by the literature then, focusing on open innovation on an organizational level (Bogers et al., 2017) and then, discuss its application in the space sector. Afterward, the topic related to technology transfer is analyzed based on the assumptions made by Heinzl et al. (2013), who assumes a process point of view of the subject, then, the components that need to exist to technology transfer process occur are identified and lastly, topics related to the process of innovation, supported by the framework proposed by Bessant and Tidd (2015) in which the works of Osterwalder et al. (2015) and Osterwalder and Pigneur

(2010) are particularly relevant to the purpose of this dissertation. The publications used in this literature review are displayed in Appendix A.

2.2. The New Paradigm of Innovation

It is known across the literature that innovation is a key driver to economic growth (Maradana et al., 2019). In a highly connected world, enterprises must deal with the pressure of growing global competition and innovation is one of the approaches that companies have to ensure their competitiveness (Ciocanel & Pavelescu, 2015).

Crossan and Apaydin (2010, p. 1155) define innovation as the *"production, assimilation, and exploitation of a value-added good; the renewal or expansion of pre-existing products and services; the development of new production systems and the establishment of new management models, being both a process and an outcome"*. Furthermore, innovation also includes the successful implementation and market reach of a new idea, product, or technology (Chesbrough, 2003).

Intrinsic to these concepts, there is a duality related to the types of innovation that exist, whether it is incremental or radical. The first is represented by small changes in products, technology, or processes that already exist and thus, are not new to costumers (Chandy & Tellis, 1998). This can be attributed to the search for the optimal performance of a product or service that leads to improvements in existing processes or technology and can be sustained throughout time (Summerer, 2012).

According to this argument, incremental innovation can be exemplified by the annual launch of new cell phones, the adaptation of culinary goods to attend to a specific group of customer's diet restrictions, like gluten-free products or vegetarian and vegan versions of popular foods such as hamburgers.

On the other side, radical innovation can be classified as totally new products, technology, or processes developed by companies in anticipation of customer needs or even developing brand new markets (Chandy & Tellis, 1998). Some examples of radical innovation are the commercial space flight business models that SpaceX and Blue Origins operate or, taking a more extreme approach, the creation, and expansion of the internet itself.

Although both of them share the same principles, there are notable differences since the incremental type can be achieved naturally by the continuous iterations inside a firm or the modern world fast-moving society and it represents the normal path of evolution of technology. In contrast to that view, Chesbrough (2003) states that radical innovation implies drastic changes in social and economic practices that can be extremely hard to predict or even how it will affect society.

However, this classical view of innovation is currently being overwhelmed by the innovation model proposed by Chesbrough (2003) that establishes a new paradigm to approach innovation, dividing it into closed and open innovation.

Closed innovation is known to be the most common type of innovation method that highly Research and Development (R&D) focused companies utilize nowadays (Johannsson et al., 2015). It is represented by the urge to obtain competitive advantages and create value for customers in a closed and well-controlled environment within the company boundaries and the flow of knowledge from inside the company towards the market (Chesbrough, 2003).

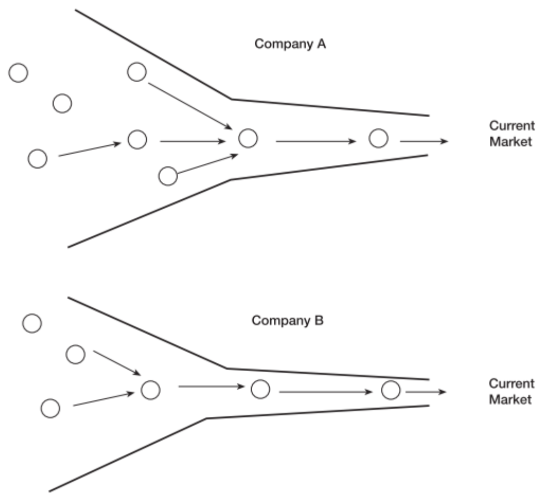

Figure 3. Knowledge flow in closed innovation models.
Retrieved from Chesbrough (2003).

As shown in Figure 3, the process of innovation is done within the boundaries of a company. Not having two-way trades of knowledge and capabilities implies that all the activities needed to develop and market innovation are performed only with the resources of the company. In certain cases, a closed innovation strategy narrows the market opportunities, preventing the discovery of new markets to explore.

Nonetheless, one notable example of how CI model can be applied strategically is the case study of Lindt & Sprüngli done by Manzini et al. (2017) that relate the company's choice to remain "as closed as possible" on their innovation process due to its experience, longevity in the market and the nature of their business model.

The case of Lindt & Sprüngli is a good example that open innovation does not attend to companies' necessities. The transition from closed to open innovation is complex and requires a lot of resources to be made and does not necessarily come with the guarantee of success (Huizingh, 2011; Lopes & de Carvalho, 2018). Although closed innovation is vastly used in various industries and has relevance to companies' innovation, open innovation has shown has become a growing trend amongst experts and practitioners.

2.3. Open Innovation

2.3.1. Open Innovation Overview

In this section, the classification established by Bogers et al. (2017) was used to define the analysis level and research object for open innovation research. Thus, the following discussions focus on the organizational level, which relates not only to practices or processes that organizations apply to integrate external innovations but also to the perspective of new entrants, being SMEs or entrepreneurs in pursuit of new business opportunities.

Open innovation models take on a different approach on how innovation occurs within several entities, it allows an entity to benefit from internally integrating capabilities that are external to itself or enables the results of internal R&D to be explored by external actors that presented to be more efficient, and so, according to this model, the flow of knowledge and technology is divided into two types, inwards or outwards (Gambardella & Panico, 2014).

The inwards flow is referred in the literature as Inbound Open Innovation (IOI) and is represented by the integration of ideas originated outside the companies frontiers, meanwhile, Outbound Open Innovation (OOI) consists in searching outside the boundaries of the company for more efficient and reliable companies to market part of technology developed inhouse (Chesbrough & Crowther, 2006; Lopes & de Carvalho, 2018; Spithoven et al., 2011).

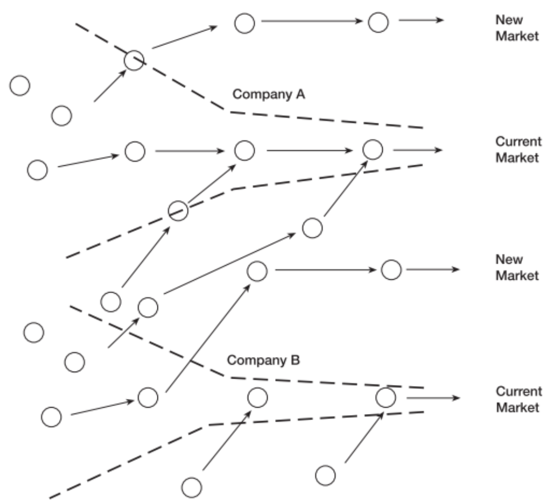

Figure 4. Knowledge flow in open innovation models.
Retrieved from Chesbrough (2003).

In Figure 4 it is possible to notice the characteristics of inbound and outbound open innovation, taking Company A as an example, IOI can be applied to remove the dependence on inhouse R&D (Lopes & de Carvalho, 2018) and enhance the innovation's path to a current market while increasing the firm's innovativeness (Chesbrough & Crowther, 2006).

Meanwhile, OOI can be used not only to generate new streams of revenue by the discovery and exploitation of new markets but also to achieve strategic objectives such as the establishment of new standards for an existing industry, expansion of the current market being exploited, development of new technology in partnership with other companies and attend to common goals, improving efficiency on the development process and marketing of innovations (Masucci et al., 2020).

2.3.2. The Triple Helix Model

Collaboration is the essence of open innovation and the efforts of several entities are needed. The Triple Helix Model is a representation of the three main actors that take part in the open innovation process and thus, directly impact its results. Marcolin et al. (2017) categorize them based on the type and role they play in the open innovation process. First, there is the business blade, composed of large companies, SMEs, start-ups, or entrepreneurs who are responsible for creating market-driven solutions that attend customers' needs, also, it is composed of large companies, SMEs, start-ups or entrepreneurs.

The second blade represents the government, who is responsible for making policies to foment innovation and promote overall open innovation practices upon their jurisdiction, other actors take an important part in this blade, such as Science and Technology Parks, incubators, and technology hubs. Lastly is the research blade, which is represented by R&D institutes, that can be public or privately funded, also universities or higher education institutes, whose main goal is the development of technology-based on scientific principles. Furthermore, the authors also propose another classification, dividing them into five0 categories, depending on how each entity contributes to the process, these categories are: Suppliers; Customers; Competitors; Non-competitors; Consultants.

To address the impacts of the actions taken by the Triple Helix actors on innovation performance, the study made by Guerrero and Urbano (2017) analyses how the participation in collaborative R&D agreements, access to financial resources such as private funds for R&D projects or governmental support, and lastly, the socio-economic context in which the studied firms are embedded. Based on the evidence displayed in the study, the authors concluded that these factors have indeed a positive effect on the entrepreneurial innovative performance of these types of companies.

2.3.3. Barriers, Capabilities, and Practices for Open Innovation

The innovative performance of enterprises that adopts open innovation practices can also be related to how they organize and mobilize resources complemented by their capacity to manage and use these resources to overcome some obstacles. A study made by Ozkan (2015) explores how Procter & Gamble Co. (P&G) achieved success in the implementation of open innovation. The author concluded that the company was able to achieve success due to several changes in organizational mindset, strategic alliances with universities, the establishment of joint ventures, external licensing and partnership with leading companies in various markets.

Some of these practices may vary according to some of the company’s characteristics, as an example, Moellers et al. (2020) point out that in the case of multinational enterprises operating multiple business units, the most common OI practices are: Gathering knowledge from external sources; Opening to end users the possibility to join the project as sponsors or evaluators; the application of innovations that were developed in one business unit, in other ones to reduce the time between innovation cycles; Promote innovation by sharing projects with employees with an internal crowdsourcing system; Documentation and communication of successful business model implementations.

However, the implementation of OI does not depend solely on the company's capabilities, since not all organizations have access to abundant resources. According to Gredel et al. (2012), the two main challenges that SMEs face is not only a financial constrain, due to scarce access to investment funds, but also access to supportive assets such as specialized workforce.

Complementing the idea behind the Triple Helix Model, Leckel et al. (2020) show the importance of public policies to enhance the spread of OI concepts and practices at a regional level throughout Local Open Innovation (LOI). This concept focuses on SMEs, which commonly depend on third party agents to overcome existing barriers. The author further demonstrates how LOI can enhance collaborations between companies due to factors like geographical proximity, enhanced communications, and co-creation strategies.

A study made by Şimşek and Yıldırım (2016) on 102 SMEs operating on Turkish Science and Technology Parks evidence that the most common barriers that new firms face are related to administrative constraints such as access to financial or human resources; suppliers not meeting required time or quality; poor innovation management in a sense that there is not enough personnel with technical knowledge nor the existence of a well-defined innovation process; Intellectual Property ownership rights; customer-related problems such as the inability to meet customer's demand due to misunderstanding of their requirements.

The P&G's successful implementation of OI exemplifies some capabilities that are required for a company to sustain innovation and also some practices that these organizations can implement to overcome those barriers. Nonetheless, several authors have different approaches towards these aspects, for instance, Lichtenthaler and Lichtenthaler (2011) describes an organization's capabilities as absorptive and desorptive inside the technology transfer context, where the previous refers to the capacity to apply external knowledge in the internal innovation process and the latter being the opposite, regarding the firm's capacity to identify opportunities and transfer technology. Also, Min et al. (2020) argue that the success of external technology acquisition equally depends on the absorptive capacity and the nature of the transfer object.

Complementing this idea, Lazarenko (2019) implies that if companies want to be efficient in open innovation and knowledge management they must pursue absorptive, sharing, and co-creation capability. The first two are very similar to the previous author's idea, however, the third is different, since it represents the capacity to combine and manage these capabilities as well as knowledge flows with another company. Furthermore, the author also states that a company's innovation capability is measure by its capacity to manage inwards and outwards flows of knowledge and information and using it to acquire a competitive advantage.

2.3.4. Open Innovation in the Space Sector

The space industry has suffered in the last decade due to several budget cuts from the governmental agencies (Summerer, 2012) and in the specific case of Europe, a large financial crisis that struck the continent forced countries to reduce investments in space-related activities (van Burg et al., 2017). This resulted in a revolution that pushed institutions to new ways of thinking and problem solving and thus, adopting innovative methodologies to keep a continuous stream of projects, technology development and avoid stagnation.

Due to its nature, the Open Innovation model has been a primordial tool used by institutions to sustain the space-related technology development (van Burg et al., 2017) by allowing multi-faceted partnerships where governmental space agencies rely on universities or private companies to develop better quality technology at a lower cost and with relatively lower development risk (Johannsson et al., 2015).

As stated before, knowledge and technology flow inwards and outwards of a company, in that case, it is possible to verify how this works in the space sector by defining the public organizations as the scope of the analysis representing the space sector and their business partners as a non-space sector.

Nowadays there is the existence of a "technology pull" that causes a great difference in the volume of knowledge and technology. According to OECD (2010), this technology pull is driven by the costumer's demand, in which the fit between technology and customer need is the main reason that technology commercialization is viable.

The flow from non-space to the space sector is much more significant than the opposite, even though the other way around has proven to deploy as many benefits as well (van Burg et al., 2017).

Although this new approach has had a positive impact on the sector (Summerer, 2012) by opening the market to highly specialized smaller companies and allowing them not only to compete with already established players but to also, build solid business alliances with bigger companies or institutions that could benefit both sides.

However, some restrictions slow down the advance of open innovation practices within the industry. Johannsson et al. (2015) point out that some aspects delay the implementation of open innovation practices, the legal aspect which relates to how intellectual property is managed throughout the sector, and the existence of governmental regulation and compliance, both motives prevent smaller companies to enter this market.

A great way to overcome the legal aspect of this is to develop and market a non-space business model from space technology, this will cause the market to expand granting more intellectual appropriation for the other companies in the market (van Burg et al., 2017).

There is also the technical aspect that reflects on the complexity associated with the development, testing, and implementation of space-grade technology for commercial use. Furthermore, van Burg et al., (2017) complement this by exposing the underutilization of technological start-ups capacities that could and should play a more active role inside the industry.

However, these barriers are slowly falling apart due to the increasing interest of tech giants and small start-ups on the business opportunities that the space sector generates, and governments that are slowly increasing investments to agencies and creating policies to stimulate technology transfer among companies in the aerospace industry. This represents a large spectrum of new subjects to be studied and explored by the opportunity to develop a more structured partnership with enterprises from other industries.

2.4. Technology Transfer

In light of the topics discussed previously concerning the growing trend of open innovation and the shift in paradigm on how companies pursue innovation is shaping the interaction between several entities. By opening their innovation process and interacting with external actors through OOI or IOI, an organization may benefit from the commercialization of its technologies to outside actors or through the access of previously unavailable technology, respectively. In both cases, the concept of technology transfer appears to be relevant since it is embedded within the principles of OI.

2.4.1. Technology Transfer Overview

The definition of technology transfer varies according to the subject and discipline of the research (Bozeman, 2000), in this sense, Heinzl et al. (2013) assume technology transfer as a process in which technology is passed from a science-based institute to an industrial entity, the author further implies that it also depends on the implementation of the technology to develop new processes, products or somehow promote innovation to succeed.

Furthermore, Lavoie and Daim (2020) explain that the technology transfer can be: Internal or External depending if it occurs within one or more entities; Domestic or International, if they are located in the same country or not; From a university to the private sector in a sense that technology is developed inside the university and then commercialized by private partners; technology is transferred from its development process into the development process of a product mainly due to its potential to be applied.

These definitions fit the purpose of this work, however, this approach restricts the process to occur only within already established organizations, excluding the possibility of an entrepreneur, as the industrial entity, with intent to exploit business opportunities. Another aspect that must be considered is that there are several other entities regarding the public sector that perform R&D and commercialize technology such as research institutes and governmental agencies.

Nonetheless, if the objective is to analyze a certain technology transfer process it may present characteristics from one or more of the types described above, as an example, a European private company acquiring technology from a North American governmental agency can be categorized as an internal, international transfer occurring from public to private sector.

Another important concept that needs to be precisely defined is the transfer object, since its definition may vary according to the context in which it is embedded, Bozeman (2000) argues that it is very important to specify the configurations of what is being transferred to facilitate the transfer process. Furthermore, Heinzl et al. (2013) state that the transfer object is the specification of what is being transferred and must be associated with neither the transfer media nor transfer mechanisms.

Moreover, it is necessary to understand the concept of technology within the context of technology transfer. Bozeman (2000) conceptualizes technology by relating it with the transfer object, in a sense that it is a well-defined set that contains processes, products, and knowledge, in a sense that when a product or process from technological essence is commercialized, the means to apply and use them, in other words, the knowledge, must be transferred to the other entity as well.

2.4.2. Technology Transfer Process

The previous section focused on understanding the concepts behind technology transfer as well as its importance in the open innovation context. This section explores the mechanisms and the process of transferring technology.

Bianchi et al. (2011) studied organizations that commercialize their technology and observed the main activities they perform, under the light of a process for technology commercialization. The process used consisted of five stages, it starts with a planning stage, where the decisions about internally or externally exploiting a determined technology are made, then, an intelligence stage where the potential of the technology is measured and opportunities on the market are identified.

When there is an intent of purchase from another entity the negotiation stage begins. In this stage, information related to technology is disclosed, the price is negotiated between the parts, and the terms of the transfer contract begin to be written. After both parts agree with the terms, the realization stage begins, it consists of effectively transferring the technology and the collaboration amongst the first takes place. To sustain long term benefits, the control stage is crucial to monitor if both parts are keeping up with the initial conditions agreed upon the contract and also to verify indicators towards the success of the partnership.

This process addresses technology from and outbound point of view, that is, from the perspective of entities belonging to the business blade, previously described in Section 2.3.2, the Triple Helix Model. Complementing this perspective, Bozeman (2000) proposes the Contingent Effectiveness Technology Transfer Model, which was further revisited by Bozeman et al. (2015), it focuses mainly on technologies transferred from scientific and governmental blades to the business blade, it measures the effects of technology transfer based on the actions taken by the entities participating in the process, the nature of the transfer object and the characteristics of the transfer recipient.

Another model displayed in the literature is the one proposed by Khabiri et al. (2012), in which the focus is technology transfer amongst SMEs. This model helps to decide the mechanism that is more appropriate based on seven other elements as well as the nature of the relationship between transferor and transferee. The author also implies that this model turned out to be useful in the feasibility study stage since it was able to enlighten the best mechanism available.

Although these models revolve around the same principles for open innovation and technology transfer, it is possible to notice that there is no coverage on the literature of models that approach technology transfer based on an entrepreneurial perspective, starting on the assumptions that the transfer recipient is always well-established companies with access to resources and dedicated to maximizing the chances of success for the technology commercialization. Nonetheless, there are aspects of these models that could be useful when developing a methodology focused on entrepreneurial point-of-view.

Furthermore, one concept that is crucial to the process of transferring technology is the transfer mechanism. It can be defined as the mode that the transfer object is passed towards the transfer recipient (Heinzl et al., 2013). Nonetheless, companies are presenting a growing interest in mechanisms such as spin-offs, joint ventures, collaborative research, and patent licensing as a means to acquire technology (Min et al., 2020).

Although there are multiple options regarding which transfer mechanism to choose, the process of deciding which one will be used can be vital, since each one has its risks and variables that may or may not become beneficial for the transfer recipient. To better decide which mechanism is the most suitable, Khabiri et al. (2012) developed a conceptual framework that analyzes various elements that take part in the technology transfer process and the relationship between them.

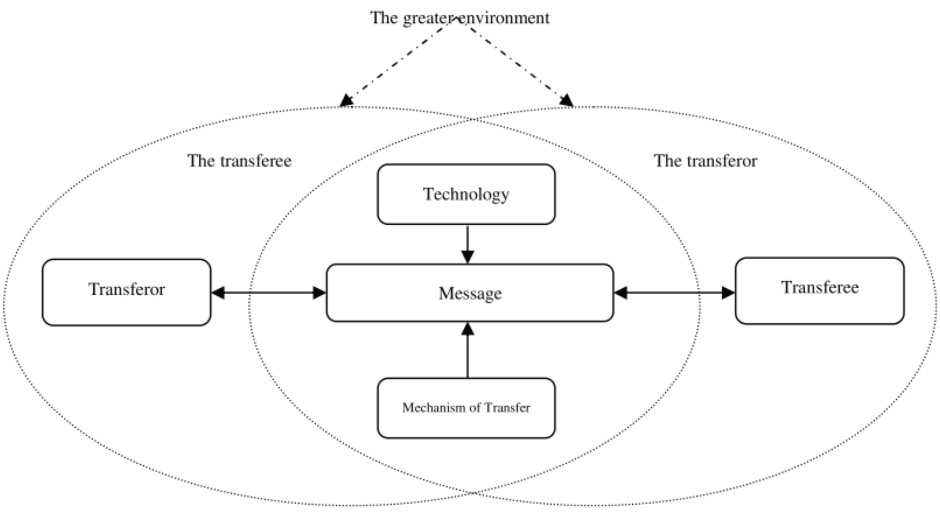

Figure 5. Conceptual framework for transfer mechanism.
Retrieved from Khabiri et al. (2012).

Displayed in Figure 5 are the elements that are relevant to this framework but also, the relationship between each one of them. The first two elements are the transferor and the transferee, being the entity that owns the technology that will be transferred and the technology recipient respectively, in this sense, there is always a sell-buy duality between those actors. The third element is the technology itself, in which its concept was addressed in the previous section, as being considered the transfer object. Subsequently, the transfer mechanism presents itself as the fourth element.

The two following elements are the transferor and transferee environments, which concerns the conditions and assumptions needed to complete the technology sale and buy, respectively. Lastly, the environment that surrounds the transferor and transferee needs to be analyzed since factors are emanating from both entities that have a direct influence on the technology transfer process.

This model suggests that the transfer mechanism should be chosen in the early stages of the transfer process by the transferee since it is the most benefited by the process and also it can serve as a way to assess the feasibility of the project. However, this is not always possible, for example, an entrepreneur participating in a technology transfer program, the mechanism can be already pre-defined by the transferor.

Another aspect found in the literature is the concept and importance of technology roadmaps, where Lichtenthaler (2008) states that this is crucial to align a firm's technology commercialization strategy with the successful exploitation from external and external projects in a future perspective. This author also promotes an integrative point of view where these three aspects, since the same technology can be used both internally and externally and thus, providing not only its efficient use but also a more financial benefit.

2.4.3. Space Technology Transfer

In the European context, the use of space technology is considered a major source of economic growth and job creation in the continent (Giannopapa, 2010). Nonetheless, the development of a technology for use in space requires high investments to be made for covering the elevated costs related to the specialized workforce and materials needed to develop solutions that meet the above-average technical requirements established in the industry (Wachowicz & Bury, 2017).

