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**THE INFLUENCE OF DECISION-MAKING QUALITY ON INNOVATION PORTFOLIO AGILITY:
A CASE STUDY USING THE DYNAMIC CAPABILITIES APPROACH**

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Pontifícia Universidade Católica
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APPROACH**

Dissertation submitted on the Master's Degree Program in Administration with emphasis on Strategy, Organizations and Society of Pontifical Catholic University of Rio Grande do Sul – PUCRS, as a partial fulfilment for the degree of Master in Administration.

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Porto Alegre
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TIAGO ARGIMON HERMANN

**The Influence of Decision-Making Quality on Innovation Portfolio
Agility: A Case Study Using the Dynamic Capabilities Approach**

Dissertação apresentada como requisito parcial para a obtenção do grau de Mestre em Administração, pelo Programa de Pós-Graduação em Administração da Escola de Negócios da Pontifícia Universidade Católica do Rio Grande do Sul.

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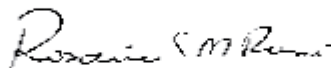
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This dissertation is dedicated to my family and everybody who got involved on this somehow during this journey.

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LIST OF ABBREVIATIONS AND ACRONYMS

IPPM	Innovation Project Portfolio Management
IPM	Innovation Portfolio Management
PPM	Project Portfolio Management
NP	New Product(s)
NPD	New Product Development
DC	Dynamic Capabilities
RBV	Resource Based View
BU	Business Unit
OA	Organizational Agility
KPIs	Key Performance Indicators
PMO	Project Management Office
IP	Intellectual Property
NPV	Net Present Value

ABSTRACT

Portfolio agility is one way to achieve a broader organizational agility, as it represents the extent to what a firm is able to adapt its portfolio of projects to changed conditions. Portfolio agility is a dynamic capability that seems to be highly mediated by the quality of the decision-making process, which, in turn, represents the degree that portfolio management decisions are made in a transparent, stable, comprehensible, and rigorous manner. To date, academics focused mostly on methods for selecting and terminating individual projects, lacking studies investigating the entirety of the decision-making process and how it can influence portfolio agility. In order to support the investigations on these fields, a limited number of researchers started adopting the Dynamic Capabilities framework as it seems to represent a powerful approach to analyze how the quality of the decision-making process can influence the portfolio agility capability in turbulent and changed competitive conditions. This research **analyzes the influence of the quality of the decision-making process on innovation portfolio agility through the use of the Dynamic Capabilities framework.** Counting on document analysis, twelve interviews, and seven direct observations in innovation committees, this is a case study in a multinational firm with innovation portfolios distributed in three different countries. Results of this study leads to the conclusion that high quality decision-making processes for portfolio management can slow down decisions for the benefit of assertiveness, that well-structured decision-making processes can decrease power- and opinion-based personal styles of decision makers, and that turbulence may decrease the conformity to formalities, which, in turn, decreased the quality of the decision-making process. In terms of practical contributions, managers and practitioners can benefit from this research by understanding the conditions required to develop higher quality decision-making processes and portfolio agility.

Keywords: Decision-Making Quality. Portfolio Agility. Portfolio Management. Innovation. Dynamic Capabilities.

RESUMO

Agilidade de portfólio é uma maneira de alcançar agilidade organizacional e representa o quanto uma empresa é capaz de adaptar seu portfólio de projetos às condições de constante mudança. Agilidade de portfólio é uma capacidade dinâmica que parece ser altamente mediada pela qualidade do processo de tomada de decisão que, por sua vez, representa o grau em que decisões de portfólio são tomadas de maneira transparente, estável, compreensível e rigorosa. Até o momento, o foco acadêmico tem sido, principalmente, sobre métodos para iniciar e descontinuar projetos de forma individual, faltando estudos que investiguem o processo de tomada de decisão como um todo e como ele pode influenciar a agilidade de portfólio. Com o objetivo de auxiliar nas investigações nestes campos, um número limitado de pesquisadores começou a adotar a abordagem de Capacidades Dinâmicas por esta indicar ser uma poderosa ferramenta para entender como a qualidade do processo de tomada de decisão pode influenciar a agilidade de portfólio em condições turbulentas onde estes sistemas estão inseridos. Diante desse cenário, o objetivo deste projeto de pesquisa é **analisar a influência da qualidade do processo de tomada de decisão sobre a agilidade de portfólios de inovação, através da aplicação da abordagem de Capacidades Dinâmicas**. Apoiando-se em análises de documentos, doze entrevistas e sete observações diretas de comitês de inovação, este é um estudo de caso qualitativo em uma empresa multinacional com portfólios de inovação distribuídos em três diferentes países. Os resultados deste estudo levam à conclusão de que processos de tomada de decisão de alta qualidade para gerenciamento de portfólios podem retardar decisões em benefício da assertividade, que processos de tomada de decisão bem estruturados podem diminuir a carga de perfis pessoais baseados em poder e opinião, e que a turbulência pode diminuir a conformidade com processos formais, o que, por sua vez, diminui a qualidade do processo de tomada de decisão. Em termos de contribuições práticas, gerentes de portfólio e profissionais podem se beneficiar deste estudo a partir da compreensão das condições necessárias para desenvolver processos de tomada de decisão de alta qualidade e agilidade no portfólio.