These constraints added with the fact that the governmental agencies are the main entities behind technology development for space exploration, make a scenario where the results of these public-funded research turn to be extremely proprietary and of strategical secrecy for the government. Furthermore, van Burg et al. (2017) indicates that this level of secrecy and the trend to be as closed as possible in the R&D process makes the technology transfer process in the space sector very difficult for new entrants and smaller companies.

However, the increase in space-ready technology that is being patented enhances the technology spill-over from space to earth markets and foment the participation of smaller companies and start-ups on this process. Nonetheless, this creates a paradigm related to patents developed for space, Wachowicz and Bury (2017) argues that in the process of application for a patent, is required that the applicant discloses some, if not all, characteristics and components of its invention before the license is granted, assuming a risk of it being denied and giving up his inventions, the authors call this the Space Patent Paradox. Furthermore, due to confidentiality inherent to the space sector, this risk is even higher to the applicant.

Another problem related to technology used for space exploration is the requirements that they need to possess to sustain the harsh environment they supposed to be used on. This causes the cost of development to be extremely high due to material acquisition and the extremely qualified human resources to develop them, however, this also creates a vast array of opportunities and applications in various industries and allow entrepreneurs to benefit from the offering of these technologies.

To attract entrepreneurs and foment technology spill-over many agencies have their TTP, offering a variety of products, manufacturing processes, software, and systems to those who are willing to take advantage of them and try to make a change in earth markets. As stated previously, ESA has its TTP with an exclusive focus on new start-ups or SMEs that uses these technologies to make a profit in an attempt to amplify the spill-over.

A well-established standard in the aerospace industry to measure the maturity of technology is the Technology Readiness Level (TRL), this tool is a standard for ESA since 2005 with the main goal to reduce uncertainty and risks throughout the technology transfer process (Giannopapa, 2010).

Furthermore, the OECD (2010) define TRL as a way to identify the stage of an innovation that is being funded, the levels range from Level 1 to Level 9 and are divided into four categories: Basic Research (TRL 1 and 2); Development (TRL 3 to 5); Demonstration (TRL 6 and 7); Early Deployment (TRL 8 and 9). Displayed in Figure 6 is the model for

TLR, followed by a brief explanation of each level and what they mean based on the definitions made by ECSS (2014).

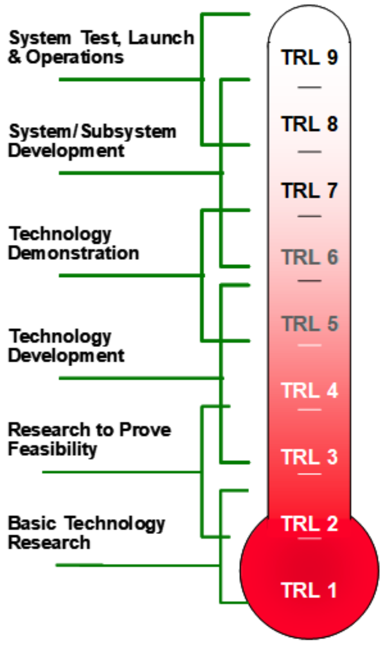

Figure 6. Technology readiness level.
Retrieved from *Feasibility Studies* | *ESA Business Applications* (n.d.).

- TRL 1: When basic principles of technology can be observed and were reported. To be considered of level 1, there must be a previous identification of the possible implementations and basic uses for the technology.
- TRL 2: The concept and a well-defined application for the technology must be already formulated. Although in this phase a POC is not required just yet, the initial design and basic elements of it must be defined with the main purpose of understanding the future use of the technology.
- TRL 3: Initial performance is required to be demonstrated and supported by data collected through analytical models or laboratory experiments. An initial design model must be presented with the elements that are going to be addressed at the proof of concept.
- TRL 4: In this level, the elements are tested in a controlled environment to prove the performance of its components. In these tests, the previously established performance requirements must be achieved and the results reported according to the standard.
- TRL 5: The critical functions of the technology are identified, a test plan is elaborated, validated and executed in a laboratory experiment that also

includes the assessment of the relevant environment in which the technology is embedded. The technology is also subjected to scaling proof and the results of it are reported together with the tests.

- TRL 6: The performance is demonstrated within the relevant environment through the verification and validation of the model containing the critical elements.
- TRL 7: Another environment is mapped, the operational one, where the technology will be tested where it will be mainly used, being on the ground or, if needed, in space. A model must be developed to demonstrate the performance of the technology in the operational environment. Both the descriptions of the model and results must be documented.
- TRL 8: The model is ready to use in the operational environment and is integrated with the existing system.
- TRL 9: The technology is considered to be mature, and the element's efficacy and operations are proved throughout several successful flights and by analyzing in-orbit reports of its performance during its usage in the operational environment.

One factor that must remain under evidence is that this classification works only for the technology's use in space since it depends on the mission's technological constraints and requirements. In this sense, to use aerospace derived technology on an earthly application it needs adjustments, generally, a downgrade in these specifications due to the above-average technological requirements for space missions.

2.5. Innovation Process

2.5.1. Innovation Process Overview

Innovation is not a discrete event that yields instantaneous results but a continuous cycle of identifying opportunities and exploiting them. Understanding it as a process is crucial to outline the resources and activities needed to develop new products and services. Based on this premise, Bessant and Tidd (2015) established a framework that explores four sequential steps that compose an innovation process, and also, enlightens crucial aspects related to the success of this process.

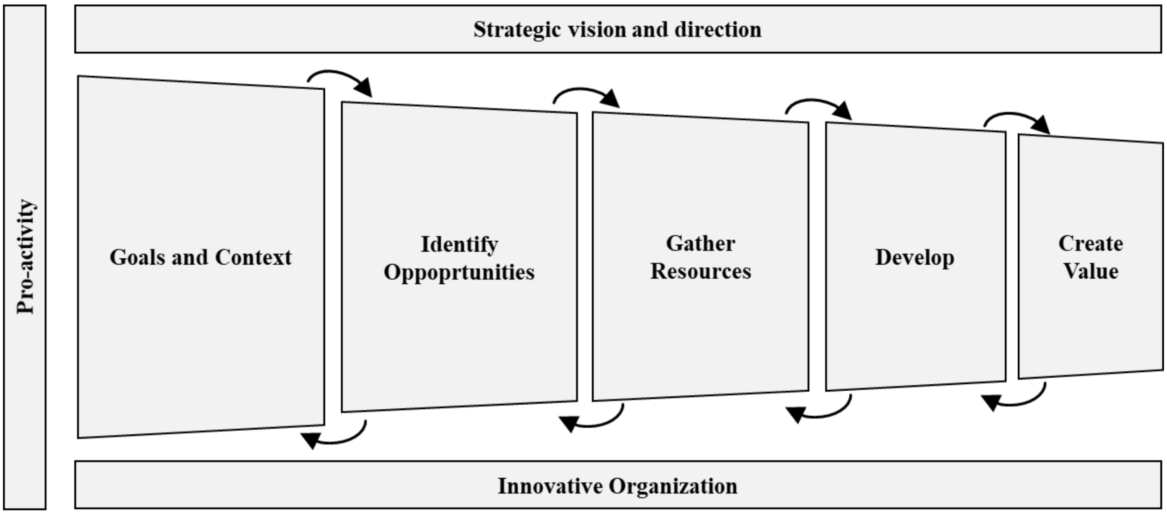

Figure 7. Framework for the innovation process.
Adapted from Bessant and Tidd (2015).

Displayed in Figure 7 is the framework discussed previously. This model implies that the innovation process starts with the identification of trigger signals, which may come from personal motivation or by importing external ideas, in both cases, it is up to entrepreneurs to continuously monitor their surrounding environment to capture these signals and transform them into business opportunities.

Subsequently, the second step is responsible for strategically identifying, managing, and mobilizing the resources needed to pursue the chosen opportunity. Despite the risks and uncertainty, it is necessary to dedicate resources to start the innovation process. Nevertheless, this step consists in matching the idea, derived from previously identified opportunities, with the resources available. Besides, Casanovas et al. (2014) indicate that it is necessary to do a validation process, this can be done by verifying the fit of the identified opportunity not only with the financial assets and human resources available but also, with the context in which the idea is embedded.

The idea then starts being built in the third step. It is in this stage that the combination of ideas and resources takes place and a business model starts to take form, by an iterative process, continuously validating new ideas, solutions, prototypes with the stakeholders, a process in which, if succeeded, eventually will originate a solution ready to market. Although this can be considered as an implementation phase, a lot of creativity is needed due to inherent risks associated with innovation.

Furthermore, just because a novelty turns out to be good and works, it may not sell well enough to cover the initial costs, selling, so, it is vital to be proactive, use the feedback gathered from the stakeholders and be proactive towards bringing solutions that even the costumers did not know they need it.

The fourth and last step is related to capture the value created throughout the process, meaning it is the moment to analyze what was done previously, learn from mistakes and correct them while simultaneously understanding what went right and try to improve it. It is also when the rewards of the risks are collected and more importantly, guarantee the longevity of the business.

Alongside these steps, the authors also highlight other aspects that heavily influence the innovation process. Although the risk is always surrounding innovation, it is not wise to go blind-folded and accept all risks, thus, it is all about knowing that the risk exists and rely on leadership guidance to elaborate risk mitigating strategies, preventing inefficient use of the resources and enlighten the path towards innovation.

The innovative characteristics of the company are also an overriding factor to innovation, an informal environment, low or none communication barriers and free of the typical bureaucracy, that many firms suffer with, can help improve the creativity of the employees. Nonetheless, this needs to be well-balanced to avoid unproductivity. These characteristics show how a start-up takes advantage of their smaller size to be innovative, however, the smaller the company is, the harder it is for them to obtain the resources needed.

The success of a new idea is dictated by the firm capacity to solve this paradox, and in this case, it is common that start-ups establish a network of partners to grant access to crucial resources they need. This goes in conformity with the open innovation concepts previously discussed, and thus, the management of the relationship with these key partners turns to be of extreme importance to the success of the innovation process.

2.5.2. Value Proposition Design

The Value Proposition Design is a tool developed by Osterwalder et al. (2015) that complements his previous work, the Business Model Canvas (BMC). It is a highly customer-oriented tool and has the main purpose of allowing companies and entrepreneurs to create value, if it is being built from scratch or, in the case of already established organizations, enhance the value delivered for their customers.

Value is what a business offers to its customers and partners to solve their problems or to attend their needs, on some rare occasions, it may also create a need for a customer segment that they did not even know they needed. Moreover, the value proposition of a company does that through a set of products, services, or a mix of both that are aimed specifically at a group of customers (Osterwalder & Pigneur, 2010). And thus, the value proposition can be defined as "*benefits customers can expect from your products and services*" (p. 06 Osterwalder et al, 2015).

This tool consists of a canvas that focuses on the Value Proposition and Customer Segment blocks of the BMC. It is divided into two perspectives, the customer profile and the value map. The main purpose of making this analysis is that it is possible to reach a connection between a specific customer segment needs and the value that is being offered for each product or service. Subsequently, the desired outcome is the fit between the value that is being offered and the customer needs.

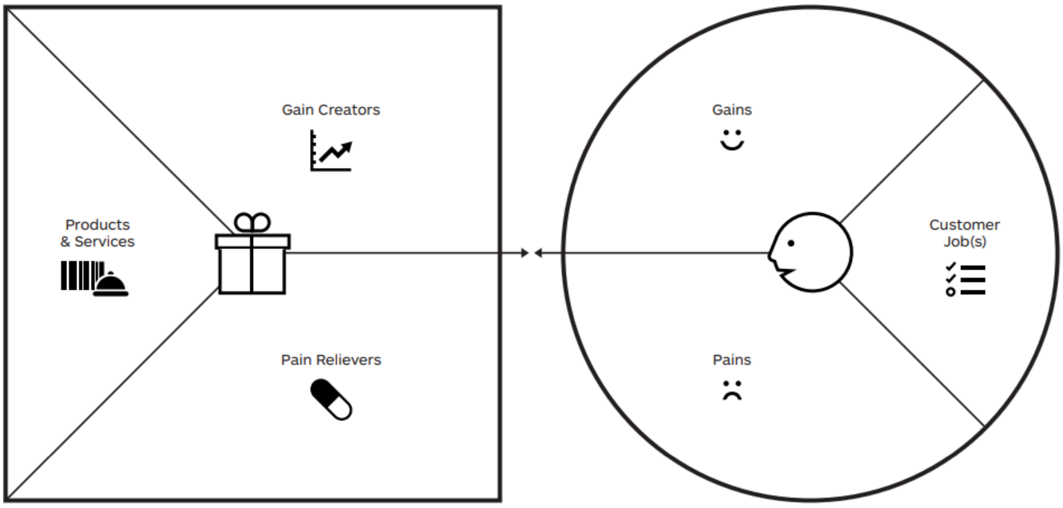

Figure 8. Value proposition canvas.
Retrieved from (Osterwalder et al., 2015).

In the canvas displayed in Figure 8, there are two sections, the one on the left side is the Value Map, which itself is subdivided into three distinct parts: Products and Services, Gain Creators and Pain Relievers. By enlisting all the products or services that are supported by the company's value proposition, it is possible to identify what are the customer's main problems that your offerings are trying to solve (Pain Relievers) and how these products a generate benefits for the customers (Gain Creators).

On the right side, there is the Customer Profile, an important block of information that consists of a detailed description of the specific customer segment that will be focused and is also divided into three parts. Firstly, it is crucial to map the customer job, that is, what activities are they trying to do, a few examples of these jobs can wash the dishes faster, market professional skills, or map the motivational status of a firm's employees.

The second piece of the customer profile is the pains of the customer, in other words, the barriers, challenges, or risks that difficult or prohibit the execution of the customer jobs. The term pain fits well on this part since it describes things that make customers uncomfortable and thus, may serve as an opening for offering an innovative solution.

Lastly, but equally important, comes the customer gains, which consists of a description of the payoffs that the customer gets when the job is done. Some of those gains are extremely necessary since, without them, the customers would not want to purchase a solution. There are also those gains that are desired but not preponderant on the buy decision, on the other hand, there are the ones that are already expected by the customers and have an impact on the decision of buying a solution. Furthermore, some innovations can surpass customers' expectations and delivery extra gains, this may positively affect customer loyalty towards one group of products or a company.

Nonetheless, these three aspects may present variations depending on the context in which they are embedded, in the sense that the gains, pains, and the job that one customer segment may present differs from another customer segment since one group may have preferences over some aspects. The crucial aspect is to identify what are the jobs that are more important to customers, the severity of their pain, and the relevance of their gains and thus, propose a solution that is focused on relieving what is more important. Thus, when the customers approve the value proposition, it is a representation that the company is addressing important jobs, which cause notable pain and provide solid benefits for that segment.

2.5.3. Business Models

One of the most difficult aspects of successfully implementing OI practices is to also create an innovative business model that shows the missing capabilities and how to integrate them to sustain long term innovation programs (Chesbrough, 2003). In this sense, the business model is a structured set of organized variables, that shows how a company will manage multiple aspects of its operation and integrate them internally and externally to capture and deliver value to its customers (Zhu et al., 2019).

A business model can be defined as a tool that conceptualizes and manages the relationship between the variables discussed above. In which case, the main objective here is to present a simple compound of these concepts that clarify to the customers what is the value that the company is delivering to them, how it is delivered, and the costs of it (Osterwalder et al., 2005).

In the literature, some tools are commonly used by enterprises that enlighten the process of developing a business model such as the Lean Startup Methodology or the Business Model Canvas. In other hand, companies also need to adjust to the shifting environment that they are embedded, this can be done by innovation their pre-existing business model, a tool that fits this purpose is the framework proposed by Geissdoerfer et al. (2017).

The Lean Startup methodology proposed by Ries (2012), revolves around the concepts of innovation, experimentation, and improvement, mainly guiding entrepreneurs into transforming ideas into products in an organized and structured way, supported by extensive interactions with the customers, which directly influence the outcome of this process, while avoiding risks. Another aspect that the author discusses is that not only products can be created but markets can be created and developed by the entrepreneur.

By definition, a business model is a description of the way an enterprise technically and financially conducts its business to generate and deliver value to its customers and society (Osterwalder & Pigneur, 2010). These authors also defined nine essential building blocks that are represented in a canvas format and represent crucial information on a company’s actions and cover four main aspects: what is it that the company is offering; the financial structure; costumer and stakeholder information; required infrastructure. Displayed in Figure 9 is the configuration of the building blocks inside the Business Model Canvas, and below, a brief explanation of each block is made based on the work of Osterwalder and Pigneur (2010).

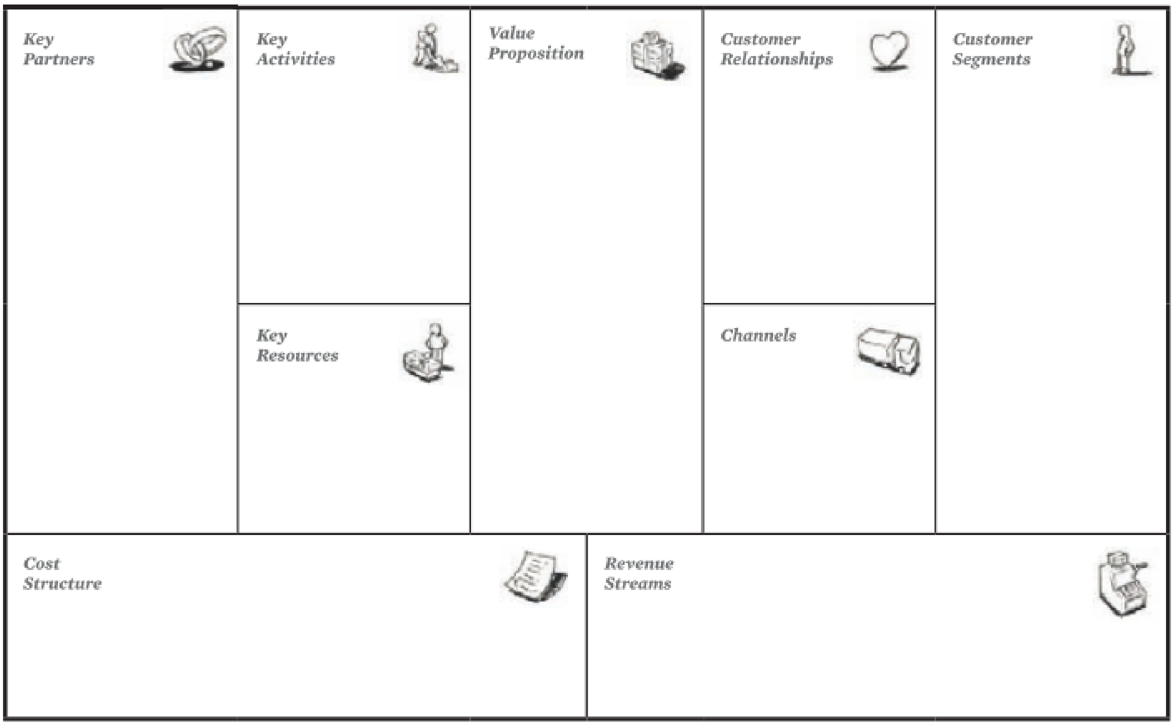

Figure 9. Business model canvas.
Retrieved from Osterwalder & Pigneur (2010).

- **Customer Segment:** Has the main purpose to identify which customers groups the company will focus on and what will not. These segments can be based on shared characteristics or attributes among them and also be defined by the size of the markets.
- **Value Proposition:** Demonstrates what products or services the company has to offer and how they will generate value to the previously defined customer segments. Another approach is trying to identify what problems the customers are facing and how the company's products or services plan to solve them. One company's value proposition may differ from another in several dimensions, namely the degree of novelty they are offering, the price that's being charged, functionality, design, or performance.
- **Channels:** It is the identification and establishment of paths in which the company can reach out to its focus customer segments and then deliver the proposed value. There are other secondary purposes for this block such as the creation of awareness about new products and services, promote existing products, provide aftersales support to costumers, and ultimately, be a platform that shortens the connection

between firm and costumer, by allowing customers to give feedback and evaluate the contact with the company.

- **Customer Relationship:** It is how the company will manage the strategies that will be used to establish its relationship with each one of the customer segments. These strategies can vary from personal assistants, self-service, and co-creation or even automated services for a lower level of interaction. It is also important to notice that these strategies can be applied simultaneously, depending on the situation.
- **Revenue Streams:** This block represents how the company pretends to generate financial income and two main decisions need to be taken, both are explained as follows. One is the pricing mechanism, that represents how much these customer segments are willing to pay for the value that is proposed to them, can be divided into two segments, fixed pricing, where the price depends exclusively on variables related to the business nature, or dynamic pricing, where the price is volatile and depends on variables related to the market. Furthermore, a company can generate multiple revenue streams from various customer segments depending on the strategy that was chosen. Furthermore, the revenue stream can be divided into single transactions, such as charging fees for stock trading, or continuous revenue, which can be exemplified as the purchase of a monthly subscription of books.
- **Key Resources:** Contains the main assets that the company needs to be able to operate the business model itself, being crucial for the creation of the value proposition and may also vary accordingly to the business model nature. Moreover, these resources can be divided into four categories, which are: financial resources such as investment funds or credit; human resources, which are a key aspect in certain industries that heavily rely on knowledge-based workforce; intellectual resources that are related to intellectual property, licensing and patents that were developed by the enterprise; physical resources like manufacturing facilities or warehouses.
- **Key Activities:** Enlist and describe the main activities that the company must perform to successfully implement the business model and also guarantees the business's operations. The activities are also crucial for the creation and delivery of the value proposition or solidify the relation with costumers. Some enterprises focus on product development and manufacturing while others could focus on software development for problem-solving or platform development.

- **Key partners:** It is responsible for describing how the company will manage strategic alliances with other players on the market such as suppliers, competitors, or even other companies that do not compete in the same market. Within the context of open innovation, a notable strategy is the creation of joint ventures to develop new technologies or exploiting new opportunities. Another valid approach is to improve the relationship management with suppliers, this can bring benefits such as inwards and outwards information flows, better fit to specifications, or competitive prices.
- **Cost structure:** Is a detailed description of all the costs that are related to the operation and also the costs strategy that the company intends to utilize to deliver value to its customers while being profitable to investors. The cost structure is dictated by what resources are going to be needed, what activities will be made and how good the relationship with the suppliers is. There are mainly two types of strategies that a company can address: Low-cost operations focus on optimization of the cost structure, offering low-cost value propositions and almost always compete for the lowest price in the market; Value-oriented represents a strategy that the main goal is the opposite of the low-cost approach, generally charging a premium price for a niche value proposition.

This represents that using the business model methodology in parallel to the OI practices could bring benefits to the development of new technology, processes, or products. Also, a new approach to business models and their relation to the open innovation paradigm is leading to several changes in the space sector, especially on how companies organize and structure themselves since they now need to integrate external sources to internal capabilities to obtain the desired results.