Palavras-chave: Qualidade da Tomada de Decisão. Agilidade de Portfolio. Gerenciamento de Portfolio. Inovação. Capacidades Dinâmicas.

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1 INTRODUCTION

“In turbulent markets, organizational agility, which is defined as the capacity to identify and capture opportunities more quickly than rivals do, is invaluable” (Sull, 2010, p. 1). The root or origin of agility is derived from agile production (Nafei, 2016) and this is a concept that has gained traction over the last years. There are three distinct types of organizational agility: strategic, portfolio, and operational (Sull, 2010). Portfolio agility represents the extent to which a firm is able to change and adapt its portfolio to changing conditions (Kock and Gemünden, 2016). An agile firm can quickly shift its development focus to incorporate a new technology into its production line. Alternatively, it can quickly eliminate a project that either no longer strategically fits the portfolio, or that has become technologically disadvantaged (Kester et al., 2011).

A portfolio is a collection of projects, programs, subsidiary portfolios, and operations managed as a group to achieve strategic objectives (Project Management Institute, 2017). According to Cooper et al. (1999):

Portfolio management is a dynamic decision-making process, whereby a business's list of active new product (and R&D) projects is constantly updated and revised. In this process, new projects are evaluated, selected, and prioritized; existing projects may be accelerated, killed, or deprioritized; and resourced are allocated and reallocated to the active projects.

The premises on which decisions were originally based may change – and therefore new decisions to adapt to these changes are needed (Kock and Gemünden, 2016).

Portfolio management process has been adopted as a coordinating system by many different types of firms or departments within organizations. These coordinating systems can assume different names, such as Project Portfolio Management (PPM), New Product Development (NPD) portfolio management, and Innovation Project Portfolio Management (IPPM). Some authors adopt the term IPPM, such as Lerch and Spieth (2013), and Spieth and Lerch (2014). Other authors adopt IPM (Innovation Portfolio Management), such as Behrens (2016), Kock and Gemünden (2016), and von Ahsen and Heesen (2009). Moreover, others keep using the most traditional term PPM as referring to Project or Product Portfolio Management inserted within R&D or new service and product projects, such as Killen et al. (2008), Killen and Hunt (2010), and Floricel and Ibanescu (2008). Bentzen et al. (2011), and Grewal et al. (2008) adopt the term Product Development Portfolio (PDP) Management in their studies. Since I am interested in understanding the decision-making process within Innovation Project Portfolio Management systems, I adopt the term IPPM because it seems to better represent and

define the subject under investigation. Nevertheless, all the variances aforementioned are considered during this analysis. Therefore, I understand the term Innovation Project Portfolio Management as the application of portfolio management principles to innovation and R&D projects.

Innovation is central to improvements in living standards and can affect individuals, institutions, entire economic sectors, and countries in multiple ways (OECD/Eurostat, 2018), and portfolio management is fundamental to successful new product developments (Cooper et al., 2000), which is key to implement systematic and sustainable innovation programs in competitive firms. This coordinating system is a broad research field due to its multiplicity of influencers. The most common topics that have been investigated in recent years on this field include practices, methods, design and tools adopted by IPPM systems (Killen et al., 2008; and Lerch and Spieth, 2013), IPPM performance (Spieth and Lerch, 2014), and new product performance (Klingebliel and Rammer, 2014; and Spieth and Lerch, 2014). Other topics have also been covered by the community but with a lower number of publications.

Many of these studies aforementioned investigating IPPM processes focus on optimal portfolio configurations but pay little attention on the decision process of how firms decide to develop such a superior set of projects; that is, they focus more on tools than on processes. Although some studies have investigated aspects of portfolio decision-making, they have not uncovered the processes by which firms make IPPM decisions (Kester et al., 2014) on its entirety. Insights that prevent or resolve challenges in the daily practices of overall portfolio decision-making are scarce (Kester et al., 2011) as most prior research concentrates on success factors and neglects the decision-making processes underlying IPPM (Kock and Gemünden, 2016).

Exploring this research gap, Kester et al. (2011) identified three dimensions of effectiveness of the IPPM decision-making process: (1) portfolio mindset, as the firm having a complete overview of the entire portfolio, as well in-depth knowledge about each individual new product development project; (2) focus, as the firm focusing development efforts on those projects that achieve their long-term goals; and (3) agility, as the firm being agile in how they make and implement IPPM decisions.

In an empirical study, Kock and Gemünden (2016) investigated the antecedents of the quality of the decision-making process and how they can affect portfolio agility. According to them, *“the quality of the decision-making process represents the degree to which portfolio management decisions – such as initiation, (re)prioritization, or even termination of projects – are made in a transparent, stable, comprehensible, and rigorous manner.”* The quality of the

decision-making process is conceptually distinct from decision effectiveness because the former does not necessarily imply that decisions actually result in desired outcomes. Although relevant findings, Kock and Gemünden's study is mostly focused on the antecedents of the quality of the decision-making process, leaving an ample avenue for investigation of the relationship between the quality of the decision-making process and portfolio agility.

This broader view of IPPM decision-making process as being more than the simple adoption of methods and tools to select the best projects, and the consideration that portfolio management is a dynamic decision-making process, have recently provoked the adoption of the Dynamic Capabilities (DC) approach as a framework that can be helpful to investigate the decision-making process in its entirety. A few researchers have adopted DC not only to understand the decision-making process as a whole, but also to aggregate in their studies the effect of it on portfolio agility.

1.1 RESEARCH PROBLEM

Portfolio agility increases the firm's ability to quickly adapt its portfolio to changing conditions (Kock and Gemünden, 2016). These changing conditions can be new market and technological trends, new products or technologies launched by the competition, change at the organizational strategy, new customer requirements such as new products or product characteristics, or changes in internal and external resources that can affect the portfolio of projects of an organization.

Portfolio management capability can help firms to build organizational agility, which is vital in current days for the firm's ability to build and sustain competitive advantage (Sull, 2010). Teece et al. (2016) refers to organizational agility as the capacity of an organization to efficiently and effectively redeploy/redirect its resources to value creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant.

Cooper et al. (1997a, 1997b) verified that firms holding a superior IPPM performance are those that have selected the best set of projects. Despite the authors have investigated the tools and methods to select the best projects, they do not provide details on how firms achieve this superior IPPM performance.

In a qualitative case study, Kester et al. (2011) extended the work of Cooper et al. through the identification of organizational processes that can lead to a superior decision-making process in innovation portfolios. The identified organizational processes are: (a) portfolio mindset, which means that the decision-makers make their decisions taking in consideration the entire portfolio and not only individual projects; (b) focus effort, linking short-

term actions with long-term goals; and (c) agile decision-making, which means that decision-makers can make decisions quickly. It means, per Kester et al.'s study, that portfolio agility is only one of the three dimensions that compose an effective decision-making process. Authors also found that the portfolio decision-making process is influenced by three personal styles: (a) evidence-based, which consists of making decisions based on facts and detailed information; (b) power-based, when the goals of someone or subgroups dominate others; and (c) opinion-based, when decisions are made based on personal experiences or feelings rather than on facts. All these three personal styles are influenced by five factors: cross-functional collaboration; practices of critical thinking; practices of market immersion; politics; and opinion. The interaction between those three personal styles leads to a greater or lesser decision-making processes effectiveness.

Despite identifying the processes, dimensions and interactions involved in the decision-making process, and indicating that they influence the agility in decision-making, it does not elaborate on how it is possible to deliver greater agility; authors restrict themselves to building the decision-making framework. In addition to not providing indicatives of how to deliver greater agility, the sample that they used is very small. Another restriction is related to the instrument used for interviews, in which there is no question related to how agile the decisions are made by the organizations, that is, it was not possible to draw a correlation of the processes and dimensions of the decision making process with the agility of the portfolio. The explanation of how to deliver greater agility, identify additional components of the decision-making process, and correlate these processes and dimensions with the effect on portfolio agility, could help complement the knowledge about the process of decision-making in innovation portfolios.

According to Kock and Gemünden (2016), differences in innovation portfolio decision-making can be explained by: (a) individual decision-making styles, (b) group dynamics, (c) organizational politics, and (d) cultural factors. In a quantitative study of a cross-industry sample of German firms holding innovation portfolios, Kock and Gemünden (2016) developed a framework focusing on five components of IPPM processes that arguably influence decision-making quality, which in turn is supposed to affect the portfolio agility. These five components are grouped in two sets. Three structural organizational components: (a) clarity of a firm's innovation strategy; (b) the formality of the portfolio process; and (c) the intensity of controlling, defined as the effort and quality of continuous screening and monitoring of the portfolio; and two cultural components: (d) organizational innovation climate; and (e) the extent of its open risk climate. They verified that all these five structural and cultural components positively influence decision-making quality, which in turn influences portfolio agility.

Furthermore, they found that four of these five components are even more important on decision-making quality under high environmental turbulence; the exception is process formality, which seems to be less important under this condition.

Kock and Gemünden's (2016) study confirm the influence of these five components on decision-making quality, as well as, its influence on portfolio agility, but it presents two limitations that can be better explored. First, they don't explain why and how these five components influence decision-making quality and portfolio agility, not providing any guidance to academics and practitioners on how to work on these components to increase decision-making quality and portfolio agility. Second, their framework did not cover all the antecedents of decision-making quality and agility, such as individual decision-making styles, group dynamics and organizational politics. Therefore, a qualitative case study could provide answers to these why and how questions in order to increase understanding on them, as well as, it could explore other variables influencing decision-making quality and agility such as leadership styles and organizational politics. Moreover, it could identify additional antecedents through interviewing decision-makers and other people engaged in IPPM processes.

Killen et al. (2008) have identified IPPM practices as a dynamic capability of an organization that enhances competitive advantage through effective management of the portfolio of innovation projects. Authors focused on organizational learning mechanism aspects associated with the implementation and use of IPPM processes through the use of the DC framework. Petit (2010, 2012) also adapted the DC framework from Teece et al. (1997) to portfolios facing dynamic environments. He demonstrated that the DC framework can also be used to analyze operational levels of the organization (IPPM processes), as opposed to the strategic level, which is a more traditional field using this framework. Petit focused on answering how uncertainty affects portfolios managed in dynamic environments. Both studies represent the beginning of the use of DC framework on IPPM processes. Results showed an adequate approach to investigate innovation portfolios in the sense that this framework integrates many practices of IPPM processes that are usually investigated in an isolated way.