Being an extension of the traditional business model, the Sustainable Business Model promotes growth in the environmental, social, and economic spheres while creating and delivering value that can bring increased efficiency and positive relation with society Geissdoerfer et al. (2017). It has the main purpose to support new companies to overcome what the authors call the design and implementation gap, which related to the fact that, although the tools for business development are known, they are not effectively used and implemented.

To support those organizations in the development of sustainable businesses, Geissdoerfer et al. (2017) also proposed the Cambridge Business Model Innovation Process

(CBMIP). Figure 10 displayed below, demonstrates the framework and shows that the process is divided into eight steps divided within three main phases, being the conceptual design the first, then the detailed design and, lastly, the implementation phase, the steps that are part of this process are addressed as follows:

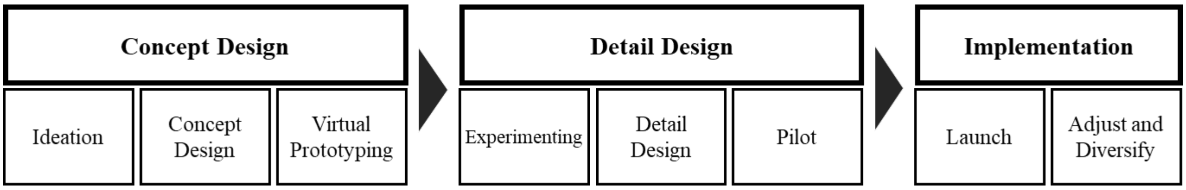

Figure 10. The Cambridge business model innovation process.
Adapted from Geissdoerfer et al. (2017)

- **Ideation:** Marks the beginning of the process, in an attempt to solve problems, the purpose of the business is defined, where ideas are proposed and then selected, also, stakeholders are identified and then the value proposition is created trying to align it with stakeholders needs. In this phase, tools for value proposition ideation are essential.
- **Concept Design:** In this phase, the selected ideas are integrated towards the objective of the and the business, and also, decisions about how the proposed value will be created, delivered and captured are made as well as the other building blocks of the traditional business model created by Osterwalder and Pigneur (2010).
- **Virtual Prototyping:** Based on the characteristics obtained through the blocks of the business model, several prototypes are made and the ones that show better performance are selected. Also, these test versions serve as bases for performing a benchmarking of the characteristics and the concepts proposed for the business model with the targeted industry. This step marks the end of the concept design phase of the process.
- **Experimenting:** Using the information and the initial prototypical forms the detail phase begins. In this step, key aspects or variables are identified to be tested within a controlled environment, is through modelling or laboratory experimentation. In this act, tools such as the Design of Experiments can be very useful since it allows a series of experiments and improved capacity to reduce the test time of certain variables. Furthermore, the data obtained throughout the testing phase should be used for adjustments and improvements.

- **Detail Design:** After the testing phase, a set of variables should be already defined, serving as a base for the detailing and in-depth analysis of the elements of the business model.
- **Piloting:** When the elements are well established and form a complete system, it is time to begin to plan the pilot test for the innovation's functionalities as a whole. Subsequently, the pilot version is tested in a previously established parcel of the targeted market to test some of its elements, the results obtained in these small-scale applications are used to enhance the pilot and correct failures. At the end of the pilot tests and several improvement iterations, the detail design phase has its end.
- **Launch:** The launch marks the beginning of the implementation phase, where, after a successful pilot stage, with validation from costumers and stakeholders, the system is now ready to be completely deployed to the market, with its full range of specifications, and also, efforts to scale-up its production needs to be made to support future demand.
- **Adjustment and Diversification:** The last step of the process consists of monitoring the costumer's feedback in an attempt to continuously improve the offered product or service. In the case that there is an unattended customer need, there is a possibility to do adjustments to create new solutions for that niche group of customers.

Although the CBMIP was initially conceived based on the assumptions that there is already an established company, it could be generalized for other purposes due to its approach to innovation as a process as well as the iterative nature of its phases, which are somewhat similar to initial steps of the Bessant and Tidd (2015) innovation process.

2.6. Summary

To conclude this chapter, the present section aims to consolidate the knowledge gathered so far and discuss the aspects that appeared to be relevant to the further steps for the development of this dissertation.

Understanding the concepts of open innovation

Being collaboration one of the key pillars to open innovation, in a sense that in the efforts of more than one actor are needed to overcome the risks related to the research and development of new products or services and to provide a continuous stream of solutions to customers. This also implies that there must be tangible benefits for all parts into engaging in this endeavour. Taking the actors presented in the Triple Helix Model, the business blade may benefit from taking novelty and value to already faithful customers but also, penetrate new markets that could be of great interest for an expansion plan.

Governments should also be interested in this aspect since, as stated before, it is a key factor for economic growth and social welfare, and lastly, the research blade fulfils its purpose of turning basic research into useful technology that can be spread for society by businesses willing to take risks. Nonetheless, assuming those risks must be planned carefully and with a strategic perspective since a lot of the research aspect could involve large amounts of financial resources and sometimes, conflict of interest could present to be a problem for the development of innovations.

Perceiving innovation and technology transfer as a process

In regards to perceiving innovation as a process and not a punctual breakthrough in a certain field of knowledge, Bessant and Tidd (2015) and Geissdoerfer et al. (2017) explains very well several steps that may guide businesses and entrepreneurs to overcome barriers and risks inherent to novelty.

These authors established a path to those willing to assumes these risks and more importantly, improve the chances of successfully create a business that impacts positively society around them. Another notable aspect is that, by perceiving it as a process, it enables them to perform iterations among the development of the steps and not only correct what is being done wrong but also, exploit and expand the good and correct things that are being made. In summary, using a defined process with sequential and iterative steps help entrepreneurs to narrow down opportunities, fit the value offer with its customer's needs, be more efficient in terms of resource consumption, shrink the overall time to market of the novelty, identify risks and define strategies to mitigate those risks.

Those concepts can also be exported to technology transfer as it is a way that not only companies can commercialize in-house developed technologies to other entities but also exploit from external capabilities that may be too risky or expensive to develop.

Nonetheless, it is still a process that needs good planning and execution, thus the importance of roadmaps argued by Lichtenthaler (2008) and the frameworks for technology transfer defined by Bozeman (2000), Bozeman et al. (2015) and Khabiri et al. (2012) to enhance this process and raise the chances for a successful transaction.

Specificities of technology derived from the space sector

It surely can be said that all the restrictions, barriers, and difficulties are amplified when dealing with the above-average space requirements for technology. High development costs, high risks, and a lot of governmental and societal pressure may lead to a lengthy risky process that faces tight schedules.

Although governments, by the means of public space agencies, actually hold the majority of intellectual property directed to use in the space environment, it is both a necessity and a duty to promote the spread of this technology for civil use. However, this technology spill-over faces its challenges, the Space Patent Paradox is one of them, and also, the fact that the majority of the projects for developing new technology for space use involve governmental confidentiality that may prevent that smaller companies and entrepreneurs to access crucial information to the development of their businesses.

Nonetheless, those agencies are currently fomenting that technology spill-over and trying to augment the participation of start-ups and entrepreneurs via technology transfer projects such as ESABIC, in the case of the European Space Agency, that has the main purpose of help and improve the development of new solutions from patents from space.

3. METHODOLOGY

This chapter is responsible for exposing and explaining the methodological approach that was selected for the execution of the present dissertation, the sequential steps that were executed to achieve the main objectives, previously explained in Section 1.2, and, the methods selected to collect and analyze the data for this work.

3.1. Methodology Overview

Using a solid methodology is key to provide valid results in a research project, since it serves as a guide to the research to perform its job, by providing systematic tools and methods that will dictate how the study is performed and justify some choices such as data collection and analysis methods. The Research Onion (Figure 11) is a research methodology proposed by Saunders et al. (2019) that guides research projects in the business and management field of knowledge, thus, this model was chosen to guide the execution of this work. According to this model, it is possible to classify a study based on six dimensions, which are discussed below, together with an explanation of why the research was structured this way.

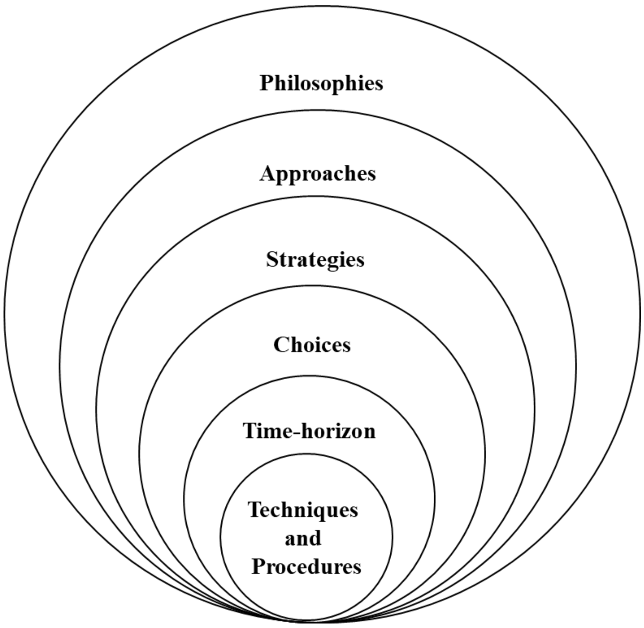

Figure 11. The research onion.
Adapted from Saunders et al. (2019).

- **Research Philosophy:** The philosophy that better fits the characteristics of this research project is interpretivism. In contrast to what positivism preaches, it establishes the search for new and profound knowledge upon the object of study, based on the perspective of the subject, which are subjected to different social realities and thus, present multiple points of view. Since innovation can be classified as a social construct that mainly depends on regional variables such as a country's legislation or even the characteristics of entrepreneurs. Due to the complexity and uniqueness of this process, executing this research based on an interpretivist stance can better evidence the particularities of this specific process and enable the appearance of problems and solutions for such specificity that only the ones subjected to it can describe.
- **Approach:** Due to the purpose of this research, the inductive approach was used. Knowledge collected throughout a structured literature review and analysis on ESABIC's documents served as a base to develop an initial methodology that was then, enhanced using data and information obtained through semi-structured interviews performed with experts in the research's subjects.
- **Methodological Choice:** A multi-method qualitative research is most aligned with the propositions of this study since both the literature review and semi-structured interviews and the subsequent analysis of the collected data, consists exclusively of qualitative methods. Also, the methods used in data analysis are qualitative.
- **Research Purpose:** Since this study aims to develop a methodology that clarifies the process of business development from an entrepreneur's perspective, which is surrounded by uncertainties and risks, an exploratory study presents the better fit in when relating it to the purpose of the study.
- **Strategy:** Concerning the research strategy, a case study was chosen since it enables the researcher to obtain in-depth knowledge about a specific phenomenon as well as the particularities of the studied object that can empirically contribute to the research itself. Furthermore, it is possible to classify this project as being a single-case holistic case study, due to the uniqueness and complexity of the object of study.

- **Time Horizon:** Due to time restrictions of this project, since it consists of a five-month effort related to a curricular internship, thus, representing only a limited time, this study is classified as cross-sectional.
- **Techniques and Procedures:** Due to the exploratory nature of this study and the context in which this work is embedded, a documental analysis of ESABIC's guidelines, standards, and requirements. Furthermore, it is also valid to include semi-structured interviews to obtain insights on the research topic from those who are on the daily usage of the theoretical compound of it. This resulted in a better understanding of the challenges, strengths, and weaknesses that the proposed methodology has to face. Lastly, a thematic analysis was made in the data collected throughout the interviews.

3.2. Research Steps

This project was undertaken throughout sequential steps (Figure 12) that oriented the execution of this project. Initially, a planning step was necessary to delimit the project's scope, purpose, and objectives. Even though these aspects were partially defined at the beginning of the internship, two meetings between the author, the project advisor, and the manager of ESA Space Solutions Portugal were also required to better align the scope with the needs of the institution.

With these foundational aspects aligned, the second step consisted of performing a structured literature review, focused on the topics of innovation and technology transfer, in which, the methodology that guided this process, the analysis of the literature, and further discussions were previously presented in Chapter 2. Also, at this step, the first major objective of this dissertation is accomplished, when documents such as proposal templates for business applications and guidelines for proposal evaluation process for both the feasibility studies and demonstrator projects were analyzed to obtain insights on the criteria, requirements, and standards that the applicants must meet to be successfully qualified for the ESA's technology transfer program.

Based on the information gathered in the second phase, an initial conceptualization of the methodology was developed and given the name P2B, which stands for Patents to Business. Although it is supported by the findings of a literature review and had aspects derived from ESA's standards and guidelines, the methodology at this stage of the process has a limited practical component that is crucial to align it with what is used by professionals acting on the market. To enhance the methodology, a series of semi-structured interviews were performed with experts that work or study the process of transferring technology and its relation to innovation. The data gathered in those interviews were processed using a thematic analysis, which evidenced recurrent themes amongst the data set, which could then be used to confirm what was established in the methodology's initial conceptualization, merge or exclude existing activities, or include new ones. This process enabled the enhancement of the P2B Methodology by integrating practitioner's insights, suggested activities and tools, adding to its practical component.

Figure 12. Steps of the research project.

3.3. Data Collection and Analysis

As previously stated, the method that was chosen to perform this project's data collection was the semi-structured interviews, in which, due to the interpretivist stance that this research assumes, enables the perception and description of phenomena based on the perspective of entities that are somewhat related to innovation and technology transfer and thus, are relevant to this project's purpose and objectives.

According to Saunders et al. (2019), a semi-structured interview consists in a non-standardized and qualitative research method where there are not a closed set of questions but instead, a group of themes or topics that are relevant for the research or general questions that may vary depending on the expertise or context in which the interviewee is related. The semi-structured interview represents an excellent method for collecting additional information to enhance the P2B methodology since it enables the author to enhance it throughout the discussion with professionals and practitioners that contribute with in-depth knowledge of the themes.

The process of selecting the interviewees was particularly important since, to provide relevant insights and fulfill this stage objective, they needed to possess not only theoretical knowledge but practical expertise on the research topics. The focus was to interview professionals that not only work with technology transfer within Portuguese universities, accelerators, and incubators but also entrepreneurs that created businesses that possess or take advantage of a technological component.

With the selection criteria defined, the first contacts with possible interviewees were made, in some cases, via a professional social network and, in other cases, directly via e-mail, also, the messages contained an introductory text explaining the reason for the contact and a briefing with general aspects of the research as well as the topics that were to be addressed during the interviews, the interview briefing is presented in Appendix B. After the initial contact, a convenient date for both the author and the interviewee was scheduled with those who were available and agreed to be interviewed. The contacts and interview schedules were made between May 15 and May 31. This turned out to be a delicate process since the majority of the professionals were overcharged by the above-average workload caused by the pandemic and thus did not had much time available.

A total of 13 interviews were performed during June 2020. Due to the pandemic scenario in the first semester of 2020, all the interviews were necessarily internet-mediated and thus, conducted digitally and supported by web conference applications such as Zoom, Microsoft Teams, Skype, and Google Rooms. Nonetheless, there was no preferable platform, and the choice of which platform to use in what interview was primarily based on the preference of the interviewee.

It is possible to observe that in Table 2 the interviewees were given a code to guarantee anonymity and confidentiality and also, the organization that they work were summarized in three main groups: University, when the interviewee works at technology transfer offices or programs from a Portuguese University; Business, when the interviewee created or work on a company in which the core is technology transfer; Incubator, when the interviewee works in a Portuguese incubator or accelerator program. Furthermore, the orientation of their knowledge is also presented, this will help in the data analysis process further in this document.

All the interviews were planned to have a duration from 45 to 60 minutes each, however, as shown in Table 2, this forecast was a bit of the mark because some interviewees had more available time than others, nonetheless, the average interview duration was 45 minutes. Also, the interviews were structured to occur in two distinct parts. The first consisted of presenting an overview of the research project to the interviewee and then, understanding what is the interviewee's relation with innovation and technology transfer.

Since the semi-structured interviews are made more freely then surveys or other methods, this step was crucial to align the interview with common understandings of the topics, allowing the interviewer to make questions more related to the expertise of the interviewee, thus, obtaining more valid discussion.

Table 2. Interviews' characterization.

Int.	Duration (min)	Organization	Orientation	Experience
I.1	42	University	Technology Transfer	Advisor in Innovation and Entrepreneurship and former executive director of an incubator
I.2	30	University	Technology Transfer	Director at a University's technology transfer office
I.3	56	Business	Innovation	Co-Founder of a company that works with the energy market
I.4	49	Incubator	Innovation	Head of open innovation in an accelerator
I.5	52	University	Technology Transfer	Coordinator of a not-for-profit organization focused on innovation and technology transfer and professor
I.6	44	University	Technology Transfer	Manager at technology transfer office of a University
I.7	45	University	Technology Transfer	Researcher in technology and innovation management and professor
I.8	44	University	Technology Transfer	Coordinator at a centre for research and innovation
I.9	46	Business	Technology Transfer	Founder of a company focused on deploying digital solutions
I.10	63	University	Technology Transfer	Director at an association focused on the interface university-market
I.11	32	Incubator	Innovation	Innovation manager at an incubator
I.12	38	University	Technology Transfer	Researcher at business systems office in a University
I.13	45	Incubator	Innovation	Innovation Director at a technology transfer institute

In the second part of the interview, each stage of the initial conceptualization of the P2B methodology was displayed to the interviewee, followed by discussions related to that specific phase, this means that first, the Phase I was presented, then a discussion regarding themes relevant to that stage occurred and then, proceeded to present the Phase II and so on. This means that each interview provided a qualitative data set that required to be organized and analyzed.

The analysis of the data gathered in the interviews was made by using thematic analysis, a method that consists in scanning the data set to identify themes that are recurrent and, at the same time, relevant and aligned with the research purpose. It is a versatile method that enables integration of data and evidence themes or patterns in the data set, and also, allows the researcher to obtain different insights about the phenomenon that is being observed and generate discussions over them.

Some guidelines were exposed by Saunders et al. (2019) to perform a thematic analysis, a set of iterative activities going back and forth over the data collected. First, it is necessary to become familiarized with the data, this happens naturally as the interviews are conducted, also, transcribing the interviews serve as both a way to develop familiarity with the data and start to expose recurring themes. The interviews performed for this work were recorded natively on the web-conference software used and then transcribed using the digital platform *AWS Transcribe.*

The second activity consists in coding the data, in other words, relate the data to a certain theme, in a sense that if a piece of data has the same meaning or is related to the same topic in the research, then, the same code should be assigned to both pieces of data. For this study, deductive coding was used, since some themes were already known to some extent and it was expected for them to appear on the interviews, and thus, the interview data was scanned to find those specific themes. Also, themes that interviewees talked about but were not expected by the interviewer were coded inductively.

The third activity occurs somewhat simultaneously to coding, this represents the search for themes and identification of relationships amongst them. Although this search usually happens when all the data is already coded, some of the themes should come clear as the coding process takes place. As this process occurs, it will eventually lead to some themes that are more relevant or more recurrent than another, thus, classifying them as primary, secondary or even, tertiary themes will help define how each theme related to each other and its relevance based on the research topics.

The fourth activity, which is when the themes are refined, this means that, according to the purpose of the research or the topics that are somewhat relevant to the study and the relationship between themes, they are combined or separated, leading to the creation of new themes and thus, turning the information from data clear. The important part of this process is to establish a good relationship between the codes and link them to their respective theme.

The coding of the data collected through the semi-structured interviews as well as the theme identification and refinement was made with the support of *NVivo Software*, which took advantage of the interview transcriptions made on the first stage. Furthermore, the analysis of the data collected from the interviews is made in the following sections. The interview's codebook was divided into "Challenges", displayed in Appendix C and "Activities" in Appendix D.

4. CASE STUDY ANALYSIS

The first main objective established was the study and analysis of ESABIC's documents to obtain knowledge on how this entity operates, the existing guidelines that entrepreneurs must follow, the requirements that applicants of the technology transfer program must comply with and ESA's standards on applications. Thus, in this chapter is presented an overview of the ESABIC network, focusing on the entity's representation in Portugal and its information.

4.1. Overview of the ESABIC Context

As part of the ESA's Technology Transfer and Business Incubation Programme Office (TTPO), the Business Incubation Centers have the purpose to foment entrepreneurial behavior in the member state's innovation ecosystem and amplify the usage of space derived technology into terrestrial applications. This is achieved by giving all the support that entrepreneurs need to develop their ideas and business models to create companies that can commercialize such technology.

Since its implementation in the year of 2003, the ESABIC network was alone responsible for the creation of more than 700 start-ups, with a perspective of nurturing 140 more each year and thus, promoting positive socio-economic impact amongst the state members. The ESABICs also support these companies by providing funding, training, and granting access to ESA's technology portfolio with more than 600 opportunities between inventions and patents that are available for commercialization. These numbers were achieved by having more than 18 incubation centers spread across 15 countries of the European Union.

In addition to this, TTPO also established the ESA's Technology Transfer Network, composed of 16 brokers located around Europe. The main purpose of this network is to collaborate with industries and the National Technology Transfer Initiatives (NTTI) to deliver solutions based on the demands of local industries using space technologies in non-space fields and thus, helping European industry to become more competitive in a global scenario, this process is presented in Figure 13. Nonetheless, technology transfer inside

ESA's context can occur mainly in two ways, the first is when an already established company wants to improve its industrial production using space technology and the second consists in the creation of a new company, usually start-ups, by supporting entrepreneurs with ESABICs resources and technical expertise, nevertheless, the focus remain in transferring technologies from the space environment to terrestrial markets.

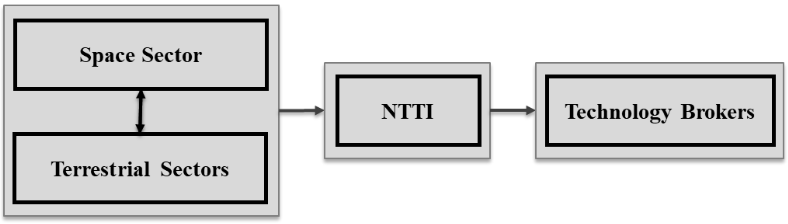

Figure 13. Relationship between space and non-space sectors with NTTI.
Adapted from *ESA - National Technology Transfer Initiatives* (n.d.)

The partnership between ESA and IPN constitutes the National Technology Transfer Initiative in Portugal (PTTI), which is supported by the Space Office of the Science and Technology Foundation (FCT). This initiative converges with the main goal of ESA's technology transfer program, which is to facilitate the use of space technology in terrestrial applications and showcase the social benefits of the investments in space technology development, by providing funding to Portuguese initiatives.