There is a lack in the academic and managerial literature in regarding with the research fields of decision-making quality, portfolio agility and the application of the DC framework on IPPM processes. Therefore, considering the scarcity of in-depth case studies trying to analyze in detail how the quality of the decision-making process can influence the innovation portfolio agility, the research question of this study is: **How does the quality of the decision-making process influence the innovation portfolio agility in IPPM units?**

Understanding the correlation between these two phenomena helps portfolio managers and PMO practitioners to design high quality governance processes and understand, at the same time, the effect of this quality on how fast or slow portfolio decisions are made.

Innovation is now understood to be the main driver of economic growth in developing nations so the importance of maximizing outcomes from innovation project portfolio is escalating (Killen et al., 2008). Due to its importance, this research project focuses on innovation projects only.

1.2 OBJECTIVES

To answer the research question, the main objective of this study is **to analyze the influence of the quality of the decision-making process on innovation portfolio agility and its influencing factors in IPPM units.**

The specific objectives of this study aim to:

- A. Investigate how to build a high quality decision-making process to influence firm's ability to quickly adapt its innovation portfolio to changed customer needs and competitive conditions.
- B. Assess how environmental conditions affect the quality of the decision-making process and the innovation portfolio agility.
- C. Assess how personal decision-making styles influence decision-making quality and innovation portfolio agility.

1.3 JUSTIFICATIVE

Defined as a novel creation that produces value, an innovation can be as slight as a new nail polish color or as vast as the World Wide Web. For Nagji and Tuff (2012), "*most companies invest in initiatives along a broad spectrum of risk and reward. As in financial investing, their goal should be to construct the portfolio that produces the highest overall return that's in keeping with their appetite for risk*". There are management innovations under way all the time in organizations; many fail, some work, and only a few make history (Birkinshaw and Mol, 2006). In order to increase the effectiveness of the choices, a sound portfolio evaluation requires assessment of the individual innovation projects relative to business strategy, business constraints, business model, capacity for innovation, competition, and competencies (Paulson, O'Connor and Roberson, 2007). Companies that make poor choices with respect to their new product development (NPD) portfolio run the risk of losing their competitive advantage (Chao and Kavadias, 2008).

Despite its importance to firms performance, existing researches about decision-making processes in IPPM systems describe the performance relevance of effective decision-making and of adapting to changing environmental conditions but they do not investigate organizational factors that favor or hamper this desired behavior (Kock and Gemünden, 2016). These existing researches mostly focus on tools and methods to select the best set of projects but they do not analyze the decision-making process in an integrated way with other organizational factors that can affect or be affected by the portfolio choices.

Portfolio decision-making processes are more effective when firms can make decisions quickly in order to take advantage of the timing of opportunities and threats. Portfolio agility is the capacity to shift resources, including cash, talent, and managerial attention, quickly and effectively out of less promising business areas and into more attractive ones (Sull, 2010). An agile firm can quickly shift its development focus to incorporate a new technology into its product line. Alternatively, it can quickly eliminate a project that either no longer strategically fits the portfolio, or that has become technologically disadvantaged (Kester et al., 2011).

Recent research projects on firm's performance have indicated that portfolio agility is one type of organizational agility (Sull, 2010). These studies have a more broad perspective as they do not go deep in trying to understand portfolio agility as an antecedent for this overall organizational agility and how to accelerate portfolio decisions.

Heretofore, a small handful of investigations have deepened in trying to understand how to improve portfolio agility and what are its antecedents. Kester et al. (2011) developed a general model containing the components involved in portfolio decision-making processes and they provided insights into how some of those components can be combined to contribute to portfolio decision-making effectiveness and market performance. Kock and Gemünden (2016) contributed to the portfolio agility research field by analyzing what factors enable firms to make better decisions and implement them more quickly and comprehensively. Both Kester et al. and Kock and Gemünden studies analyzed the quality of the IPPM decision-making process in order to understand its effect on innovation portfolio agility.

Kock and Gemünden (2016) findings generalize the understanding that a high quality decision-making processes deliver higher portfolio agility. Yet Kester et al. (2011) findings establish a condition based on the personal styles of the decision-makers involved in the process; they argue that processes where decision-makers have an opinion or power-based personal style tend to be more agile than processes led by people that have a personal style more based on evidences. These are the only two studies that have analyzed how the quality of the decision-making process can influence portfolio agility and yet each one of them ends up in a slightly

different conclusion. Moreover, an additional analysis about the effect of the personal styles on portfolio agility, as mentioned by Kester et al. (2011), is beneficial to understand how to design robust IPPM decision-making processes and avoid unfunded decisions.

Due to its dynamic characteristics, innovation portfolios run under turbulent environments as innovation endeavors are usually dominated by technical and market uncertainties. This turbulent environment of innovation portfolios have been subject of study by Floricel and Ibanescu (2008), Sethi and Iqbal (2008), Petit (2012), and Kock and Gemünden (2016). The strategic, organizational, and cultural antecedents of the quality of decision-making processes are likely to be affected by the extent of turbulence in the firm's environment (Kock and Gemünden, 2016). The understanding of the turbulence effect on innovation portfolios is in its early stage and additional research is needed to help organizations to make better choices to tackle uncertain situations.