Another tool that ESA possesses to ensure the success of technology transfer is the Technology Forum Database, a digital market place focused on leveraging the creation of spin-offs and the transfer of technologies that were developed by or in partnership with ESA (*ESA - Technology Forum*, n.d.). This is a powerful tool since it enables companies to not only search the database for available technologies but also interact with other entities to display interest in technologies that are not in the platform and to showcase technologies of their own. By supporting this interaction, the platform also enables that any questions related to technical aspects can be discussed and subsequently, solved.

4.2. ESABIC Portugal

Engaging with ESABIC is an opportunity for entrepreneurs to create a business with innovative technology since it provides support in different areas, ranging from access to funding, technical support, expertise for developing business ideas, and connection with ESA's network partners. Although there are various benefits from the program, entrepreneurs need to apply to open calls and follow certain procedures and guidelines that are promoted by the incubation center in which the application is made.

Generally, there is a set of document templates that contain some guidelines to the applicants and it is necessary to fill and submit these documents. These open calls occur three times a year in which a vast group containing entrepreneurs, research organizations, companies that are related or not to the space sector, and other entities are eligible to enroll in ESA's technology transfer program.

These initial studies are composed of three phases that will, one part at a time converge into transferring the technology. The first phase is called the Activity Pitch Questionnaire (APQ) where the applicant, concisely and shortly, presents a general perspective of his idea, mainly regarding information about the company, what is the proposed value, what costumers will it addressed and what is the space assets are supposed to be used to achieve that.

This questionnaire serves as a standardized means to the agency to evaluate proposals and accept the ones that better fit ESA's purpose. ESA then indicates what directions that such a project should take and so, the proposal can assume one of two paths, a Feasibility Study or Demonstrator Project, depending on the level of development that the proposal presents and the intent of the applicant. In this sense, the FS can be considered an initial assessment to identify and verify if the solutions proposed by the applicants are feasible according to a set of requirements, such as the obligatory use of at least one space technology in the business model and focused on the final user. These projects have a pre-determined duration of six to nine months, depending on the complexity and the acceptance of users. On the other hand, the Demonstrator Project aims to demonstrate to stakeholders that the proposed product or service is aligned with market needs and can be operationalized. Due to the nature of the present dissertation, further analysis will be taken into consideration that the entrepreneur is applying for a feasibility study.

Independent of the direction, the proposals that are accepted are requested to submit an Outline Proposal if they wish to proceed, which will then be evaluated by ESA, together with its Joint Commission Board that is responsible for approving or not the proposal. This proposal's content is broader than the APQ, requiring more specifications about the project and detailed planning of the subsequent steps, such as market analysis, a description of the system architecture, and the outline of the company's financial plan.

Once the OP is accepted by ESA and the commission board, the applicant is then invited to submit the Full Proposal, which is the last stage of the process. The Full Proposal consists of a cover letter and a document containing a detailed analysis of the business model and its components, a technical and financial plan containing risk forecasting and mitigation strategies, and an in-depth analysis of the purpose that the space technology will fulfill in the project. These documents should be submitted to the evaluation of the Tender Evaluation Board. Besides, it will only accept proposals that contain a Letter of Authorization for Funding. If the Board responds positively to the proposal, the applicants are informed and a meeting is scheduled to negotiate the final agreements of the contract.

In the case of ESABIC Portugal, the most recent call, *"Spark 4 Tech"*, has the main goal to fund feasibility studies that are focused on the technology transfer from space to non-space applications. This is an example of what is discussed previously, that when National Delegations or Agencies make those open calls, they provide a set of requirements that aligned with the purpose of the call, which not only serves as a base for the proposals but also should be followed by the applicants.

4.3. Guidelines and Requirements for ESABIC Portugal

In this sense, the requisites, standards, and guidelines for tendering into ESA's technology transfer program will be further explored. The information used to elaborate this section was composed of non-confidential documents made available by ESABIC's innovation manager, such as proposal templates and evaluation guidelines, also, documents that are publicly available in ESA's digital platform (*Documents | ESA Business Applications*, n.d.). These documents served as a base to develop the initial form of the P2B Methodology.

Eligibility and evaluation of the proposals

According to PTTI's guidelines, there are a set of aspects that applicants must agree upon. Proposals are only eligible if they match one out of three scenarios in regards of its activity: being developing solutions in the space sector; being enlisted in Faculty of Science and Technology (FCT) Space Office's database or have the previous contact with ESA's programs; show interest in developing new solutions for terrestrial applications based on pre-existing space technology. This narrows down the context in which applicants pursue the agency's funding and maintain the subsequent proposal's alignment with the purposes of the program.

Another topic that is relevant to evidence is the legal aspects that the applicant must comply with to be eligible. Firstly, the applicant must be located in Portuguese territory and be subjected to Portuguese law, taxes, and social security requirements. Also, companies that have collaboration agreements with international partners will be fully responsible inside the Portuguese jurisdiction. Enforcing these aspects to applicants ensures that the value and all the benefits created by the program remain inside the country. Furthermore, the program has a restriction to only accept one feasibility study and one demonstrator project for each applicant.

The project's direct and indirect costs are also crucial to evidence the eligibility of a proposal and its management is on the applicant's full responsibility. Applicants must design their cost structure to obey the limits established by ESA since the coverage is only applicable if the costs are: critical for implementing the feasibility study or the demonstrator project; should be incurred during the project's duration and aligned with previously exposed in the cost schedule; must be exposed before of taxes, interests, and other financial duties.

These costs must also be considered according to what is the total program budget and funding limit for the proposals, which is, in the case of a winning feasibility study may earn up to €30.000 and in the case for winning demonstrator projects, this amount can fluctuate between €30.000 and €50.000 depending on FCT's previous approval. Furthermore, applicants should also consider that these amounts must cover 50% of the total project costs. An applicant must attend these requirements or else their proposal will not be admitted to evaluation. The proposals are analyzed by the Tender Evaluation Board and appraised according to a series of aspects that compose the proposal, these aspects are explored as follows.

1) **Use of space technology:** Since the main goal of ESA's TTP is to broaden the use of space technology, it is a requirement that all proposals use one of the patents available in ESA's portfolio, and so, applicants must include in their proposal a detailed description of the technology that is intended to be used in their project. It should contain technology main functions, features, and innovations. This includes analysing the maturity level of the technology, verifying if the technology is already protected by intellectual property rights, compare the technology capacities such as range of specifications and operating characteristics to other technologies that are similar and already explored by some market.

More than a description of the technology, discussing how the applicant pretends to integrate the space technology to their solution is also essential to be explored in the proposal. This consists in describing the new application for the technology, which includes what novelty it brings to the market and why it can be considered an innovation, the reason of choosing space technology over other existing technologies, what value can that specific space technology add to the new solution, and a brief demonstration of the possible customers or users and a market analysis that the new solution is supposed to attend.

2) Market and Customer Analysis: Knowing the customer and understanding his needs is a crucial factor and a must-do to any business, and in the case of ESA's technology transfer program is no different. It is requested for the program's applicants to provide an analysis of key aspects related to targeted customers and other stakeholders that are somewhat related to the project being developed. This involves describing the customer or user segment, its characteristics, their representativeness in the market segment, and what problems they required a solution and what are the benefits that the customers can expect from the proposed product or service.

A quantitative market analysis is also requested, it should contain the estimated size of the market, geographic factors, meaning what country will be focused or what specific region, and how the new application will be positioned. Another factor that is evaluated is the prospect of future markets and the company's reach over that market.

Another essential aspect is analysing the competitive environment that surrounds the project, what companies are competitors, what products and services are they offering for each market segment, and what is their value proposition. On other hand, what companies can be integrated into the value chain and be considered partners, and also, their capacities and the dimension of their market is a factor that must be addressed together with an analysis of the competitive nature of the environment. Furthermore, all the aspects previously discussed should be addressed in a quantifiable way, that enables a good perception of the existing market and will support a decision to go further in a specific market segment and thus, providing a perspective of market penetration.

3) Value Creation and System Architecture: The use of space technology should be related to what is the value that it brings to society as a whole, but more specifically, to the users and stakeholders of the project. This aspect can be brought to the proposal by presenting the new application's value proposition and describing how the novelty will generate value for the customers. More than a definition, the proposal should also display how the applicants plan to validate their value proposition with each group of customers.

In addition to this, proposals have to contain a definition of the product or service that will be offered to each specific group of users or other stakeholders. At this stage, it is expected from the applicants to possess a sketch of the value chain, detailing resources, activities, and partners as well as the interface between these actors that are required to operationalize the project. These aspects lead to the determination of the system architecture, that in summary, represents how the proposed products and services will reach its customers, how can it benefit from the existing structure amongst clients, suppliers, and other relevant stakeholders, understanding how the operation is related to external actors and resources that are crucial to the project's success.

4) Technical Feasibility, Business Model, and Business Plan: The technical feasibility analysis is related to the viability of the system to be operationalized with minimal risks and variation towards what is initially planned. In this topic, the final concepts of the service must be provided, together with an explanation of how the process of validating the system architecture occurred. Also, this set of aspects has the main goal to assess the overall technical viability of the system architecture, and to do so, proposals shall include all issues that have an impact on the project's viability and what are the success factor that needs to be addressed. Furthermore, a risk analysis must be made, consisting of identifying all the risks that are related to the operation, the development and the implementation of the new solution, and, using a matrix displaying the chance and impact of each risk, proposing mitigation strategies.

A crucial factor that is also evaluated in the proposals is the business model. This must be aligned with what was defined previously such as the value proposition and the service concept. Related to this topic, it is requested for the applicants that they address in their proposal at least: what partners are expected to be involved; the resources that will be needed; how the customer relationship will be managed; how the product or service that is being developed will reach the market; what activities need to be made to successfully operate the business model and a forecast of the revenues and costs incurred to the project. Complementary to these aspects, there must be displayed in the proposal all the activities related to validation of the assumptions made in the business model.

Following the business model, it is recommended to the applicants to develop a business plan, emphasizing the financial aspects of the project by presenting a financial plan. It must feature a sales forecast and how these sales will develop in time, also the use of financial indicators, such as payback analysis, net present value, and break-even, are highly recommended and could be complemented by a projection of the company for the next five years addressing all these themes.

Also, in the business plan, there must be presented a description of the team that will execute the project, showing the team member's competencies and qualifications as well as a demonstration of why these capacities are required to execute the project. Furthermore, in the case that there is no availability of a qualified human resource, how it is planned to acquire or substitute it in future moments.

The business plan is also intended to show to the evaluators the overall performance and viability of the project, and so, an impact analysis should be taken in consideration, demonstrating the social and economic impact that results from the operation of the business model in the environment around it, in a social context, an example is how many jobs would be created and in the economic sphere, what will be the effect of the new application in the market. In regards to the viability assessment, the applicants should identify in their proposal critical elements that directly affect the success of the project, both in the social and economic context, define indicators on how to measure and control the existence of these elements as well as establish mitigation strategies.

5. INITIAL P2B METHODOLOGY

This chapter has the objective to demonstrate how the development of the initial conceptualization of the methodology occurred and to describe its phases. Based on the findings of the structure literature review, previously addressed in Chapter 2, and information obtained by analyzing the case study of ESABIC Portugal, Chapter 4, it was possible to make an initial conceptualization of the named P2B methodology.

5.1. Initial Conceptualization

The initial conceptualization of the P2B methodology, as shown in Figure 14, it is composed of four phases: Technology, Value, Business Modelling, and Business Plan, and supported by a prototyping process that occurs in parallel with the final phases. Each phase consists of blocks of activities that provide crucial information that helps decision making in that phase, in a sense that, at the end of the phases there will be a set of information and decisions made towards the development of the business.

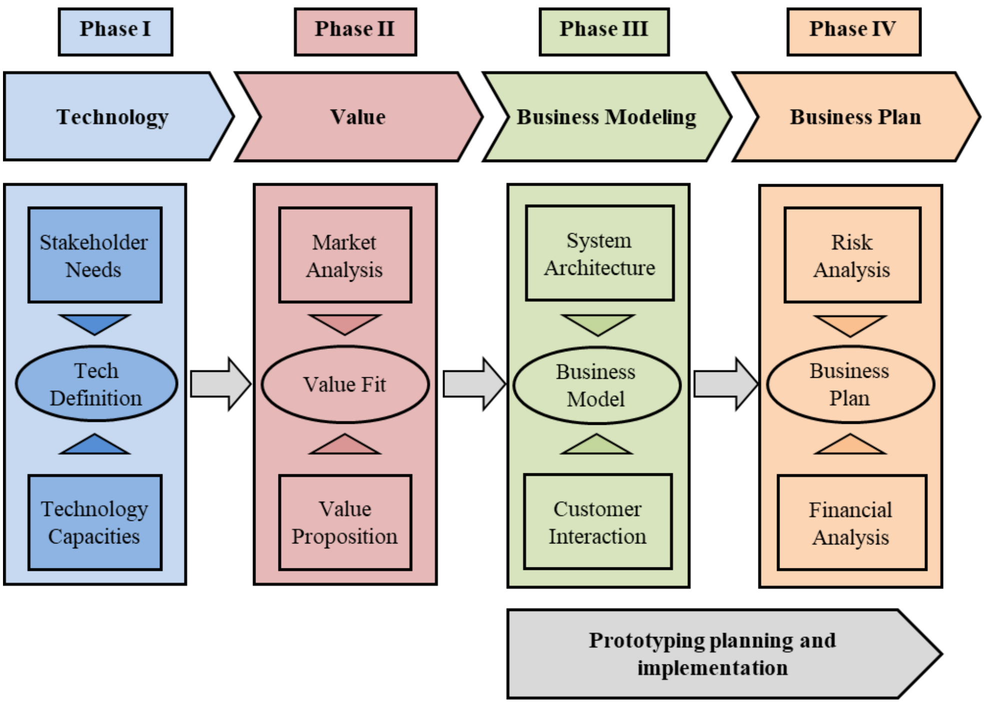

Figure 14. The initial P2B methodology.

The initial conceptualization of the P2B methodology, displayed in Figure 14, was partially inspired by the innovation process that was proposed by Bessant and Tidd (2015), in whose model suggests that such process should have its origins in the context that the entrepreneur is embedded and his capacity to observe and understand the environment around him and identify trigger signals that could indicate market opportunities.

Another aspect that highly influenced in the development of this initial conceptualization, was the concepts and ideals promoted by Osterwalder et al. (2015) which states that the business development should be heavily customer-oriented and use the needs of customers and users to develop a product or a service more aligned with the market. On the other hand, the documental analysis highlighted several aspects that can provide significant help to entrepreneurs in the development of business models, one of these aspects is the risk analysis, which is crucial to determine risks, its impacts and thus, establish mitigation strategies.

Although the methodology appears to be sequential since as the project and the phases develop, they tend to an endpoint, in reality, this is a highly iterative process. This happens because it is required to be highly capable of adapting to a rapidly changing scenario, and so, some activities can be revisited and some decisions may be readjusted accordingly to the situation at a given moment. As follows, the details for each phase, and their relative blocks of activities are discussed.

5.2. Phase I: Technology

The P2B Methodology begins with what is called Technology Phase (Phase I), in which it is the starting point is considered to be when an entrepreneur identifies a problem that is embedded in his reality and wants to develop a new solution to that specific problem using a certain technology, that is protected by a patent. Nonetheless, this phase is based on the assumption that there is a problem and that problem is solvable, and one of the ways it can be done is by developing a technological solution derived from a patent. This phase has two main blocks, the *'identification of customers and other stakeholders needs'* and the *'definition of the technology's capacities'*, thus, the purpose of this phase, and also, the desired outcome is to identify one patent that can address the technical requirements of the problem and, subsequently, the customer's needs.

Identifying customers and other stakeholders needs

In the process of identifying, outlining, and determining the problem that is going to be addressed and its causes, it is also necessary to, not only, evidence who are the possible customers for that new solution, but also, distinguish amongst them, the ones that will effectively use the solution, called the users, and the ones who will pay for it, and thus, considered the paying customers. Although in the majority of times the user is also the paying customer, in some circumstances these are different entities that have distinct needs that must be attended individually. Besides the customers, all the other stakeholders that directly influence or are influenced by the project must be mapped and their needs, identified.

The technology's capacities

As said before, the entrepreneur resorts to technologies that are made available through TTP to solve a problem. However, each problem requires a specific solution, that also carries along with a set of technical requirements, essential to attend to the customer's needs, in this sense, it was incorporated in the methodology an activity dedicated to *'identifying and defining the technical specifications'* that are required to develop a solution, which could be obtained by understanding very well the problem and relating them to the stakeholder's needs.

When the technical requirements are known, the next step is to search in the market for patents that can attend to them. The process of choosing the technology should consider aspects such as the current TRL for the technology, the purpose that it was originally developed, and ranges of technical specifications it can achieve. For this reason, research entities often have a technology portfolio or a similar interface, which showcases what technologies are available and provides technical information over them. In the context of ESABIC Portugal, there is the ESA's patent portfolio and a Technology Forum with all the patents that are currently available for commercialization, which entrepreneurs can research for the technology that better fits their requirements.

After initial research on the patent portfolio, it is recommended to select a set of possible patents that fall in the technical requirements, and thus, it is necessary to verify the characteristics of each one of them to decide what will better fit. Nonetheless, in some cases this is not necessary since there is a chance that only one patent will emerge as a possibility or have the right characteristics. There is a chance that none of the selected technologies attends to the problem's technical requirements and, although it can happen, this leaps out of the methodology's scope.

And so, the first phase of the methodology culminates with the selection of a technology that has the attributes aligned with the technological requirements of the problem and so, can lead to the development of the new product or service that will properly attend the customer needs. Another result of this phase is a set of possible customers and their needs, which can be addressed in the next phases of the methodology.

5.3. Phase II: Value

After the previous Phase defined what patent that will be explored, its capacities are known, and the possible customers and their needs are identified, Phase II takes place. Denominated as the Value Phase, it is where the value proposition begins to be formed and a deeper perception of the market is obtained in an attempt to achieve the fit between the market needs and the value that can be created by the chosen patent.

Market Analysis

This block of activities represents the continuation of what was done in the previous phase related to the *'identification of customers and other stakeholders needs'*, so, the information analysed regarding these customers and other stakeholders of the project, now give space for activities that focus on getting a better knowledge of the market itself and the several actors operating on it. With that in mind, the second phase of the methodology begins with a market analysis, using as a base the requirements for ESA's TTP, which also demands the inclusion of quantified information about the market, a few examples of it are: what is the total size of the market that will be targeted; what of that total market can will the solution possibly achieve; what is the growth forecast for each segment of the market.

Another relevant aspect that must be analysed is the competitive environment that revolves around the market. Knowing what companies can be perceived as possible competitors and understanding what they offer to what customer segment as well as their value proposition, could bring significant impact when deciding the positioning of the new product or service in that specific market. This can be achieved by performing a benchmarking with the possible competitors to better understand the products and services that they are offering and what kind of value they are taking to their customers.

As follows, a market penetration analysis is suggested to better known in what position the new product or service will be inserted in each market segment and know the expected market share for it is. And thus, it is also necessary to delimit a strategy for each product or service how they will be introduced to each of their markets.

Value Proposition

The second activity block of Phase II represents the process of defining and validating the value proposition. For this to be achieved, the technical capacities of the patent must be known and explored deeply, since they serve as the base for the definition of what products and services will be developed and offered to customers.

A key aspect of all companies, the value proposition is a demonstration of how a business intends to solve its customer's problems with its products and services. In this sense, the focus is to encounter a fit of what the customers need. As shown in the literature review, the main tool that entrepreneurs can have to perform this activity is the Value Proposition Design, created by Osterwalder et al. (2015).

This tool connects all the topics that were addressed previously since on one side it is crucial to know the customers well enough to understand what are that they are trying to get done, the difficulties that they are facing while executing that task, and what are the benefits for completing the job. On the other side, there are the characteristics of the product and service that will be offered that derived from the perception of the patent, thus, allowing to forecast how they will facilitate the customer's life or attend to their needs.

Since there is already a notion of who are the customers for each product or service that is being developed, in this phase occurs the first real contact with them, to validate, at some level, the value proposition. Related to the concepts of OI, displayed in Section 2.3, this proximity with the users and customers while in the development stages of the product has become more relevant nowadays, and it is a crucial activity, since engaging with customers in early stages of the process, bring several benefits, including the fit between their needs and the value proposition.

The fit between needs and value

Phase II searches to obtain a good fit between what is the value that the company is trying to offer through its products and services and what is demanded by the market. This is where the validation part of the methodology is important when possessing reliable information regarding the market needs and knowing the range of specifications that are workable for the patents, it is possible to converge both aspects.

Validating the value proposition is a crucial part of this process to be successful because, if a product or service does not attend a customer needs it simply will not sell well enough to support the company’s operational costs and thus, is not worth the investment on it. Nonetheless, outlining the value proposition can be tricky since the market is rapidly changing and new needs emerge too often to keep a record.

One of the outcomes of the process of the value proposition and the market needs convergence, is that the characteristics of the product or services start to become clear and will be validated together with the value proposition itself. Also, this is a highly customer-oriented process, meaning that the decisions that should be taken regarding the product or the service need to be focused on attending the customer’s necessities.

5.4. Phase III: Business Modelling

In the previous Phase, an iterative process that established the first contact with the customers resulted in the definition of the value proposition and deeper knowledge of the market. And so, the third phase of the P2B Methodology begins and has the main objective of developing the business model that will be responsible for effectively taking the product to the customer’s hand. In addition to the business model, during Phase III it is also presented a prototyping block of activities that will help to validate the assumptions made with the focused customers.

System Architecture and Business Model

The start of Phase III is marked by the building of the system architecture. This architecture represents an overview of the value chain for the new product or service, in other words, it is the graphical representation of the activities that will take place, the actors engaged in the value chain, such as users, customers, suppliers, partners and the interface between each one of them.

Even though the system architecture is a general view of the chain an some of its processes, it is an essential activity to perform since it enables a good perception of the flow of resources and information through the chain but can also evidence risks and elements that are critical and can represent some level of threat to the project overall. Thus, these risks and elements should be identified as a strategy to avoid or mitigate them should be traced. For better understanding, an example of this could be that the new product has in its components a rare earth mineral and only one company supplies it in the right specifications, so, the scarcity of this material should be considered a risk, subsequently, this problem should be addressed by substituting this material in the design phase.

The resulting diagram will then serve as the base for the construction of the business model, in which, the tool that served as a base for the development of this block of activities and is also suggested to guide the execution of the subsequent activities is the Business Model Canvas, created by Osterwalder & Pigneur (2010), previously discussed in Section 2.5.3. The BMC was chosen to be used in the P2B Methodology since it is a reliable way to develop business models, it is well spread in the literature and it is directly recommended in the documents provided by ESABIC Portugal.

Prototyping

The prototypes that will be referred to in this phase are not the same ones that are made for the development of the technology in the laboratory environment, as displayed in Section 2.4.3, most common in lower TRL, such as 3 and 4. Instead, these prototypes consist of simpler versions of the final products or services that are developed to be taken to the market and test specific components. Furthermore, the content of these activities was inspired by the Detailed Design Phase, of the model proposed by Geissdoerfer et al. (2017).