The activities related to innovation portfolio management have been seen lately as being a dynamic capability due to its dynamic characteristic of continuous evaluation of projects. Four studies adopted the DC framework since 2008 to analyze IPPM processes. Killen et al. (2008) have identified IPPM practices as a dynamic capability of the organization that enhances competitive advantage through effective management of the portfolio of innovation projects. Petit's (2010, 2012) research adapted Teece's framework to structure the micro-foundations of the DC used when managing project portfolios under high levels of uncertainty. Teece et al. (2016) explores the application of the DC framework to develop organizational agility and Sensing, seizing and Transforming / Reconfiguring are cited as IPPM capabilities. Results from these authors indicate that this framework fits on these analyses and more studies adopting it can help to leverage its use on IPPM analyses.

This research study provides contributions to the academy by increasing the scarce literature about the quality of decision-making processes, innovation portfolio agility, and DC framework. First, this study sheds light on the innovation portfolio decision-making process at its entirety, not only on methods and practices adopted by IPPM processes to create or discontinue single projects. Second, this further analyzes the correlation between the quality of the decision-making process and innovation portfolio agility. Third, this research analyzes the impact of personal styles and environmental turbulence on the quality of the decision-making process and portfolio agility. And finally, this analysis extends the studies that have adopted the DC framework to investigate IPPM processes. Mastering on managing an innovation portfolio can help firms to achieve the portfolio management goals mentioned by Cooper et al (1997a, 1997b), that are: (a) firm's financial results maximization, (b) portfolio balance

between high and low risky projects, and short-, mid, and long-term launches, and (c) strategic fit of the projects with the firm's strategy.

Understanding how to increase innovation portfolio agility brings benefits to Project Management Offices who strive to increase IPPM performance, which, in turn, increases the overall firm performance that is pursued by any top manager, CEO and shareholder.

A high quality decision-making process may affect the innovation portfolio agility. Therefore, understanding how to design a process such that can be of extreme importance to help decision-makers involved in portfolio decisions. Finally, the use of the DC framework to investigate the quality of the decision-making process and portfolio agility is on its early days at the academic world and the results are very preliminaries to date, which opens up several avenues for research on this field.

1.4 RESEARCH STRUCTURE

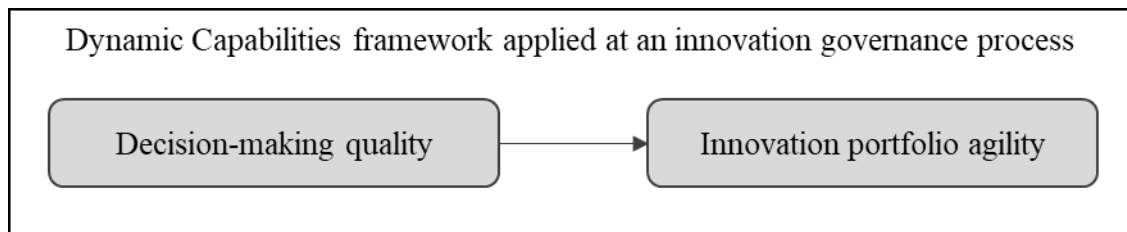
After introducing this study, its research problem, stating the objectives, and justifying the theme, this work is structured as follows. Chapter 2 contains the theoretical background that supports this investigation; that chapter begins by presenting the most recent and relevant studies about IPPM, then explores the yet few studies about the quality of the decision-making process and innovation portfolio agility, and finishes by presenting the uses of the DC framework on IPPM studies and the adaptations made in this framework to be used by this current research. The research design of this work, the presentation of the firm under investigation in this research, the data collection techniques and the data analysis procedure are presented in the Chapter 3. Chapter 4 presents the analysis of the results, subdivided in each one of the three dynamic capabilities: Sensing, Seizing, and Transforming / Reconfiguring. The analysis of the documents, the results of the interviews, and the direct observations in innovation committees permeate each capability under investigation. Chapter 5 (Discussions) elaborates on the data collected. Chapter 6 presents the theoretical and practical contributions of this study. Chapter 7 closes this research with the conclusions, limitations and future works.

2 THEORETICAL BACKGROUND

This chapter presents a literature review underpinning this study. First, it presents a summary of studies about IPPM, its findings and research agenda. Second, it presents the scarce literature about the quality of the decision-making process and about portfolio agility. Third, this section explores what is available about the use of the DC framework on IPPM studies. Finally, a set of propositions built based on this literature review is presented.

Figure 1 illustrates the general scope of this study, in which the DC framework is applied in an IPPM system in order to analyze how the quality of the decision-making process can influence innovation portfolio agility.

Figure 1: Research project scope.



Source: Author.

2.1 INNOVATION PROJECT PORTFOLIO MANAGEMENT (IPPM)

This section presents a literature review about IPPM to provide an overview about what has been investigated by the academy, and what are the latest trends on this field of research. I start sharing the most commonly accepted definition of IPPM which states that innovation “portfolio management is a dynamic decision process, whereby a business’s list of active new product (R&D) projects is constantly updated and revised. In this process, new projects are evaluated, selected, and prioritized; existing projects may be accelerated, killed or deprioritized; and resources are allocated and reallocated to the active projects. The portfolio decision process is characterized by uncertain and changing information, dynamic opportunities, multiple goals and strategic considerations, interdependence among projects, and multiple decision-makers and locations” (Cooper, Edgett and Kleinschmidt, 1999, p. 335). In addition to new physical products, an innovation portfolio can also consist of modifications in existing products, new market developments, new or modified business models, new or modified processes, and new or modified services.

Briefly summarizing the history of IPPM studies, this is a broad research field where investigations have gained traction from publications by Cooper, Edgett and Kleinschmidt from

1997 on. First investigations focused primarily on methods and tools adopted by portfolio managers to select the best set of projects to the firm. Some researchers correlated these different methods and tools with IPPM and firm performances. Since portfolio management is all about making decisions, this is an ample research field within IPPM studies that has evolved from simple techniques to choose the best set of projects to more deep investigations on the aspects underlying the whole decision-making process. In addition, more emergent researches on IPPM have shed light on green product developments, stakeholder engagement, IPPM challenges, and service portfolio management (SPM). IPPM studies have been published in many different journals, such as: *Strategic Management Journal*, *Journal Product Innovation Management*, *International Journal of Research in Marketing*, *Business Strategy and the Environment*, *R&D Management*, *Project Management Journal*, *Journal of Business Research*, and *Management Decision*.

First significant impact on the IPPM literature is resultant from a set of publications by Cooper et al. (1997a, 1997b, 1998, 1999, 2000) in a large investigation mostly on North American firms. Three high-level or macro goals for effective IPPM systems were identified by Cooper et al. (1997a, 1997b) in an exploratory investigation about portfolio management practices. These three broad and macro goals have been largely referenced by authors of publications about IPPM. These goals are:

- *Value Maximization*: In some firms, the concern is to allocate resources so as to maximize the value of the portfolio in terms of some company objectives (such as long-term profitability, return-on-investment, likelihood of success, or some other strategic objective);
- *Balance*: Here the principal concern is to achieve a right balance of projects in terms of a different number of parameters; for example, the right balance of long-term projects versus short term ones; high-risk versus low-risk and sure bets; and across different markets, technologies, product categories, and project types (e.g., new products, improvements, cost reductions, maintenance and fixes, and fundamental research); and
- *Strategic Direction*: The main focus here is to ensure that, regardless of all other considerations, the final portfolio of projects truly reflects the business's strategy – that is, the breakdown of expenses across projects, departments, and markets is directly tied to the business

strategy (e.g., to previously delineated areas of strategic focus), and that all projects are on strategy.”

The most common tools and methods to deal with value maximization and portfolio balance are indicated by Cooper, Edgett and Kleinschmidt (1997a) in the first of two publications. A range of financial methods and scoring models are used by companies to maximize portfolio value, ending up with a rank-ordered list of “Go” and “On hold” projects. Visual charts are the most common methods to pursue a balanced portfolio; these visual representations include portfolio maps and bubble diagrams. Finally, tools and methods to deal with the strategic direction goal is revealed in the second publication, which includes strategic buckets model, a top-down method for setting spending targets, a bottom-up scoring scheme that emphasizes strategic criteria, and the strategic check (Cooper, Edgett and Kleinschmidt, 1997b). In a later investigation, Cooper, Edgett and Kleinschmidt (2002) identified a fourth goal, which is to select the right number of projects in order to avoid too many projects underway for limited resource availability. The way to achieve this goal, according to the authors, is the adoption of resource capacity analysis.

A second broad investigation on methods and tools adopted by companies to manage their portfolio of innovation projects has been presented by Killen, Hunt and Kleinschmidt (2008). The purpose of this research is to develop a benchmark and identify best practices for both service product-based and tangible product-based development portfolios in 60 Australian organizations in a diverse range of industries. This work verifies that IPPM practices shown to be very similar for service and tangible product development project portfolios. New product success rates show strong correlation with measures of IPPM performance and the use of some IPPM methods is correlated with specific IPPM performance outcomes (Killen, Hunt and Kleinschmidt, 2008). The three most common methods used by IPPM organizations are: financial; business strategy; and portfolio maps. Strategic methods and portfolio maps have the strongest positive influence on the performance of the portfolio while financial methods are correlated with a positive performance in only one IPPM measure and do not lead to higher value projects in the portfolio as expected. This last finding on financial methods not leading to higher value projects in the portfolio is in line with Cooper, Edgett and Kleinschmidt’s (1997a) findings.

Resource allocation in IPPM organizations has been investigated in terms of financial and people allocation. A substantial body of research has been focused on the question of which innovation projects to pursue (Shane and Ulrich, 2004) and portfolio managers tend to adopt multidimensional decision-making tools or ranking methods (Loch, 2000). Strategic buckets in

IPPM systems have been lately proposed as a way to ensure the fit between innovation projects and organizational strategies, and also to ensure a well balanced portfolio of incremental and radical innovations. Loch and Kavadias (2002) and Chao and Kavadias (2008) made significant progresses on this field of resource allocation. Through the investigation of strategic buckets, Chao and Kavadias (2008) verified that environmental complexity shifts the balance towards radical innovations; conversely, environmental instability shifts the balance towards incremental innovations. More focused on people allocation, Klingebiel and Rammer (2014) investigated different resource allocation strategies for IPPM and verified that breadth resource allocation strategy has a significant positive direct impact on innovation performance; the effect of breadth resource allocation strategy is more significant than that of increased project investment; firms achieve greater performance if they allocate broadly at first and then also discontinue projects in later stages; and that innovation performance is determined by the amount of resource spent and by the way these resources are allocated.