Since the methodology deals with the development of technological entrepreneurship, prototypes are essential since it enables the extraction of practical functionalities of the product while being or tested. The prototyping activities in this phase begins with the identification of technical components that needs to be tested in a more practical environment. As follows, it is equally important to define the method in which the prototype validation will occur, thus, metrics linked to the test objects and success factors should be defined, since they will serve as a gauge to approve or not the prototypes.

Applying prototypes to all of the users or clients is inefficient, instead, its application should be focused on a narrow group of customers or users that were selected according to shared attributes such as age, gender, or annual income. The selected group should be engaged in the process and receive information such as, the main features that are being tested, the reason for the test, and even how to use the product. Furthermore, the scale of the testing has to be defined beforehand to produce the exact number of prototypes required for the specific customer group.

Making prototypes can be a complex process and demand a certain amount of resources to be dedicated exclusively to this task and this resources must be available by the time this activity takes place so, this should be carefully planned to avoid mistakes that could delay the project, or in the worst case, cause troubles for the customers. When the resources are mobilized, the customer group is known and engaged in the process and the validation methods are established, the next step is effectively building the prototype and applying it to the customer group. The most important part of this process consists in carefully collect the feedback from the users, ideally, the good feedback has to be mapped and the aspects linked to it further exploited. When there is negative feedback, it should be investigated and its causes discovered, solved and improvements should be made before the next version of prototypes.

Although the prototyping activity is referred to only in Phase III, this process could be extended until Phases IV, it depends on the time and quantity that each prototype takes to be developed, deployed, its feedback analysed and improvements implemented. This can be seen in the representation of the P2B Methodology displayed in Figure 14.

5.5. Phase IV: Business Plan

The P2B Methodology's last stage is called the Business Plan Phase. This is where all the information, knowledge and decisions are taken so far converge into the activities displayed in this phase. In a traditional view, a business plan is a document that contains detailed information about a business and is usually presented to investors to obtain funding for the project. In the case of the P2B is not very different, except the business plan serves as a foundational document to elaborate proposals and applications for technology transfer programs.

Financial Analysis

Since is the goal of every business is to generate profit for their investors, the financial plan is an essential component of the business plan, and thus, this block of activities searches to map the financial risks associated to the business model and its operation, such as high payment receipt times or non-payment risk. These occurrences can directly affect the financial health of a company and thus, there is the necessity to define mitigation strategies for each one of the mapped risks.

The overall viability of the endeavour is also directly related to the financial aspects and they must be disclaimed in the financial plan, one of them is the sales forecast, which enjoys the information collected in the market analysis made in Phase II to provide a reliable predict. However, there must be metrics to measure their evolution over time, and the main ones are the payback, net present value, and the internal return rate. Furthermore, other financial indicators are suggested in ESABIC’s documents, such as the CAPEX and OPEX. Independently of the metrics used, the data provided must be reliable and represent a plausible scenario, closest to the reality as possible.

To conclude this block of activities, the entrepreneurs must make a scenario analysis, which consists in establishing different future scenarios where some variables, such as revenue or operational costs, vary inside a specified range of values, and thus the effect of these variations on the financial metrics are observed and compared. This will evidence what variables must be better controlled and thus, determine the limits of the project’s viability.

Risk and Impact analysis

Risks are inherent to all activities and projects and are determinant factors when assessing the viability of a business model. In addition to the financial risks mapped in the previous block of activities, the risk and impact analysis block is aimed specifically to identify risks related to the operation in a socio-economic sphere. In Phase III, the business model was developed and validated, a sub-product of that process is the identification of weaknesses and risks of that business model.

In addition to those risks, the impact of the operation on society and the economy in which it is embedded must also be addressed. The implementation of a new business has always a good and a bad side, some examples of positive impact in the economical context could be represented by the jobs created or, in the social sphere, in a more specific case, if the solution is related to the healthcare system, it is expected that around that new product there must be a positive impact on health indicators.

On the other hand, there are also negative impacts that directly affect the business model, for instance, if the solution somehow impulses the tourism of one specific region, that closed environment will suffer from possible degradation of public spaces or historical heritage from the increased flow of people and also, the local population could suffer from rising prices for basic products. This could ultimately lead to a downfall of the company's public image.

The purpose of the P2B Methodology is to enable entrepreneurs to collect information, throughout their innovation endeavour, which will help them to compete for funding in technology transfer programs. In a certain way, the perspective of the investor should also be taken into consideration when gathering information to build a business plan.

5.6. Challenges to be Addressed

Throughout the literature review, the analysis of the ESABIC Portugal's case study, and the development of the initial conceptualization of the P2B Methodology, several aspects were evidenced that can represent challenges that entrepreneurs may face when going thru the process of developing business from patents. This is demonstrated in Table 3 where these challenges, related to each phase, were linked to the findings of the literature review (LR) and insights obtained during the analysis of ESABIC's documents (DA) that symbolized those challenges to be addressed.

Table 3. Main challenges for each phase of the P2B methodology.

Phases	Challenges	Source	Information
Phase I	C1. Business Trigger	LR	The innovation process starts with the identification of trigger signals (Bessant and Tidd, 2015).
		DA	Applicants have an interest in developing new solutions from space technology.
	C2. Information Paradox	LR	It is required that the applicant discloses some, if not all, characteristics and components of its solution before the license is granted, assuming a risk of it being denied and giving up his solution (Wachowicz and Bury, 2017).
		DA	Applicants should describe the technology that is pretended to be used, its capabilities and how it will be integrated into the new solution
Phase II	C3. Value Orientation	LR	It is vital to be proactive, use the feedback gathered from the stakeholders, and be proactive towards bringing solutions that even the costumers did not know they need it (Bessant and Tidd, 2015). Value is what a business offers to its customers and partners to solve their problems or to attend their needs (Osterwalder & Pigneur, 2010).
		DA	The value that technology adds to the new solutions and its possible customers.

Phases	Challenges	Source	Information
	C4. Product-Market Fit	LR	The fit between technology and customer need is the main reason that technology commercialization is viable (OECD, 2010). Reach a connection between a specific customer segment needs and the value that is being offered for each product or service (Osterwalder & Pigneur, 2010).
		DA	Understand the market, the customers for the new solution and the competitive environment
	C5. Working with the customer	LR	Opening to end users the possibility to join the project as sponsors or evaluators (Moellers et al., 2020). Customer-related problems such as the inability to meet customer's demand due to misunderstanding of their requirements (Şimşek and Yıldırım, 2016).
		DA	Evidence of how the value proposition will be validated.
Phase III	C6. Prototyping	LR	Continuously validating new ideas, solutions and prototypes with the stakeholders, a process in which, if succeeded, eventually will originate a solution ready to market (Bessant and Tidd, 2015).
	C7. System architecture and business models	LR	How a company will manage multiple aspects of its operation and integrate them internally and externally to capture and deliver value to its customers (Zhu et al., 2019).
		DA	Presentation of the value chain, containing the relationship between all its actors, drawing the system architecture and showing how the products or services will reach its customers, and how it is going to be validated
Phase IV	C9. Intellectual Property Management	LR	Intellectual Property ownership rights (Şimşek and Yıldırım, 2016). Align a firm's technology commercialization strategy with the successful exploitation from external and external projects from a future perspective (Lichtenthaler, 2008).
	C8. Managing Uncertainty and Risk	LR	Elaborate risk mitigating strategies, preventing inefficient use of the resources, and enlighten the path towards innovation (Bessant and Tidd, 2015).
		DA	Identification of all risks related to the system, the operation and the business model, evidence the impact of each risk and propose mitigation strategies

Each challenge received a codification (C1 to C9), then they were taken to discussion with the experts during the second phase of the interviews and presented as possible challenges during business developing process. They served as a baseline to develop a conversation and obtain the interviewee's perspective over each specific challenge. The discussion over these challenges and analysis of the data collected is presented in the next chapter.

6. RESULTS OF THE INTERVIEWS

This chapter presents an overview of the interviewing process, display the results obtained from the analysis of the data collected during the semi-structured interviews and showcases the consolidation of the valuable information collected.

6.1. Results Overview

As stated in Chapter 3, interviewees work in three major entities groups, 'University', considered research institutes that develop technology and want to license them, 'Business', represented by entrepreneurs that created businesses from the use of technology, and 'Incubator', representing incubators and accelerators.

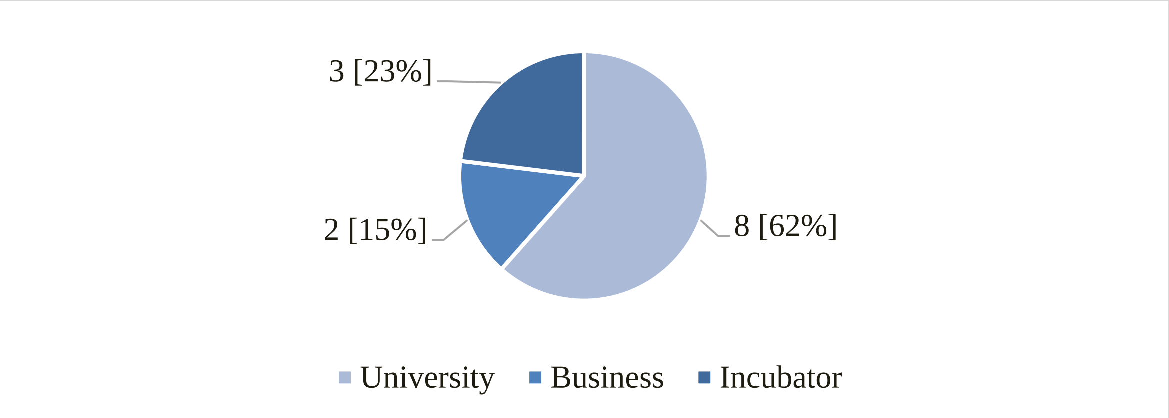

Figure 15. Interviewee's organizations.

It is perceivable in Figure 15 that the majority of the interviewees worked on research institutes, followed by incubators and accelerators and last by the business section. It was expected to interview equal numbers of those three sections. However, due to time restrictions that this dissertation had and, to the fact that interviews were dependent on the time availability of the participants, it was not possible to achieve the desired number of interviews.

It was also necessary to understand the context in which the interviewees are embedded in. As seen in Table 2 in Chapter 3, their orientation is evidenced, representing the field of knowledge that participants are more familiar with. In Figure 16, it is possible to perceive that the overall orientation tended more towards technology transfer, with 69% of participants oriented to technology transfer, in opposition to 31% with more proficiency in innovation.

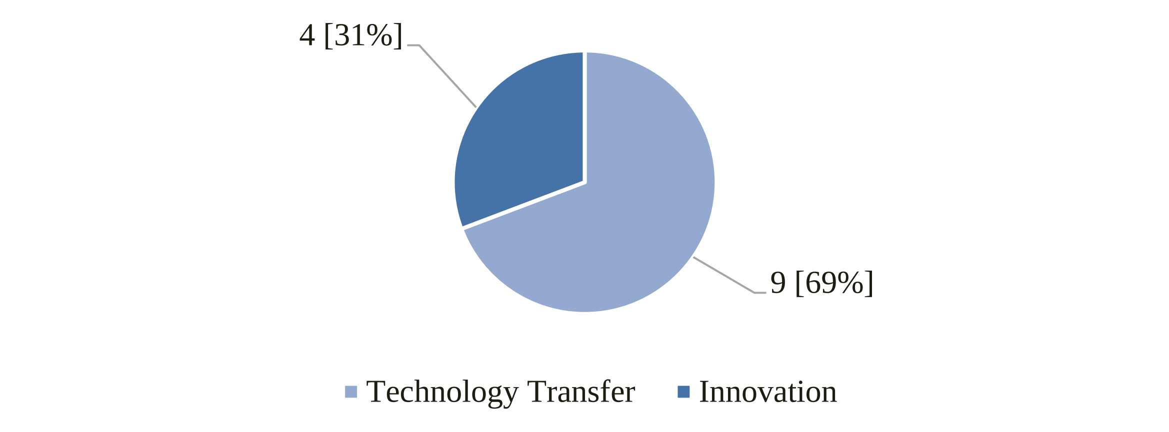

Figure 16. Interviewee's orientation.

Since each interviewee has its orientation, it is understandable that the interviews differ one from another content-wise, this was evidenced when refining the codes within the data set, furthermore, at this stage the themes began to be understood as challenges. Not all the challenges were brought up in all the interviews, and thus, some presented itself more often than the others. This was the case of the challenges related to Phase I, which came upon all the interviews, as seen in Figure 17. Nonetheless, the other ones that did not appear quite often were the ones related to Phases II and III and yet were discussed in eleven of the thirteen interviews made.

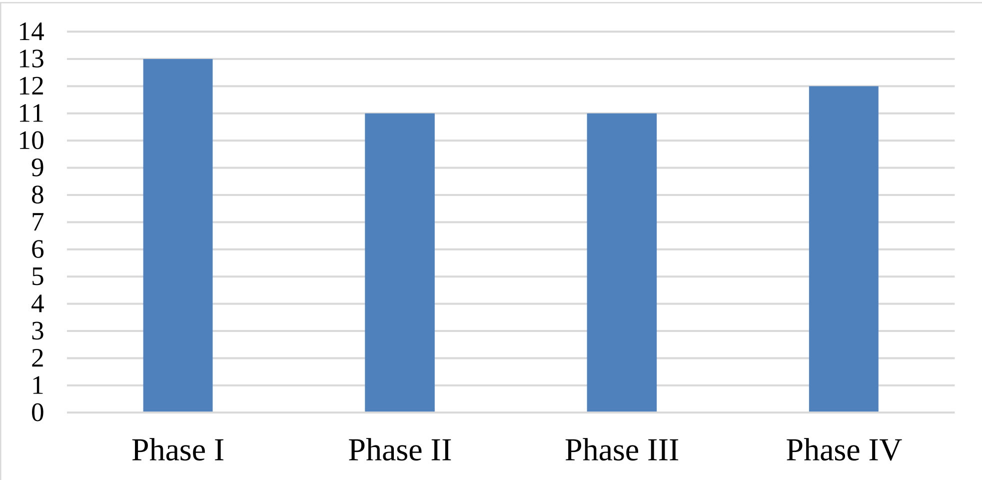

Figure 17. Times that a challenge related to each phase was mentioned during the interviews.

An explanation for that could be the fact that not all interviewees were knowledgeable of all the challenges addressed during the interviews, for example, a person who is an expert in technology transfer has more to contribute about this topic than anything related to innovation. For instance, interviewee I.2 is a specialist in technology transfer from a Portuguese university and so, the natural flow of the interview was more focused on the themes related to Phase I.

In addition to the challenges displayed in Table 3, interviewees evidenced another challenge amongst the methodology's phases, the *'Inventor's Conflict of Interest'* (C10), which was coded inductively since they were brought up by interviewees and were not forecasted by the interviewer.

Also, activities to overcome these challenges and tools that could support the entrepreneur were suggested for each challenge. Since the purpose of these interviews was to obtain knowledge from the experts and promote improvements on the P2B Methodology, all the discussions and arguments presented in this chapter were decisive to include or merge those activities and tools, based on their relevance, if they represent a significant improvement, or clarify any aspects related to these themes in the methodology.

Displayed in Figure 18 are the main challenges that were addressed during the interviews, classified according to the respective Phase that they are related, and is also presented the number of references that were coded for each one possesses, which means, if an activity, tool or task were discussed within that specific challenged, its reference is counted inside the challenge.

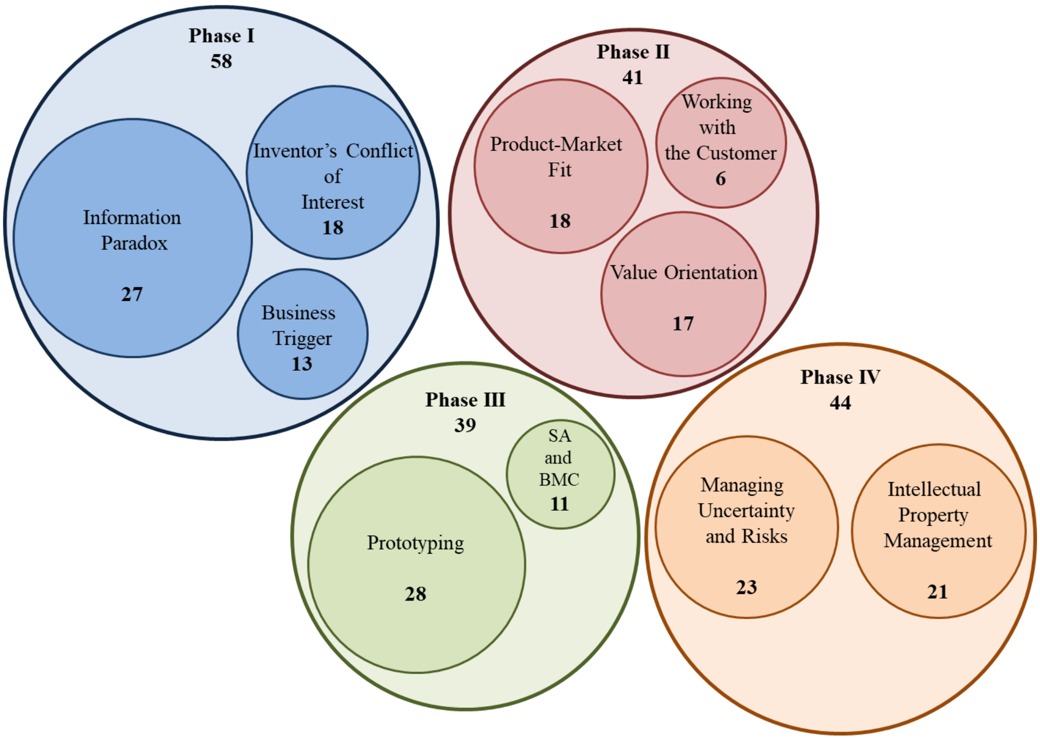

Figure 18. Each phase's challenges by the number of code references.

6.2. Technology Phase

6.2.1. Technology Phase Challenges

C1. Business Trigger

In Phase I, it is unclear if the existence of a problem is the only trigger for this methodology, as in reality there could be multiple sources of motivation, where the entrepreneur could not have a well-defined problem, but instead, possess a deep knowledge over some technology or field of knowledge that is related to a specific theme of his interest, and thus, wants to explore it further and possibly, turn it into a business by using patented technology.

This theme came up on ten of the thirteen interviews, in which the majority of participants considered the main reason that entrepreneurs pursue the development business models is the attempt to solve a problem that is embedded in its reality. Other perspectives were discussed, one that the motivation comes equally from a problem, and the other, focus on the exploitation of a certain technology.

In agreement to the first point of view, I.3 related that his company was created because he was bothered about aspects related to electric bills and the electric companies that provided such service and, after a while, he saw an opportunity that presented itself to them, which in his words: "*the business was made to explore a market opportunity that was created from the establishment of new legislation*".

However, when there is a problem to solve, the window of opportunity for entrepreneurs is usually small, because start-ups generally do not have enough financial resources available to challenge already established companies in the race for the development of a new solution, in agreement to that, I.1 commented that "*when there is this market necessity, existing companies in that market tend to rapidly respond to that demand*". Thus, in reality, the goal of entrepreneurs should not be to deploy the solution first, but instead, they must focus on deploying a better solution, more aligned with the customer needs.

As discussed previously, that is not the only source of motivation, indeed, I.1 stated that in his belief: "*It is fifty percent where the motivation is related to the social reality of the entrepreneur, and the other half comes from the development of technology to fit a certain market need*". The same interviewee also complemented that if this motivation was exclusively originated from the attempt to solve a problem, the whole process would be easier because of "*lower market resistance and higher market attractivity*".

Two examples of Portuguese start-ups were provided by I.8 that support this perspective. One of these companies was "*created based on a technology that was developed during the inventor's doctorate, which assisted decision making in the field of healthcare diagnosis*", which eventually was turned into a business and won several European investment rounds. The other case was the creation of an application based on a problem experienced by a group of medical doctors, in the words of the interviewee "*we realized that there was this problem, and based on that, we developed a product that had the objective to help in the decision making process from those doctors*". In this case, the market necessity appeared, and then a product was developed to attend that specific necessity.

C10. Inventor's conflict of interest

This leads to another discussion related to what if the entrepreneurs have some kind of relationship with the research institute or the patent, and if this relationship could present itself as a conflict of interest between both parts. It is not clear in the literature as well as in the documents analysed if this conflict has influence in this process and if it does, what kind of mitigation strategies could be taken to prevent its occurrence.

Discussions related to the *'Inventor's Conflict of Interest'* were brought up during the interviews and appeared in seven of them. Most of the interviewee's arguments were that this situation rarely occurs and may not have any influence at all in the process of business development, but when it occurs, most of the time, there are some activities that both parts can perform to avoid this situation.

C2. Information Paradox

In regards to the patent's information, one aspect observed while developing Phase I of the methodology was the amount of information related to each patent that the research institutes provide in their platforms. Although these interfaces contain aspects such as a brief description of the technology, their advantages and innovations and a few domains in which the novelty can be exploited, these sometimes are not sufficient to allow the entrepreneur to have a good perception of the capacities of that technology and to establish solid assumptions for the possible uses of that technology. On the other hand, entrepreneurs are afraid to ask some questions related to technology with the fear of disclosing more information than needed, and opening space for others to somewhat steal his ideas.

Discussed in eleven interviews, this topic was the most discussed amongst the ones related to Phase I. The discussions were then divided into regards to the existence of such paradox, if it incurs any problem whatsoever to the process, the reasons why it occurs and how it can be mitigated. Denying its existence, one interviewee argued that "*in a practical scenario, this does not happen because when someone is interested in a specific technology, that person usually already possesses deep technological knowledge over the patent, and so, does not require any additional information*".

Opposite to that point of view, ten interviewees recognized the existence of this paradox and discussed activities that provide entrepreneurs with ways to overcome this barrier. Agreeing that such paradox exists, but arguing that it does not represent a problem at all, I.6 commented that "*inventors make available enough information regarding the patent*", complementing this argument, I.11 said that "*entities that promote technology transfer always display relevant information about the patents to the ones that are interested in them*". This can be noticed in platforms such as the ESA's Technology Forum or IP portfolio, previously discussed in section 4.1.

Related to the *'Information Paradox'* (C2), various interviewees brought up several activities and tools to minimize its effects. Displayed in Figure 19, are the tools discussed for mitigating the information paradox and the number of participants that recognized the value of each specific method in reducing the paradox effect. The main objective of using them is to obtain more information about the desired patent, helping the entrepreneurs in the decision-making process.