The subject of decision-making has also received attention since IPPM systems rely on good decisions to achieve high performance, therefore findings on this theme are of high relevance. Beyond these themes, findings are related to more emergent themes, such as SPM systems, IPPM challenges, green product developments, and stakeholder engagement.

Success at product innovations is one key to corporate performance and it can be gauged in many ways, depending on who defines success (Cooper et al., 1995). Given its importance, many authors have investigated what factors can influence the performance of new products. Killen et al. (2008), Lerch and Spieth (2013), and Spieth and Lerch (2014) show that the performance, governance, and methods of IPPM strongly correlate with new product performance. In a similar vein, Urhahn and Spieth (2014) confirms that there is a positive relationship between project management governance, innovativeness, and firm performance. Mitrega et al. (2017) studied the concept of network capability (NC) for the management of suppliers and found that this NC positively influences the firm performance. For Sicotte et al. (2014), the performance of the innovations is highly impacted by innovative dynamic capabilities, which include IPPM capability. The performance of IPPM strongly correlates with new product performance, which reinforce the importance of understanding what influence the IPPM performance. In terms of knowledge management, Spieth and Lerch (2014) found that information availability is a key construct in driving IPPM performance. In this line, Jugend et al. (2016) confirm that practices associated with formalization, systematization, and clarification in product portfolio decision-making significantly influence the fulfillment of performance objectives. Spieth and Lerch (2014) found that PPM elements, like transparency

and formality, are key drivers of high PPM performance. Yet in terms of elements, Tidd and Thuriaux-Alemán (2016) indicate that the use and effectiveness of most innovation management practices varies by industry, and only a very small number of innovation management practices can be considered universally positive on the innovation outcomes, including external technology intelligence gathering, and technology and product portfolio management.

Kock et al. (2015) evaluated how ideation portfolio management practices influence front-end success and IPPM success. They found that ideation strategy, process formalization, and creative encouragement independently and significantly contribute to front-end success, which in turn mediates the elements of ideation portfolio management and project portfolio success.

In terms of social capital, Li et al. (2016) found that the cognitive dimension negatively affects exploratory innovation, whereas the relational and structural dimensions demonstrate inverted U-shaped relationships with exploratory innovation.

The differences and similarities between service and tangible product development IPPMs have been researched by some authors. Most of the papers compare practices and the difference of maturity between these two types of PPMs. Killen et al. (2008), Lerch and Spieth (2013), and Aas et al. (2017) compared the set of practices adopted by both types of PPMs and found no differences, meaning that both run similarly to each other in terms of design and management practices. Storey and Harborne (2012) investigated PPM systems in UK financial service firms and they suggest that this kind of organization underperform goods product firms, indicating that only 8% of service firms have what they could consider a well-executed mature PPM approach in comparison to 22%.

Understanding the challenges IPPM systems face to be implemented or established is important to the success and acceptance of them among the stakeholders. A few authors have investigated these challenges in order to provide managerial assistance to PMO leaders. Braganza et al. (2009) surveyed the challenges faced by firms when trying to build sustainable innovation programs. According to them, the main obstacles to keep sustainable innovation, which is key to keep competitive advantage and avoid flashes or spurs of innovation, are the pursuit of stability, risk avoidance, competencies and strategies inappropriate for current and future challenges, organizations locked in by resources they have, legacy systems, complex power structures, and organizations focusing internally rather than externally. Karlsson and Stetler (2015) investigated the frequency and relationship between obstacles to innovation and innovation self-efficacy. They found that the employees frequently mention resource allocation

and lack of time as obstacles. Significant relationships were found between an employee's innovation self-efficacy and obstacles related to organizational culture, how the firm works on goal setting, and obstacles related to the project portfolio.

In the field of Green Product Development (GPD), Jugend et al. (2017) analyzed how green and traditional practices of new product developments influence product portfolio and NPD performance. They found that the adoption of GPD practices significantly influence product portfolio performance and that it tends to generate positive results with regard to obtaining technological and market opportunities. van der Vooren et al. (2013) mention that car manufacturers which introduced GPD projects in their portfolio, such as CO2 emission reduction, perform better in terms of sales than manufacturers that do not have any project and product with these characteristics.

In regarding with stakeholder engagement, Beringer et al. (2012) found that the intensity of this engagement depends on other stakeholders engagement in the IPPM system, and that this dependency is moderated by the clarity of the role, which, in turn, depends on how mature the IPPM system is, because the more mature the environment is, more clear is the definition of each role. Within immature PPMs, portfolio managers are either not fully qualified or do not have resources or strength in position. On the other hand, as the PPM becomes more mature, portfolio managers have the required competencies and the basic conditions are established.

Bentzen et al. (2011), investigating what attracts decision makers' attention in portfolio meetings, found that the quality of information presented was not significant for explaining variations of decision makers' attention. Differences in project status did not explain variations in attention as well. Delayed projects did not get significantly more attention than those delivered on time. Interestingly, they found that the newness of projects to the corporate portfolio was found to be the most important parameter. This finding is very important for project managers when putting together the information about the projects they may present in portfolio meetings; in other words, the project managers may focus their presentations on the newness of their projects rather than on status, schedule, or quality of the information. It does not mean that these other information are not important but they attract less attention from decision-makers.