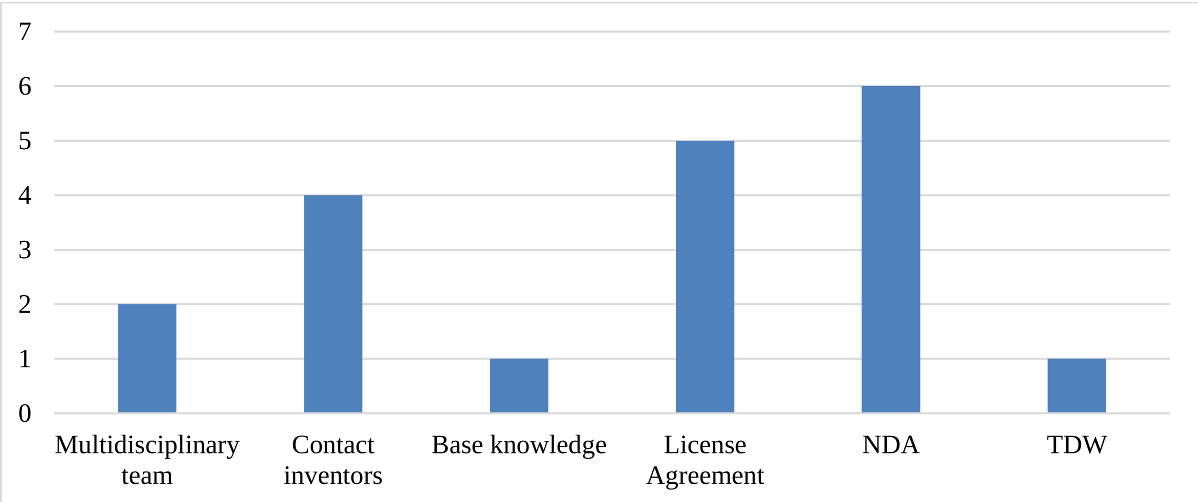

Figure 19. Number of interviewees that discussed tools for mitigating the 'Information Paradox' challenge.

6.2.2. Technology Phase Suggested Activities

A1. Prevent Conflict of Interest

When faced with what was described as the *'Inventor's Conflict of Interest'*, both entities eventually try to enter mutual agreements in regards the future of the technology, as reinforced by I.6 that "*the university will always search for the common agreement*", and represent the side of the inventor, I.1 stated that "*the goal is to safeguard the inventor's rights to those patents*". The main aspect related to this perspective is that there should always be good negotiation practices and the search for a win-win agreement and, based on these arguments, an activity called *'Prevent Conflict of Interest'* (A1) emerged.

In the case of internal researchers who want to take an invention to the market, I.10 explains that "*most universities have internal regulations related to intellectual property that provide instructions for when this type of thing happens and ways to resolve any kind of conflict that might occur*". In this sense, it can be stated that universities and research institutes in general already have established procedures and internal regulations to avoid this kind of conflict, which can be useful to prevent such conflict.

Another measure that these entities apply in these scenarios is to guide the inventors to the possibility of creating spin-offs, I.10 also commented on this, stating that "*there are orientations from the university to provide inventors with support to create spin-offs and explore the technology"*. Also, in some cases, research institutes and entrepreneurs can resort to the possibility of licensing the technology if the situations seem fit. Nevertheless, it is possible to say that in general, universities and other research institutes usually tend to stick to the inventor's side, since they are linked to the institute and thus, the benefit of exploring the technology goes to both parts.

A2. Outline Technology's Capacities

The first activity to be suggested was called *'Outline Technology's Capacities'* (A2), it is mainly related to the *'Information Paradox'*. As oriented by I.5, "*assembling a multidisciplinary team, can provide a better understanding of the technology's technical capacities*". An example of this could be a team that has members with a broad knowledge of a certain technology but is not familiarized with how to create value from it, thus, it would make sense to search and integrate another member that is experienced with value proposition tools. The same interviewee also proposed that another way to circumvent this paradox is when "*entrepreneurs chose to use a technology that he already possesses base knowledge of how it works and its capacities*". This, in a certain way, signifies that the entrepreneurs should choose technologies that are familiar to them, a better understanding of the technology could help in the development of a product or a service.

Also, to address the *'Information Paradox'*, there is the Technology Description Worksheet, a tool developed by I.7, as part of his Technology Management in Businesses lecture, which enables entrepreneurs to determine a technology's specifications, capabilities, and uniqueness. It can be used, for instance, as a complementary tool during a meeting with the inventors to better understand the technology and describe its capacity. A Technology Description Worksheet template was provided by I.7 and is presented as an example in Annex A.

A3. Reach Technology's Inventors

Contacting the inventors of the technology can be hard, nevertheless, it is an alternative if the information displayed is insufficient or need some further clarification. This argument was supported by four of the interviewees, in which I.11 explained that when this situation occurs in the incubator where he works the procedure is to "*always attempt to schedule a meeting between the entrepreneurs and the technology's inventor to clarify some of the aspects of the technology*", on the same line of thought, I.13, who works on the same incubator as I.11, complemented that "*in these meetings, usually the entrepreneur exposes part of his idea and then, the inventor respond to any further questions about the technology, and also indicates, at some extent, if the technology can be used to develop the entrepreneur's idea or not*". However, the simple fact of making questions related to technology, or talking about it with someone who deeply understands it can be considered as a risk.

A4. Pursuit Agreements

The most discussed method that interviewees highlighted was the usage of Non-Disclosure Agreements (NDA). NDAs are a kind of contract that force entities to maintain secrecy and confidentiality while trading information over the object of discussion, in defence of this tool, I.1 states that they "*are confidentiality agreements directed to who wants to commercially explore a certain technology while safeguarding the interests of the inventor* *and the technology*". Although NDAs can be, according to I.8, "*an excellent way to obtain all the information directly with the inventor*", it also represents a major risk, despite the fact it is built on a legal basis, it can be broken at some point, since "*it is worth what is worth, it is just a signed paper. When there are thefts or other problems, it is worthless*", stated I.8.

If NDAs are not an option, an alternative can be the use of Research Licensing Agreements (RLA), however, this method is only possible in more advanced phases of the methodology, in a certain way, it consists in licensing technology to the entrepreneur for a certain time, between one and two years, which allows them to fully investigate the technology's capacities. This method is what ESABIC uses to support start-ups. Although RLAs are used in practice, I.6 makes a critic about the Portuguese innovation ecosystem, stating that "*the licensing culture in Portugal is yet too small*". Perhaps by evidencing that these aspects can foment technological entrepreneurship in Portugal and thus, promote the licensing culture.

6.3. Value Phase

6.3.1. Value Phase Challenges

C3. Product-Market fit

When discussing Phase II, a theme emerged related to what was called the *'Product-Market fit'*. In a way, the perfect scenario would be the total convergence of both aspects, however, there may be cases where there is not a clear market necessity to be attended, or even if there is a market to a new product at all. This could be also related to the perspective in which the solution is being developed, if the focus is on the customer or in the technology itself, ideally, the focus has to be all on addressing customer's necessities, however, this may not be always what happens.

Although this subject matter was discussed in six interviews, the interviewee's opinions about this theme were that this fit depends mainly on three factors, firstly from the *technology maturity*, as expressed by I.1 "*it depends on the moment in which the technology is*", relating it to TRL. On the other hand, some interviewees defended that it also depends on the type of technology in question, as stated by I.7, "*the value is created from the technology and is capacities*", and also stated that the characteristics of the market are also a relevant factor for finding the fit between the market and the solution. Furthermore, I.9 highlighted that if the case is the creation of a new market, "*the way to obtain this fit is to focus on what customers are demanding*". Nonetheless, it can be assumed that these three factors have some influence on how a product developed from technology can attend a market need.

C4. Value Orientation

This led to a discussion about what the value orientation should be if the focus should be on the customer or in the technology. In this matter, opinions were balanced between one, another, and that both are equally important to define the value. In this sense, Table 4 highlights the relevant arguments for each one of the perspectives.

C5. Working with the customer

Another relevant point is the involvement of customers and users and the early stages of the process. This has its benefits, such as already establishing a connection with potential customers in the future, but also has a bad side, that is disclosing information about the product too early in the market may lead to the appearance of similarities on the competitor's products or other companies trying to do the same or offer similar things.

Within this theme, none of the four participants that addressed it, saw that bad side previously displayed, there were only positive aspects in bringing the customer closer to the process. An example of this was brought by I.3, stating that his company "*continuously work in mapping its customer's needs to develop new products and services*", in addition to this, there was a constant idea of building the product with the customer, I.8 defended that "*you have to build you product and evolve your business model together with the customer, to then obtain the perfect product-market fit*". Furthermore, the notion of working with the customer turned out to be recurrent during the interviews.

Table 4. Interviewee's arguments related to the value orientation

Interviewee	Interviewee Argument	Value orientation
I.9	"*You cannot make all decisions based purely on the market, although the focus is on addressing the customer needs, when there is no market to certain technology yet, you should base some decisions on the technology's aspects*"	Both
I.7	"*When creating the value from technology, you should always take into consideration what are the jobs that customers want to get done*"	Both

Interviewee	Interviewee Argument	Value orientation
I.1	"*At a certain point, when the technology's purpose is not yet well-defined, it is suggested to go to the customer in search of answers*"	Customer
I.2	"*We are not effectively trying to attend to a problem first, but instead, developing a technology whose potential was previously mapped and then understanding the market needs*"	Technology
I.11	"*Usually there is a first version of the product, created from the technology and then, we try to fit it into a market*"	Technology

This statement can be reinforced in the cases when dealing with B2B markets, in a specific example exposed by I.12, who works in the field of collaborative robotics, argued that "*at first there is no fit, this is built by addressing the customer's demands and verifying if the product can address those needs, if not, adjusts are required*". This argument was reinforced by I.8, which according to him "*the client must want your product, it has to perceive the value in using it*", in these cases, usually, when the client does not need your product or do not see value in it, it simply will not buy it.

6.3.2. Value Phase Suggested Activities

A5. Quantifiable Market Analysis

Since the initial conceptualization of the methodology presented in Phase II a set of requests regarding analysing and understanding the market for the future product or service, this activity came up during five of the interviews. In one of these interviews, a tool was suggested by I.9 to help in this process, "*TAM-SAM-SOM is a tool that helps in understanding some of the market's dimensions, which stands for Total Available Market, Serviceable Available Market, and Serviceable Obtainable Market* ", indeed, this was considered as a valuable tool to be used at this phase of the methodology to understand and quantify the size of the market, this was not originally predicted in the methodology and can be included in its final conceptualization.

A6. Benchmarking

Participants also highlighted that benchmarking was a crucial activity to be done to better understand the desired market. However, interviewees also discussed the importance of benchmarking similar technologies on the market to see if they are being used, who is using them and how they were applied to markets, as I.8 discussed "*we focus exactly on what patents are being used in that specific market and if there is any patent similar, we identify what company it corresponds to and what does it do*". Since benchmarking is a way to gather information over the competitors, it makes sense in the case of technological entrepreneurship to expand this process to the technologies each competitor use.

A7. Create Value from the Technology

Further exploring the argument that to create value, the orientation should bestow upon both the customer and the technology, a supportive tool was presented and suggested by I.7 that helps in the process of creating value form a technology. This tool is called TPM, which stands for the link between Technology, Product and Market, in a way that, through the identification of technology's specifications, capabilities, and uniqueness, together with the definition of what are the market needs that will be addressed, it is possible to obtain the features of the product or service to be developed, that in turn, can generate value for the customers.

6.4. Business Modelling Phase

6.4.1. Business Modelling Phase Challenges

C6. Prototyping

Another point that remained unclear is related to the prototyping process, especially regarding its impact on the results of the methodology and in what moment should it begin. With this in mind, during the iterations for the value proposition making contact with the customers is essential, and thus, the interface for this approach could be indeed an initial version of the product or service, however, if this happens too early, there may not be a definition yet about the products or services technical specifications to develop a prototype.

This was also one of the most discussed challenges throughout the discussions, addressed in a total of nine interviews, which all of these participants recognized that a prototyping process is crucial in technological entrepreneurship, in I.1's words, "*it is essential to have a prototype that is close to what is the value requested from the market, it not only helps to achieve a better final version but also helps to enthral possible investors*".

Other positive aspects of having activities related to prototyping were highlighted, for instance, through experimentation, it is possible to approach several markets and narrow down the ones that present better results, I.8 explained how his institution proceeds, "*what we do is that we contact possible customers, from different market segments, to try and make small scale tests of key components of our product with them*". Also, this helps to verify if there is a fit between the product's value and the customer's needs. Furthermore, this interviewer also defended the argument that these kinds of prototyping activities could mitigate risks related to future product development stages.

The application of prototypes at the start of the development process usually are less complex, thus, making it easier, faster and cheaper to solve any problems that may occur during the tests, according to I.5, "*the sooner the bad news, the better, there is more time to correct the mistakes and its impact is usually smaller*". This also evidences the importance of continuously collecting and analysing the customer's feedback and using it to improve the product or service.

In regards of when should the prototype activities begin, six of the interviewees believed that they should be done as soon as possible in this process, and going further, some argued that these kinds of activities should be done to validate the value proposition with the customers, for instance, I.10 stated that "*if I were the one applying the methodology, I would make these activities in parallel with the activities in Phase II*". In a way, this makes sense, since prototyping enables the entrepreneur to test, with possible customers from several distinct markets, the product or some of its components that are being developed.

This occurred in the practical example that was shared by I.3, in which "*the customer's involvement in the product's development process was essential to demonstrate to them the value of our products and services*". This argument supports the idea of *'working with the customer'*, and thus, enhances the chance of fitting its components to the customer's needs.

C7. System Architecture and Business Models

Amongst the challenges related to the Business Modelling Phase, the development of the system architecture was discussed with the participants to obtain a perspective on its relevance in the process overall. Since this is directly requested in ESABIC's proposals it can be already classified as essential in the methodology, and in agreement with that, all the interviewees whom this theme was discussed, recognized its relevance, in the words of I.9 "*it sets the ground to what will be the definition of the business model's building blocks*".

As follows, the theme that was addressed next was naturally the existence of tools to develop the business model, initially in the methodology, the Business Model Canvas was chosen to guide it. The majority of interviewees agreed to the selection of this tool, however, there were some suggestions made, for instance, I.7 commented that "*if you orient your value proposition towards the market, you should first define how the products and services will reach that market and then, define what activities you need to do*". Also, I.9 stated that "*the business model should only be defined when the market and the value proposition are already known and the initial versions of the products or services are tested and validated"*.

6.4.2. Business Modelling Phase Suggested Activities

A8. Build and apply prototypes

Although prototypes can be useful, usually they are very costly. When dealing with the development of new products and services, there is another factor that demands attention, the production costs should be always on sight. Since the focus of the P2B methodology are the entrepreneurs, they usually do not possess abundant financial resources, and prototyping can be costly, I.2 supported this argument by stating "*we try to make prototypes, however, it depends on financial availability*".

A solution to avoid high production costs was proposed by I.8, which states that "*it is better to make small scale tests, ideally with five to ten people, keep it simple, and focus on deploying value. More than ten people we begin to talk about production, and that is too expensive*". Ideally, this process should be done as early as possible and the prototypes should be applied in small batches to pre-selected customer groups.

A9. Develop and validate the business model

Since the BMC was directly suggested by ESABIC in their official documents, there is not much room to variations, however, both I.5 and I.7 directly suggested as a complementary tool for what was initially proposed in Phase III, the Lean Launchpad.

In summary, the Lean Launchpad proposed by Blank (2013) is a user-centric method that uses experimentation and iteration to enable entrepreneurs to rapidly test their product, adjust what is necessary according to the customer needs, and validate key aspects related to their business models. This goes along with all the concepts addressed so far, the iterative process of identifying, developing, testing, and improving. Although none specific activity linked to the Lean Launchpad will be included in the P2B Methodology, those principles will sure be embedded in its final development.

6.5. Business Plan Phase

6.5.1. Business Plan Phase Challenges

C8. Managing Uncertainty and Risk

Both the financial and socio-economical aspects are particularly relevant for the investor when they are analysing business opportunities. When investing money, time, or other resources on an idea it is expected some kind of return bigger than the initial efforts. However, the majority of technology transfer programs are associated with public research institutes, presenting other focus, such as social and economic welfare, so, it is unclear what should be the focus for the methodology in this aspect.

So, there is a certain dilemma related to if the focus of the business plan should be on the financial aspect or in the risks and impacts of the operation in society and the economy. This dilemma was taken to be discussed with interviewees, which indeed provided relevant information about the subject. From the twelve participants that addressed the challenges related to Phase IV, nine of them discussed this topic during the interview.

Defending the argument that the business plan should be focused on demonstration the financial viability of a business, I.9 commented that "*from a capitalist's point of view, if I am an investor, the most important aspect in a business plan would be how long it would take to get my money back and profit from it*", furthermore, he stated that "*the business plan should be focused on maximizing investor's profit*". It is hard to define if this perspective goes along with all private investors that bet on start-ups and tech companies but has a certain truth related to it.

Most of the private entities that fund new and risky endeavors expect to at least profit from the application of its capital. Nonetheless, the business plan should contain the entrepreneur's financial plans to the execution of that project, as exposed in ESA's documents, oriented trough reliable financial indicators. On the other hand, some believe that addressing socio-economic risks and impacts on the business plan has its relevance and is seed as a positive by investors.

Identifying the risks and impacts of a project, as well as defining mitigation strategies to diminish their effects on society and economy are crucial factors that can improve the chances of successfully obtaining third-party funding for a new business, especially if this funding comes from public entities. As seen on ESA's context, promoting socio-economic welfare is one of the agency's main objectives when fomenting technology transfer programs, as I.11 reported, "*in a way*, *it represents the taxes paid by citizens and contributors going back to society, in the form of social welfare and benefits for the citizen*".

Socio-economic aspects do not matter only to public entities, but private funding institutions can also give relevance to such topics. An example was given by I.8 regarding that if a new solution achieves the desired financial benefits, there can be simultaneously socio-economic ones, for instance, "*a logistic solution that enables a truck to supply a certain store one time a week instead of two, it is an enormous financial gain with gas, human resources, and truck maintenance, but also benefits the society around with less air and noise pollution, even less traffic can be considered*". This example can evidence the value that both perspectives can provide to an investor.

Following this line of thought, both of the perspectives have value and should be integrated into the methodology, however, one factor that should always be taken into consideration is the source of funding that the entrepreneurs are proposing to. Although public entities do care about the financial viability of the proposal, socio-economic risks, impacts, and strategies on how the entrepreneurs plan to deal with them can and should be deeply explored when pledging to public investment.

On the other hand, private investors primarily require that the business plan is focused on assessing the financial plan and its viability, this does not mean that socio-economic risks and impacts are not relevant to them, however, it can be said that they are in the second plan.

C9. Intellectual Property Management

Since this project uses ESABIC Portugal's context to develop the methodology, one aspect turned out to be relevant. When dealing with the transfer of space technology to create terrestrial applications, usually the technology passes through a downgrade in its specifications, and in some cases, this may open opportunities to the creation of a new patent. This requires beforehand planning and the definition of IP strategies to deal with this.

When this theme was taken to discussion with the interviewees, their responses signalled actions and concerns about the topic. The most common argument, with five participants supporting it, was that when, in technological entrepreneurship, Intellectual Property Management strategies should already be taken into consideration when managing the overall project risks, that is, similar to what is done when mapping environmental risks must be done to intellectual property.

Its importance is such that I.8 commented "*when dealing with European projects, we try to have at least two qualified professionals that deal exclusively with intellectual property management*". Furthermore, strategies related to IPM should be defined as early as possible, containing the plans for the future of the technology, also, these strategies "*should be coherent with the technology's reality*", complemented I.5. A generalist example of IPM strategy could be, instead of taking a certain product to market or license that technology and profit from the royalties.

6.5.2. Business Plan Suggested Activities

A10. Define IPM Strategies

The definition of strategies related to IPM can be considered positive from an investor point of view, according to I.5 *"investor can see the presence of intellectual property management strategies as a positive aspect since it can mitigate risks"* and further completed that *"patents can and should be considered as a financial asset"*. This is important to highlight because, when dealing with new products or services there is always uncertainties and thus, there is a chance that the project will fail. So, protecting the technology through a patent or other protection mechanism can be a way to recover some of the investment that was made and also, assuming the entrepreneur's perspective, can help prevent that imitations or copies to appear on the market.

6.6. Summary

Interview's data analysis provided thoughtful insights over the challenges that an entrepreneur may face when dealing with technology transfer to develop novelty in business development and also several activities and tools that can be valuable to overcome those challenges. Activities were also given a codification (A1 to A10) based on the order that they relate to the P2B Methodology, the same code system was applied to tools that were suggested by interviewees (T1 to T10).

Table 5. Challenges, activities and tools highlighted during the interviews

Challenges	Activities	Tools
C1. Business Trigger	-	-
C10. Inventor's Conflict of Interest	A1. Prevent conflict of interest	T1. Research Institute's Internal Regulations
		T2. Creation of Spin-offs
		T3. Technology Licensing
C2. Information Paradox	A2. Outline Technology's Capacities	T4. Assemble a Multidisciplinary Team
		T5. Technology Description Worksheet
	A3. Reach Technology's Inventors	-
	A4. Pursuit Agreements	T6. NDAs and RLAs
C3. Product-Market Fit	A5. Quantifiable Market Analysis	T7. TAM-SAM-SOM
	A6. Benchmarking	-
C4. Value Orientation	A7. Creating Value from the Technology	T8. TPM
C5. Working with the customer	-	-
C6. Prototyping	A8. Build and Apply Prototypes	-
C7. System architecture and business models	A9. Develop and Validate the Business Model	T9. Business Model Canvas
		T10. Lean Launchpad
C8. Managing Uncertainty and Risk	-	-
C9. Intellectual Property Management	A10. Define IPM strategies	-

Table 5 demonstrates the consolidation of the challenges, activities and tools that were brought up and discussed during the interviews. It also shows the inclusion of the challenge C10, *'Inventor's Conflict of Interest'* in the pool, making a total of 10 challenges, furthermore, 10 activities were discussed and proven to be valuable to the methodology, however, challenges C1 and C8 did not present discussions over activities. In some cases, interviewees also suggested tools that could help entrepreneurs in performing the activities discussed, in which 10 of them emerged during the interviews and only T9 was evidenced during the literature review.

7. PROPOSED P2B METHODOLOGY

The present chapter presents the final proposed P2B methodology, and contains discussions over its development, showcases the four phases of the methodology, and describes their respective set of activities and tools. The interviewing process provided reliable information and allowed a richer understanding of the challenges discussed, it also evidenced activities and tools that were not considered in the initial stages of this work. However, the set of activities and tools displayed in Table 5, did not cover all the challenges and thus, there is a necessity to address those unattended challenges, by including new activities and tools based on what was found during the literature review and the analysis of the ESABIC's case study.

Table 6. Complementary activities and tools identified from literature review and case study analysis

Challenges	Activities	Tools
C1. Business Trigger	A11. Outline the problem	-
	A12. Identify customers and other stakeholders	-
C2. Information Paradox	A13. Scan technology markets	T11. IP Portfolios T12. Technology Forums
	A3. Reach technology inventors	T12. Technology Forums T13. Meetings
C5. Working with the customer	A15. Proof of Concept	-
	A16. Define the Value Proposition	T14. Value Proposition Design
	A17. Identify Customer Segments	-
C7. System architecture and business models	A18. Define System Architecture	T9. Business Model Canvas
	A19. Identify Systemic Risks	-
C8. Managing Uncertainty and Risk	A20. Identify Socio-economic and environmental risks and impacts	-
	A21. Define Indicators	-
	A22. Define Mitigation Strategies	-
	A23. Elaborate Financial Plan	T15. Financial Indicators
	A24. Build the Business Plan	T16. Templates from innovation institutes

Displayed in Table 6, are 13 new activities that are proposed to address the challenges and complement the P2B methodology, furthermore, 6 new tools were also included to support some of these activities with the special case of T9, which was related to A18. A brief description of each phase and discussions over their inclusion of the activities and tools for each phase are displayed as follows. Note that the codification does not follow numerical order, but instead, it follows the order in which they are sequentially represented in the methodology.

7.1. Phase I: Technology Analysis

In the previous chapter, there was a discussion if the existence of a problem was the only source of motivation for an entrepreneur. Turns out that it is not the only one, indeed, the reality is far complex to simplify to a single aspect, at the same time that the entrepreneur is trying to solve a problem, he or she can also be exploring an opportunity that he identified on a certain market by adapting some technology. Nonetheless, it was considered the ideal scenario as a trigger of the methodology, an entrepreneur which is motivated by the necessity of solving an existing problem and sees in some technology, an opportunity to do it.

Similar to what Wachowicz and Bury (2017) describes as the Space Patent Paradox, another factor that presented itself as a great challenge for entrepreneurs is the *'Information Paradox'*. It was evidenced during the development of the initial conceptualization and can represent risks for the development of a new idea, since information is crucial to make the right decisions, and a bad decision can cost the whole idea and lead to failure. During the interviews, this challenge was confirmed and means to overcome it was proposed and included in the final proposed P2B methodology.

The *'Inventor's Conflict of Interest'* was a theme that came up during the interviews and, although it was clear that in practice it can happen, it does not represent major risks to the process since research institutions have already pre-determined policies and procedures to deal with this kind of situation, an activity (A1) was included in the methodology, to highlight that there are some ways to overcome this.

Phase I remains with the overall objectives as defined in its initial conceptualization, which are outlining the problem, identifying its technical requirements, mapping possible customers, and then selecting a technology which capacities attend to the problem's technical requirements and is available in technology transfer programs. In the initial conceptualization, some aspects were not yet defined, but they were clarified during the interviews. To accomplish these objectives, entrepreneurs should perform several activities, which are discussed below.

- **A11. Outline the problem:** The existence of a problem almost always signifies the demand for a solution, which, by the eyes of an entrepreneur means business opportunities. However, sometimes the so thought problem cannot even be a problem in the first place, or perhaps there is a solution in the market already but the entrepreneurs did not know about it. This activity comes in handy and its inclusion in methodology when addressing C1, since it allows entrepreneurs to obtain a better perspective over the problem they are trying to solve. The main information to obtain during this activity are:
    - The causes and effects of the problem;
    - The existence of a solution;
    - Technical requirements to develop a solution.

  Nonetheless, any additional relevant information about the problem can help during the next phases, the more is known about the problem, bigger are the chances to find a solution.
- **A12. Identify customers and other stakeholders:** When there is a problem, there is always someone or something that is impaired by it and who are willing to pay for a solution. By knowing the group of people that are directly or indirectly affected by the problem it is possible to then classify those individuals into who can be the paying customers, the users, and outline what benefits they will gain for using the new product or service. This is a crucial step since the next phases require a high level of interaction with these customers and including this activity in the methodology allows us to gather such information at the early stages.
- **A1. Prevent conflict of interest:** This activity is related to what was evidenced during the interviews as the *'Inventors Conflict of Interest'*. Although many interviewees stated that this is a rare occurrence, it sure can happen, and so, to avoid conflict between the investor and the research institutes, a set of good negotiation practices must prevail. Usually, within universities and other research-driven entities, there are procedures and 'internal regulations' (T1) to safeguard the inventor and its invention, and also, they provide support to inventors in the process of 'creating spin-offs' (T2) or give some kind of preference to 'license the technology' (T3)

agreements over that patent. Nonetheless, during these negotiations, the goal is to achieve a good agreement between both parts, where they can all benefit from the commercialization of the technology.

- **A13. Scan technology markets:** This activity was included to support in a specific situation when there is not a pre-selected technology to proceed with the methodology. In this case, the entrepreneurs should search for available technologies in transfer programs and research institutes that promote technology transfer usually have an interface in which they showcase their IP and other relevant information. Since this work is embedded within the Portuguese context, is recommended the use of 'ESA's Technology Forum' (T12) or 'IP Portfolio' (T11). A minimum of three patents should be selected to further analysis of their capacities, this selection can be made by simply matching the problem's requirements with the information about the patents, for instance, if the entrepreneurs are dealing with a problem related to filtering, he preferably he should look for a patent whose field of application is somewhat related to gas or liquid purification.
- **A3. Reach technology inventors:** When the patent or a set of patents that fit the technological requirements of the problem are selected, it is possible that the information available on those platforms is not enough to support reliable decisions and so, it is necessary to acquire more details about the patents, as detailed in the *'Information Paradox'*. In this sense, the 'ESA's Technology Forum' (T12) provides the interface needed to connect with the inventors and other experts to clarify any aspects related to a specific technology. Some entities that deal with technology transfer can 'Arrange meetings' (T13) with the inventors to clarify some of the entrepreneur's doubts, however, these arrangements are dependent on the motivation and availability of both the institution and the inventor. Furthermore, entrepreneurs should be careful when talking about their idea with the inventors, although unlikely, there is always a risk of theft in these situations.
- **A4. Pursuit Agreements:** During the interviews, a couple of ways to overcome the risks explained in A3 and obtain information about a specific patent is through 'NDAs and RLAs' (T6), although it can be done, it requires extensive negotiation with the research institute or the patent owner and has its risks.
- **A2. Outline technology capacities:** Outlining the technology's capacities is fundamental since it will evidence to entrepreneurs what the technology can or

cannot do, why it is innovative if it can be replicated by others, and so on. The 'Technology Description Worksheet' (T5) was highlighted during the interviews and was included in the set of tools related to the Technology Phase since it helps entrepreneurs describe the technology, identify its advantages, disadvantages, and capacities. While discussing the *'Information Paradox'*, it was highlighted to the interviewees the lack of information regarding the chosen patent can be a problem when trying to develop a solution to an existing problem. One of the interviewees suggested that 'Assembling a multidisciplinary team' (T4) can help in this aspect since diversity can lead to richer discussions and new perspectives, and also, different people from distinct fields of knowledge could complement each other. Taking the same example as before of the filtering problem, if the team is composed of mechanical engineers, industrial engineers, and environmental engineers, they can put on relevant insights on how to deal with the problem based on their experiences.

7.2. Phase II: Value Analysis

The second phase was the one that experienced the most changes. In the initial conceptualization, although the market analysis and the value proposition definition were made in parallel, there was not much intercommunication between both activities, also, there was a clear gap between the end of Phase I and the first activities of Phase II. In the transition of these two phases, there was in one end a defined technology and in another end, the process of creating value, but there was no intermediary activity to develop initial concepts of the product or service.

Adjustments were made in a fashion that a block of activity regarding making and applying proof of concepts was inserted and the activities related to the market and the value proposition were brought closer to each other. The new conceptualization of Phase II highlights the importance of the interaction between these three blocks of activities, the goal here is to bring the value closer to the customer as possible, as preached by Osterwalder et al. (2015), Blank (2013) and Ries (2012). It is believed that adopting this new conceptualization in the final proposed P2B methodology it will achieve a better fit between the market needs and the product or service, since it is all about making several proofs of concept, applying them to a pre-selected group of customers and adjusting the value proposition according to these customer's feedback.

In the initial conceptualization of the P2B methodology, there was a prototyping stage performed in Phase III, however, during the interviews it was evidenced that activities related to testing and validating with the customers earlier versions of the product should be done as soon as possible and thus, an activity related to making and testing proofs of concept was inserted into Phase II. In the context of this dissertation, POCs are represented by the testing of specific components of the product and assess their feasibility, on the other hand, prototypes are the testing of simpler versions of the operational product.

- **A5. Quantifiable market analysis:** Knowing the market is crucial to assess if a product addresses its necessities or not and define market penetration strategies, however, it is also necessary to analyse that market using quantifiable aspects. During the interviews, the TAM-SAM-SOM (T7) tool was recommended to perform this activity, and it was included in the P2B methodology since it not only enables the definition of quantified market variables but provides enough information to make reliable predictions such as sales forecast that leads to projected revenue.
- **A6. Benchmarking:** A subproduct of the market analysis is the identification of possible competitors. This activity has the purpose of gathering more information about the products and the value proposition of organizations that compete in the same market. Going further, it is also suggested to look after which patents are currently being used in that market, track down what companies that are using them, and what is the motive for the use.
- **A7. Creating Value from the technology:** Since dealing with technological entrepreneurship, is implied that technology is used to deploy value. However, this is not an easy task, thus, as evidenced in the interviewing process, there is a tool that can help in the process of creating value from technologies. The TPM (T8) can generate product or service specifications based on characteristics of the technology and the market.
- **A16. Identify customer segments:** With information about the market and the possible customers from Phase I, it is possible to define the customer segments for the product are. The results of this activity will be useful for performing proofs of concept and also to the further construction of the business model.
- **A14. Proof of Concepts:** With the customer segments defined, the next step should be the creation of proofs of concept to be tested within those groups of customers, ideally, these customers should be grouped by attributes they share between each

other and be the ones that are willing to pay for a solution. This activity can be divided into two separate stages, the first when a group of customers is selected, based on A17 and engaged, resources required for making the POCs are mapped and mobilized, and the success factor and validation method are defined and the POCs are made. The second consists of applying the POCs to the selected customer group, collecting and analysing the feedbacks, and, using those feedbacks, map what was the good and the bad points, and make improvements.

- **A15. Define the value proposition:** All the activities done so far in Phase II will eventually converge to the definition of the value proposition. This is a cyclical and iterative activity, in the sense that, based on the technology that was defined in Phase I, a first iteration of the value proposition should be elaborated, which will lead to the development of a proof of concept that is then applied to a customer group to be validated. Using customer's feedback and the knowledge obtained from the market analysis should be used to improve the value proposition adjusting it to be as close to customer's needs as possible. There is presented in the literature a resourceful tool to enable the development of the value proposition with that goes along the same path. The Value Proposition Design (T14), created by Osterwalder et al. (2015), tries to achieve a fit between the customer's needs and the value offered by the product or service.

7.3. Phase III: Business Modelling

At the beginning of Phase III, it is expected that the value proposition is defined and validated using the results of the POCs as support. Through these experiments, it is also possible to obtain several key aspects that will enable the development of this phase, such as product specifications, the size of the obtainable market, and customer segments.

The Business Model Phase starts with the development of a high-level diagram of the value chain, called the system architecture (Figure 20), this graphic representation paves the way to the development of the business model building blocks. Alongside those activities, prototyping activities occur, to test simpler versions of the full product and validate the business model with the customers.

- **A17. Define the system architecture:** This activity represents the design and demonstration of the first configuration of the system architecture. Thus, it is necessary to evidence all the entities that will be involved, directly and indirectly in the product's value chain and how they interact with each other. Zhu et al. (2019) defend that managing and integrating aspects related to the operation helps in capturing and delivering value to the customers. To perform this activity, the 'Business Model Canvas' (T9) can provide a starting point and valuable insights. Figure 20 shows a simple example of how the system architecture may look like.

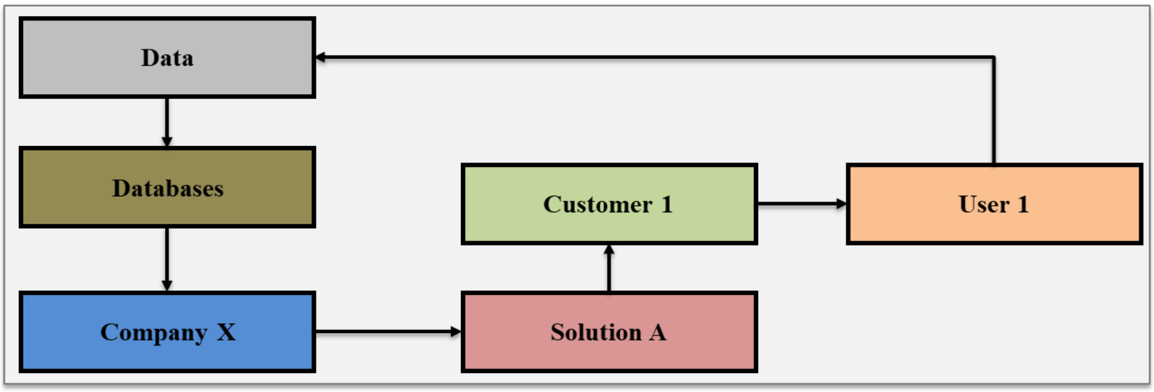

Figure 20. Example of a system architecture.

- **A8. Build and apply prototypes:** In Phase II, proofs of concept were built and tested to evaluate the feasibility of specific components of the product. In Phase III, these components are assembled into a functional, but simpler version of the final product, thus, a prototype is built. Similar to what was done with the POCs, a customer group must be selected, engaged and the prototype tested within these customers. For this, Bessant and Tidd (2015) argue that their feedback is essential to make improvements until a final product, that satisfies the customer's needs are obtained and it is ready to be marketed. This activity requires some level of planning since the process of creating and build prototypes can be costly, and as said before and stated by Şimşek and Yıldırım (2016), there are not many financial resources available for smaller companies. However, as evidenced during the interviews, producing small batches of prototypes can allow these tests to happen without being too demanding resource-wise.
- **A9. Develop and validate the business model:** Taking advantage of the previously developed system architecture (A17) and the identification of several customer segments (A16), which will now serve as a base for the development of the business model. The recommended tool for performing this activity is the Business Model Canvas (T9), originally developed by Osterwalder and Pigneur (2010) (Figure 9). In addition to that, during the interviews, the participants generally agreed that this was

a good tool that fitted the purpose of this phase, however, they also suggested that the Lean Launchpad (T10) could provide a link between the business model development and the prototyping activities that are also performed. Nonetheless, the decision of which tool to be used to develop the business model goes primarily to the entrepreneur and its familiarity with each tool.

- **A18. Identify systemic risks:** During the development of the system architecture and the business model, some risks may be evidenced. These risks can represent serious impacts on the success and viability of the business model, and thus, they must be dealt with. One example that can represent a systemic risk is, for instance, when one component of the product that is being developed requires for its production a certain material that is scarce on the market, such as rare-earth minerals, and thus, there are few suppliers for it. Related to it there is a huge risk that at some point in time, the demand for this material skyrockets and so does the prices, negatively affecting not only the operation but the financial health of the organization. Also, there must be defined mitigation strategies for the mapped risks to prevent their occurrence or minimize their impacts on the company.

7.4. Phase IV: Business Plan

All the activities performed in the previous phases converge into Phase IV. At this point of the methodology, there is a validated business model, an initial version product approved by customers that perceive its value and are willing to pay for it, strategies to mitigate and reduce the impact of risks related to the business model. However, a few aspects are remaining to make a reliable business plan, thus the purpose of the activities of these phases is exactly to fill this gap and support the creation of a business plan.

- **A22. Elaborate Financial Plan:** Any business plan should contain a financial plan, which is responsible for demonstrating the financial viability of the business model. Some aspects that ought to be presented on the financial plan are sales and revenue forecasts, cash-flow projections for at least five years in the future, financial risks, and also, 'financial indicators' (T15) must be provided as well as a prediction for them, based on realistic predicted numbers originated throughout the development of the business model and anterior activities. As presented in the ESABIC's documents, indicators such as Net Present Value, Payback, CAPEX, OPEX, Internal Return Rate, and break-even analysis are essential in this activity and should present realistic values.

- **A19. Identify socio-economic and environmental impacts:** This activity was originated based on the assumptions made by Bessant and Tidd (2015) and in connection with the challenges addressed on the interviews, where it was evidenced the relevance of identifying socio-economic and environmental impacts based on the perspective of the investor. Needless to say, it is a factor that usually depends on two factors, first, the type of the investor, if it is public funding that the entrepreneurs are after, he definitely should pay more attention to these aspects, on the other side, private investors tend to focus more on the financial plan, leaving socio-economic aspect on the side. Also, the nature of the business model can dictate how these aspects will emerge, for instance, a business that is developing a digital application to monitor the emission of greenhouse gases, ideally should not present any negative impact on society, environment neither on the economy, on the contrary, there are positive impacts that should be highlighted and included in the business plan.
- **A20. Define indicators: S**ince the financial indicators were already determined in the *'Elaborate Financial Plan'* (A22), this activity is focused on the definition of indicators that are related to socio-economic aspects of the business model over time and provide a means to monitor and control the impacts previously discussed. An example of a socio-economic indicator that can be used is, for instance, the number of jobs that are expected to be created in a certain region by the business. Also, entrepreneurs should keep in mind the environmental impact that their future company, a famous example of this is the emission of greenhouse gases. All these indicators should provide a thoughtful threshold to represent the range it is expected to be acceptable.
- **A21. Define mitigation strategies:** Directly linked to all the risks (A17) and impacts (A23), there should be the definition mitigation strategies to each one of them. These strategies should be somewhat referenced by indicators developed in the *'Define Indicators'* and *'Elaborate Financial Plan'* activity, taking in mind the thresholds for each indicator.
- **A10. Define IPM strategies:** This activity is proposed to highlight to entrepreneurs the importance of IPM strategies when dealing with technological entrepreneurship. This was exposed by Şimşek and Yıldırım (2016) as a barrier to entrepreneurs and

Lichtenthaler (2008) argues that a firm should pay attention to their technology commercialization strategies. In this context, it can be assumed that at some point during the development of a new product that is based on a technological component, there is a chance that it will generate something that is passible of protection for strategic purposes, for instance, in the ESABIC’s case, the transfer object almost always have to pass to adjustments, usually downgrading some of its specifications, to be applied in terrestrial markets, this sometimes opens up the opportunity to legally protect that new product. Dealing with legal protection of intellectual property demands time and financial resources, however, it is something that is worth addressing since it can be the factor that sustain a company.

- **A23. Build the business plan:** The culmination of the methodology is the construction of a document containing all the relevant information gathered so far, to demonstrate to the investor the value and feasibility of the idea that is being developed. This document is the business plan and although there is no right way to build one, usually there are ‘templates’ (T16) widely available and even can be provided by research and funding institutes, innovation agencies, or even governmental institutions for innovation and entrepreneurship, that can be used to build the final document.

7.1. Final Conceptualization

And so, at the end of this process, there is a set of defined key activities and tools that can address each challenge. The final conceptualization of all these aspects related to the P2B methodology is exposed bellow in Table 7.

Table 7. Final proposed activities and tools.

Challenges	Activities	Tools
C1. Business Trigger	A11. Outline the problem	-
	A12. Identify customers and other stakeholders	-
C10. Inventor's Conflict of Interest	A1. Prevent Conflict of Interest	T1. Research Institute's Internal Regulations
		T2. Spin-offs
		T3. Technology Licensing
	A13. Scan Technology Markets	T11. IP Portfolios

Challenges	Activities	Tools
C2. Information Paradox		T12. Technology Forums
	A3. Reach Technology Inventors	T12. Technology Forums T13. Meetings
	A4. Pursuit Agreements	T6. NDAs and RLAs
	A2. Outline Technology's Capacities	T4. Multidisciplinary Team T5. Technology Description Worksheet
C3. Product-Market Fit	A5. Quantifiable Market Analysis	T7. TAM-SAM-SOM
	A6. Benchmarking	-
C4. Value Orientation	A7. Creating Value from the Technology	T8. TPM
C5. Working with the customer	A16. Identify Customer Segments	-
	A14. Proof of Concept	-
	A15. Define Value Proposition	T14. Value Proposition Design
C6. Prototyping	A8. Build and Apply Prototypes	-
C7. System architecture and business models	A17. Define the System Architecture	T9. Business Model Canvas
	A9. Develop and Validate Business Model	T9. Business Model Canvas T10. Lean Launchpad
	A18. Identify Systemic Risks	-
C8. Managing Uncertainty and Risk	A22. Elaborate Financial Plan	T15. Financial Indicators
	A19. Identify Socio-economic and Environmental Risks	-
	A20. Define Indicators	-
	A21. Define Mitigation Strategies	-
	A23. Build the Business Plan	T16. Templates from innovation institutes
C9. Intellectual Property Management	A10. Define IPM Strategies	-

A total of 23 activities supported by 16 tools are provided to address each one of the challenges discussed, covering all the phases of the P2B methodology. And thus, based on all the assumptions made in previous chapters and consolidating all the knowledge gathered so far on this work, Figure 21 presents the final proposed P2B methodology.

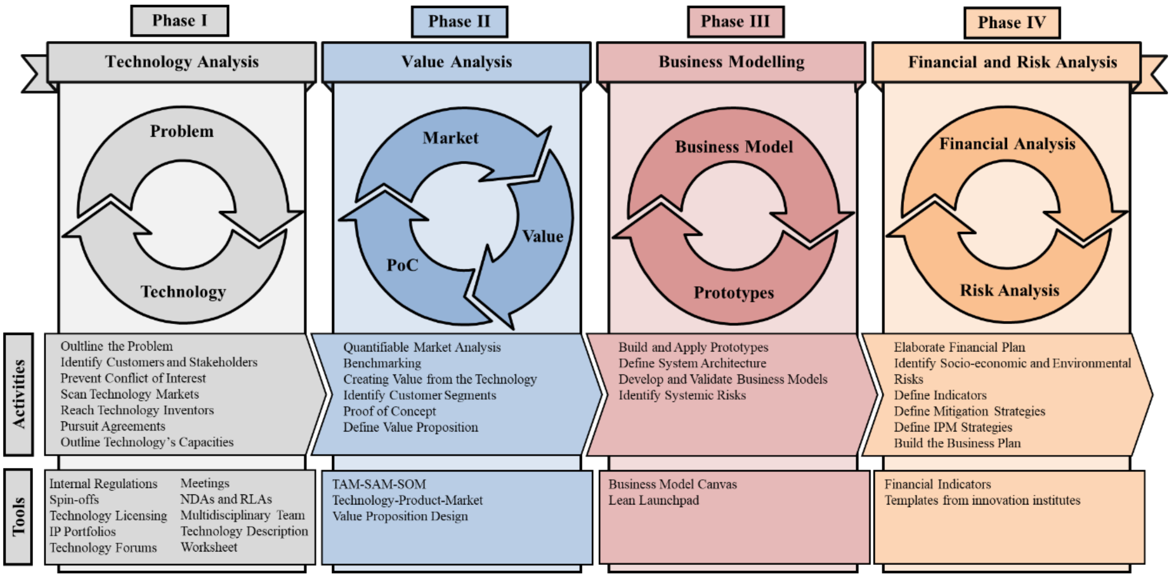

Figure 21. The proposed P2B methodology.

It showcases each phase, with its respective set of activities and tools as seen in Table 7. This represents the process that entrepreneurs should embrace when developing businesses with a technological base, specifically when using patents that are available from technology transfer programs. It also serves as a guide to facing some of the challenges that were described in previous sections of this dissertation. The representation of the methodology was made this way to symbolize their cyclical and iterative nature and evidence what is the main objective and what is expected from each of its phases.

8. CONCLUSIONS

8.1. Dissertation Overview

Innovation is a complex process, and thus there is no one size fits all recipe for successfully developing new businesses, but instead, there are small steps and a set of good practices that eventually lead to the development of novelty. Since this dissertation's main objective was to develop a methodology to guide entrepreneurs on their journey of creating business models that use patents available on technology transfer programs, the first step towards accomplishing this goal was making a structured literature review, to identify in the literature relevant knowledge about the research topic.

This enabled an understanding of the relationship between innovation and technology transfer and also, on reliable tools and methods that enable the development of business models. In addition to that, a documental analysis of ESABIC Portugal's standards, requirements, and guidelines provided deep knowledge on how entities such as ESA operates to promote entrepreneurship and innovation through technology transfer programs. Combining the knowledge obtained through the documental analysis with the findings of the literature review, the first conceptualization of the P2B Methodology was created (see Figure 14 in Chapter 5). It contained four phases starting from the assessment of the technology until the creation of a business plan, however, this initial conceptualization of the methodology unveiled nine challenges that needed further investigation (see Table 3 in Chapter 5).

Both the initial methodology and the challenges were taken to discuss with experts in technology transfer, technology management, innovation, and business model development, thus, a total of 13 semi-structured interviews were conducted. The contents of those interviews were then analysed using thematic analysis, to evidence recurrent topics that could be useful in improving the methodology, based on which several activities and tools were suggested, for overcoming some of the challenges presented. A notable example is the Technology Description Worksheet, which has good potential in addressing the challenge *'Information Paradox'*. The insights from the interviews allowed improvements are made, and thus, the final proposed P2B Methodology was developed (see Figure 21 in

Chapter 7), identifying activities and tools that can help entrepreneurs to overcome some of the identified challenges intrinsic to the development new innovative businesses based on technology.

The P2B methodology provides an important practical contribution to the field of innovation, since it compiles conceptual and empirical knowledge in an integrated and holistic methodology, which guides entrepreneurs in the development of their innovative business. It summarizes several challenges of the innovation process embedded in a technology transfer scenario, and provides means to overcome these challenges (see Figure 21 in Chapter 7). In this sense, the P2B methodology is intended to be used primarily by entrepreneurs, but it can be valuable to research institutions as well, since it can help the ones interested in developing new solutions and applications from their technology. In the end, it can benefit both sides, the entrepreneur and the research institute.

Throughout the analysed literature, notable methodologies can be highlighted, it is the case of the Innovation Process by Bessant and Tidd (2015) that has a more generalist point of view, and also, the CBMIP developed by Geissdoerfer et al. (2017) which is focused on sustainability aspects. The P2B methodology assumes the perspective of the entrepreneur and takes into consideration challenges that it may face while providing a unified set of, activities and tools to overcome them. During this process, it also clarifies some of the specificities required to create novelty and innovation using patents that are available in technology transfer programs.

8.2. Limitations

A major limitation of the present dissertation was related to the interviews. Ideally, the number of interviewee’s related to 'Business’ should be at the minimum, equal to the ‘Incubator’ and ‘University’ categories, however, due to this dissertation’s time restriction and the availability of the interviewees, this number of interviewees related to businesses was below than the expected.

Also, since the methodology was created using the specific context of a not-for-profit research institute that has its technology transfer program, when applying it in other scenarios, for instance, pursuing private funding in a European round of investment, there could be a possibility that some of its activities may be useful, others not so, it has to be adjusted to that each specific context. This happens mainly because different entities may require a different set of information that should be provided by the entrepreneurs.

Another limitation is that the P2B Methodology was developed by assuming the perspective of an entrepreneur that wants to use certain technologies to create a business. With this in mind, it is important to state that the methodology is focused on technology transfer from a research institute, such ESA or the University of Coimbra to the market, represented by entrepreneurs or start-ups, it does not englobe B2B technology transfer, which might embrace different challenges and different activities and tools to overcome them.

8.3. Recommendations and Future Work

Since the methodology has not yet been validated in practical scenarios, one recommendation made for future works is to its implementation. For example, the usage of P2B Methodology as a complementary tool during the Innovation and Entrepreneurship courses, focusing in the methodology's application on available patents in the University and their associated Research Institutes. This will foster technological entrepreneurship amongst the academic community and could also strengthen ties between the university's students and research, which can eventually pave the way to the new businesses, and wealth creation.

During the development of Phase I, a recurring discussion was about the *'Information Paradox'*. It was evidenced during the interviews that this a question that directly influences on the Portuguese innovation ecosystem, so, it is also suggested that future studies should address this paradox, but from the side of the research institutes, meaning the creation of interfaces or platforms that allow entrepreneurs to accede to reliable information, thus fostering technological entrepreneurship and allowing the ecosystem to grow.

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ANNEX A: TECHNOLOGY DESCRIPTION WORKSHEET

A.1 – Technology	
A.1.1 – Name	
A.1.2 – Short description	

A.2 – Technologist(s)	
A.2.1 – Technologist 1	
A.2.1.1 – Name	
A.2.1.2 – Role	
A.2.2 – Technologist 2	
A.2.2.1 – Name	
A.2.2.2 – Role	
A.2.3 – Technologist 3	
A.2.3.1 – Name	
A.2.3.2 – Role	

B.1 – What is the technology?	
B.1.1 – Name:	
B.1.2 – Scientific field:	
B.1.3 – Describe the technology in scientific terms:	
B.1.4 – Keywords:	

B.2 – What does the technology do?	
B.2.1 – Describe what the technology does:	
B.2.2 – List the do's:	

B.3 – What does the technology not do?	
B.3.1 – Describe what the technology does not do:	
B.3.2 – List the does not do's:	

B.4 – Applications	
B.4.1 – Describe what problems the technology solves:	
B.4.2 – Explain how the technology solves those problems:	

B.5 – Users	
B.5.1 – Describe potential users:	
B.5.2 – Explain how the users would make use of this technology:	

C.1 – Technology Advantages	
C.1.1 – In what aspects is this technology superior to other technologies?	
C.1.2 – Describe the advantages of the technology.	

C.2 – Technology Potential	
C.2.1 – Can the technology serve as a platform for multiple products? If so, please explain.	
C.2.2 – Does the technology allow for further improvements beyond the initial advantages? If so, please explain.	

D.1 – Identify the capabilities of the technology	
D.1.1 – Capability 1	
D.1.1.1 – Name	
D.1.1.2 – Description	
D.1.1.3 – How is performance measured on this capability?	
D.1.1.4 – What is your level of performance?	

E.1 – Identify technologies with similar capabilities.	
E.1.1 – Competing Technology 1	
E.1.1.1 – Name	
E.1.1.2 – Description	
E.1.1.3 – Capability 1 – Performance level	
E.1.1.4 – Capability 2 – Performance level	
E.1.1.5 – Capability 3 – Performance level	
E.1.1.6 – Capability 4 – Performance level	

F.1 – How temporary or sustainable are the advantages identified in E.2? Why?	
F.1.1 – Superior Capability 1	
F.1.2 – Superior Capability 2	
F.1.3 – Superior Capability 3	
F.1.4 – Superior Capability 4	

G.1 – Classify technology development according with the following Technology Readiness Levels (TRL).

Classification	Description
TRL 0	Just an idea under development
TRL 1	An idea supported by minimal scientific development
TRL 2	An idea supported on well-developed science
TRL 3	Technology validated in a laboratory environment
TRL 4	Technology validated with field tests
TRL 5	Technology with a complete proof-of-concept (e.g., prototype or in-vivo testing)
TRL 6	Technology scaled-up to semi-industrial production

G.1.1 – Indicate the TRL that fits your technology development level:	

G.2 – Elaborate on the technology state of development	
G.2.1 – Describe the technology's current development stage:	
G.2.2 – What are the assumptions for future development?	
G.2.3 – Estimated time to achieve TRL 5:	

H.1 – Patentability	
H.1.1 – Can the technology be patented? Justify.	
H.1.2 – Does it already have a patent(s)? If it doesn't please describe the progress towards obtaining it.	
H.1.3 – Can the present or future patent be policed?	

I.2 – Secrecy	
I.2.1 – Can the technology be kept secret?	
I.2.2 – Please elaborate on the reasons supporting the above answer.	
I.2.3 – Has there been any disclosure of this technology?	

The aim is to identify and describe potential applications for the technology.

Consider the capabilities that you have previously identified, and find applications that have a fit with those capabilities.

A.1 – Application 1	
A.1.1 – Designation (short name)	
A.1.2 – Description	
A.1.3 – Industry / Economic Sector	

APPENDIX A: PUBLICATIONS USED IN THE LITERATURE REVIEW

Publications				Topic	
Ix	**Authors**	**Year**	**Journal**	**Innovation**	**Technology Transfer**
1	Bessant and Tidd	2015	IJEBR	X	-
2	Bianchi et al	2011	RTM	-	X
3	Bogers et al.	2017	II	X	-
4	Bozeman	2000	RP	-	X
5	Bozeman et al.	2015	RP	-	X
6	Casanovas et al.	2014	-	X	-
7	Chandy & Tellis	1998	JMR	X	-
8	Chesbrough	2003	HBSP	X	-
9	Chesbrough and Crowther	2006	R&DM	X	-
10	Ciocanel and Pavelescu	2015	PEF	X	-
11	ECSS	2014	ECSSS		X
12	Eric Ries	2012	JPIM	X	-
13	Gambardella and Panico	2014	RP	X	-
14	Geissdoerfer et al.	2017	PM	X	-
15	Giannopapa	2010	ESPI	X	X
16	Gredel et al.	2012	Technovation	X	-
17	Guerrero and Urbano	2017	TFSC	X	-
18	Heinz et al.	2013	JTT	-	X
19	Huizingh	2011	Technovation	X	-
20	Johannsson et al.	2015	AA	X	-
21	Khabiri et al.	2012	SBS	-	X
22	Lavoie and Daim	2020	TS	-	X
23	Lazarenko	2019	BJES	X	-
24	Leckel et al.	2020	TFSC	X	-
25	Lichtenthaler	2008	RTM	X	X
26	Lichtenthaler and Lichtenthaler	2011	CMR	-	X
27	Lopes and de Carvalho	2015	DKE	X	-
28	Manzini et al.	2017	LRP	X	-
29	Maradana et al.	2019	IIBM	X	-
30	Marcolin et al.	2017	CIJ	X	-
31	Masucci et al.	2020	RP	X	-
32	Min et al.	2020	EER	-	X
33	Moellers et al.	2020	RDM	X	-

34	Müller et al.	2014	IJPM	-	-
35	OECD	2010	TIE	-	X
36	Osterwalder and Pigneur	2010	-	X	-
37	Osterwalder et al.	2015	-	X	-
38	Osterwalder et al.	2005	CAIS	X	-
39	Ozkan	2015	PSBS	X	-
40	Şimşek and Yıldırım	2016	PSBS	X	-
41	Spithoven et al.	2011	Technovation	X	-
42	Summerer	2012	AA	X	-
43	Svejvig and Andersen	2015	IJPM	-	-
44	Tranfield et al.	2003	BJM	-	-
45	van Burg et al.	2017	AA	X	-
46	Wachowicz and Bury	2017	SP	-	X
47	Zhu et al.	2019	EM	X	-

APPENDIX B: INTERVIEW BRIEFING

Interview Briefing

A methodology for creating businesses from technology transfer programs.

This interview integrates a study conducted by Pedro Henrique Costa Lucas, being a student in the mechanical engineering department of University of Coimbra and currently enrolled in an internship at the European Space Agency Business Incubation Centres (ESABIC). This study is being supervised by Professor Gabriela Fernandes.

Research scope

The aim of this study is to develop a methodology that enlightens the path to innovation for entrepreneurs that pursue the creation and development of businesses based on the commercialization of patents derived from technology transfer programs. A structured literature review was performed and several processes, tools and activities were identified related to how companies innovate and business models are created.

However, little was found in the literature about the use of patents from technology transfer opportunities to create new businesses and thus, an initial form of a methodology was created based on the findings of the literature review over the general topics of innovation process and technology transfer. With the purpose of collecting additional data to enhance the methodology, a series of semi-structured interviews with practitioners in the innovation and technology transfer professionals are needed.

Content of the interview

1. Interviewee’s general relation with innovation and technology transfer;
2. Characterization of the organization that the interviewee currently work or previous experiences with innovation and technology transfer;
3. Demonstration of the initial form of the methodology;
4. Discussions about what can be improved in the methodology.

The interviews should be made through videoconference applications and are expected to have a maximum duration of 45 minutes. Furthermore, all the interviewees will receive a summary containing the main findings of the interview process.

Anonymity and Confidentiality

All the data collected as well as information regarding the interviewees is confidential and will be used anonymously in the dissertation.

APPENDIX C: INTERVIEW'S THEME CODEBOOK – CHALLENGES

Name	Description	Files	References
Phase I - Technology	The first phase of the P2B Methodology	13	58
C2. 'Information Paradox'	The availability of information regarding the patent or the intellectual property.	11	27
Information Paradox does not exist	Discussed the existence or not of the Information Paradox	1	1
Information Paradox exist	Discussed the existence or not of the Information Paradox	10	26
Can be mitigated	When the Paradox exists and can be mitigated	10	19
Exist but is not a problem	When the Paradox does not exist	2	2
The inventors already disclose relevant information	The patent presents enough information for practical use	2	2
Technology licensing culture in Portugal	Poor practices in the innovation ecosystem	1	1
Research License Agreement	A tool used by ESABIC	2	2
C10. 'Inventor's Conflict of Interest'	When the inventor of a technology wants to take it to the market but there are conflicts with the research institution	7	18
Both entities search for common agreement	A win-win agreement is always preferred	5	6
Entities should have internal regulations to deal with this	Research institutes possesses internal regulations to deal with these situations	2	2
The research institute gives preference to the inventor	When taking a patent to market, the institutes always gives preference to the inventor	3	5
This problem is solved before the process starts		3	4
C1. 'Business Trigger'	This theme represents what drives the entrepreneurs to develop its business idea, such as the existence of a problem (usually social with an urgent solution), new market opportunities originated through public incentives or novel legislations.	10	13

A problem exists and require a solution	The entrepreneur's motivation comes from a problem he is trying to solve	6	7
In this case consolidated companies deploys a solution first	When there is a problem, usually bigger companies provide a solution first	1	1
New market opportunity	The problem results in the discovery of a new market	1	1
Both thins occur equally	Both motivation sources occur equally	2	2
The process would be easier if it started with a problem	The there is a problem, there is always a solution required	1	1
Explore a technology	Entrepreneurs want to explore deeper into a technology	3	3
One thing occurs more often than the other	One of both things happens more often than the other	1	1
Phase II - Value	The second phase of the P2B Methodology	11	41
C3. 'Product-Market fit'	This theme regards on the alignment of what is the value proposed, and achievable through the technology capabilities and the paying customer needs. Going deeper into this theme, there is also the market analysis to position the company in an optimal share on the market.	6	10
Only when the technology destiny is not defined	Should be customer-oriented only when the technology applications are not defined yet	1	1
Depends on technology maturity	The fit of a product on a certain market depends on its maturity level	1	1
Depends on the market characteristics	The fit of a product on a certain market depends on market aspects	4	5
If it's a new market, the focus should be on customer needs	If there are no requirements for a certain market, the customer should be the one who provides this information	1	1
Depends on the type of technology	The fit of a product depends on the technology it is derived	4	4
C4. 'Value Orientation'			
Customer orientation	The value is oriented to the customer	7	8
Focus is on the customers	Focus should always be on the customer	1	1
Jobs to be done	Understand what customer wants to be done	1	1
Technology orientation	The value is oriented to the technology	7	9

Does not attend to market need but instead develop a technology	The purpose is not to address one market need but to develop a certain technology	1	1
Sometimes there is no market yet to the innovation	There are times that there is no market defined for the technology	1	1
The product is first developed then fitted into a market	The product is developed despite the market and then adjusted into it	1	1
C5. 'Working with the customers'	Related to open innovation concepts of bringing the customer to the development	4	6
In B2B customer acceptation is key	In B2B cases, if the customer does not accept the product, there is no business	2	2
Use customer feedback to adapt to market	Iterative process made when its desired to attend unknown market needs	1	1
Use customer feedback to develop new solutions	Use feedback form customers to exploit new markets, different from the original	2	2
Phase III - Business Modelling	Third phase of the P2B Methodology	11	39
C6. 'Prototypes'	Theme related to prototyping activities	9	28
Prototypes activities are important	If the interviewee stated that such activities are important	6	16
Approach various market segments	Benefits from performing prototypes activities	3	3
Brings the product closer to the market	By testing the prototypes, it somewhat validates it with the possible market	3	4
But are restricted to the availability of financial resources	Prototypes may be expensive, thus, the decision of making them is based on the financial resources it requires	1	1
Mitigates risks related to development and production costs	Makes sure that when the production scales up, there are no design misconceptions	1	1
Shows the customer the products value	Enables the value perception for the customer	2	3
Prototyping activities should be done as early as possible	The sooner the prototypes are made and tested the better	6	12
Earlier prototypes mean early problem detection	It is cheaper and easier to solve problems early in the process	1	1
More early more costs	Making early may represent more iterations of prototypes	2	4
Avoid more costs by making small batches of tests	Small batches can show the value for the customer and minimize production costs	1	3

Should be used to validate the value proposition	Testing prototypes of the product can help validating the value proposition	3	3
'C7. System Architecture and Business Model'	Themes related to the System Architecture	4	5
BMC is a good tool for this phase	Interviewees approve BMC for developing business models	3	3
First channels then activities	The order in which the blocks of the canvas should be addressed	1	1
Should be created after the VP	The business model should be developed after the value proposition is already defined	1	1
The evolution of the BM over time	The necessity to adjust the business model over time	3	4
Serve as a starting point for the operationalization of the business model		2	2
Strategic Planning after the business model	Plan the evolution of the business model is more related to strategic planning	1	1
Lean Launch Pad as an alternative	A tool for developing business models based on customer information	2	2
Systemic Risks	Themes related to systemic risks	4	6
Mapping external risks	Importance of mapping this kind of risks	1	1
Risks across the chain	Identifying risks across the value chain	2	2
Such risks exist	Systemic risks exist and should be considerate	2	3
Re-evaluation of the technology's capacities for each market	Understanding these risks can allow the adaptation of the technology for other markets	2	2
Phase IV - Business Plan		12	44
C9. 'Intellectual Property Management'	Themes related to IPM strategies	9	21
IP Strategies should be coherent	IPM should be done according to the overall business plan proposal	4	4
It is positive from the investor perspective	Investors see IP Strategies as positive	4	7
It is seen as a financial asset	If the idea fails, there is some protection for the invested capital	2	2
Serve as risk mitigation	Could reduce risks	4	4
Reduce imitation risk	Avoid competitors to copy the new product or service	1	1
Its already included in the risk analysis		5	5
Should be defined early in the methodology	Entrepreneurs should be considering IPM since the beginning of the methodology	1	1

Should be given special attention	Needs more attention on the business plan	3	3
C8. 'Relevance of risks and impact analysis in contrast to the financial plan'	Themes related to the socio-economic risks and impact analysis	7	10
Relevant when dealing with private investors	It is relevant when dealing with private investors	2	2
Relevant when dealing with public funding	It is relevant when dealing with public investors	3	3
Return of public contributions to society	It is a way that the public contribution goes back to society	1	1
Socio-economic indicators	The need to include socio-economic indicators on the business plan	4	4
Financial Analysis	Themes related to the financial plan	3	6
Focus on financial return	Financial Return should be focused while developing the business plan	2	3
Indicators	Presentation of financial indicators	2	2
The business plan should focus on profit maximization	Entrepreneurs should always search for profit maximization	1	1
Implementation plan	Include an implementation plan on the business plan	1	1

APPENDIX D: INTERVIEW'S THEME CODEBOOK – ACTIVITIES

Name	Description	Files	References
Phase I - Technology	The first phase of the P2B Methodology	13	58
C2. Information Paradox	The availability of information regarding the patent or the intellectual property.	11	27
Assemble multidisciplinary team	Activities to overcome the Information Paradox	2	2
Reach technology's inventors	Activities to overcome the Information Paradox	4	4
Entrepreneurs possess base knowledge of the technology	Activities to overcome the Information Paradox	1	1
License Agreement	Activities to overcome the Information Paradox	3	3
Non-Disclosure Agreements	Activities to overcome the Information Paradox	6	6
Technology Description Worksheet	Activities to overcome the Information Paradox	1	1
C10. Inventor's Conflict of Interest	When the inventor of a technology wants to take it to the market but there are conflicts with the research institution	7	18
Entities should have internal regulations to deal with this	Research institutes possesses internal regulations to deal with these situations	2	2
Allows the creation of spinoff's	Research institutes give inventor the opportunity to make spin-offs	1	1
License the technology to the inventor	Research institutes gives priority to license the technology to the inventor	1	1
Phase II - Value	The second phase of the P2B Methodology	11	41

C3. Product-Market fit		The alignment of what is the value proposed, and achievable through the technology capabilities and the paying customer needs. Going deeper into this theme, there is also the market analysis to position the company in an optimal share on the market.	6	10
	Benchmark	Benchmark process to analyse the market	5	8
	Quantifiable Market Analysis	Market analysis	3	3
	TAM-SAM-SOM	Market analysis tool	1	1
C4. Value Orientation		Themes related to the value orientation	7	20
	Creating Value from a technology		7	17
	Technology-Product-Market	TPM is a method for creating value from a technology	3	3
Phase III - Business Modelling		Third phase of the P2B Methodology	11	39
C6. Prototypes		Theme related to prototyping activities	9	28
	Build and Apply Prototypes	Construction and application of prototypes	6	16
C7. System Architecture and Business Models		Themes related to the System Architecture	7	12
	Develop and validate business models	Development and validation of the business model	6	9
Phase IV - Business Plan		Themes related to business plan	12	44
C9. Intellectual Property Management		Themes related to IPM strategies	9	21
	Define IPM Strategies		4	14