As noticed in this section, some subjects have received more attention than others mostly due to the importance they have on firm's performance and the urgency to establish basic operating models. Some of the less studied subjects are related to themes that have gained attention lately, such as green products. Other themes seem to be firm specific so there is not a comprehensive research on them.

In general, studies on the IPPM field mostly adopt cross-sectional data clipping. Because of this type of data clipping and of the long-term causality effects of moderating factors of IPPM, it is not rare to find suggestions to perform longitudinal data collection to understand these effects in long term.

Another common suggestion among the researchers is to perform studies in multicultural environments and in different countries in order to understand whether their findings can be generalized or concern only to specific countries and industries. In-depth qualitative case studies are also highly recommended by researchers to understand in detail certain characteristics and moderators of IPPM systems.

Many of these studies presented in this section have a connection with decision-making process and portfolio agility, but an integrated view of them is presented in the next subchapter.

2.2 PORTFOLIO AGILITY AND QUALITY OF THE DECISION-MAKING PROCESS

Portfolio agility is a pretty new concept which represents the extent to which a firm is able to change and adapt its portfolio to changing conditions (Kock et al., 2016). An agile firm can quickly shift its development focus to incorporate a new technology into its product line. Alternatively, it can quickly eliminates a project that either no longer strategically fits the portfolio, or that has become technologically disadvantaged (Kester et al., 2011). Although this concept presented by Kester et al. (2011) cites agile firms as its definition, their focus is clearly on portfolio agility. Moreover, these authors make reference to changes and adaptations to product lines, which makes us think only in products and processes but a portfolio of projects can also encompass new business and service developments. Teece et al. (2016) refers to agility as the capacity of an organization to efficiently and effectively redeploy/redirect its resources to value creating and value protecting (and capturing) higher-yield activities as internal and external circumstances warrant. In spite of the fact that this is a broad concept of organizational agility, most of the activities involved in this concept are related to managing a portfolio of development projects by the fact that portfolio managers and decision-makers have to constantly re-allocate resources to most promising and value added projects.

The literature on portfolio agility is very scarce due to its novelty. Donald Sull (2010) published a managerial paper in the *McKinsey Quarterly Business Magazine* where his research reveals three types of agilities: strategic, organizational, and portfolio agility.

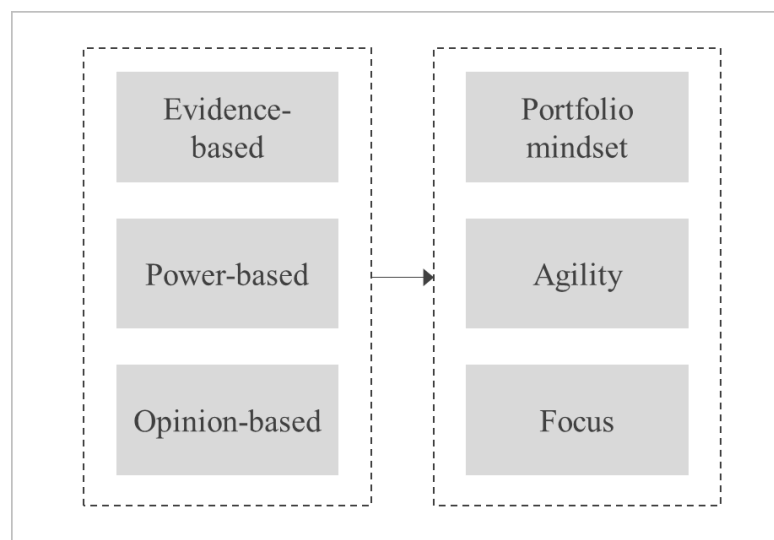
Strategic agility consists of identifying and taking advantage of game-changing opportunities that can represent huge benefits for the organization. Organizational Agility (OA) involves exploiting opportunities within a focused business model; it means, this is focused on

already established objectives. And portfolio agility represents the capacity to shift resources – including cash, talent, and managerial attention – quickly and effectively out of less promised business areas and into more attractive ones (Donald Sull, 2010). Therefore, portfolio agility is one of the paths to achieve higher levels of OA, which is a broader field of research that has been investigated by the academy and that is out of the scope of this project. One gap in the literature of portfolio agility is an objective scale to measure how agile a portfolio of an organization is compared to other companies.

Since portfolio management is all about making strategic choices (Cooper et al., 1999), there is a tight connection between both fields: portfolio management and decision-making. Based on publications of Kester et al. (2011) and Kock and Gemünden (2016), having an agile decision-making process in place targeted to make decision about project developments is the same as saying that the organization counts on portfolio agility because decision-making agility is usually an interchangeable term for portfolio agility, even though portfolio management encompasses additional components and competencies other than making decisions.

The concept of portfolio agility – decision-making agility – differs from decision-making quality in the sense of the former refers to how quickly decisions are made and the later refers to how robust the process is. Correlations between portfolio agility and decision-making quality were first built by Kester et al. (2011), whom used in-depth data and a grounded theory approach to develop a general model of how firms make new product portfolio decisions. According to their findings, which have been simplified in Figure 2, effective portfolio decision-making processes produce a portfolio mindset, focus effort on the right projects, and allow agile decision-making across portfolio's set of projects.

Figure 2: Simplification from Kester et al. (2011) findings.



Source: Adapted from Kester et al., 2011, pg. 646.

Portfolio mindset means that the decision-makers make their decisions taking in consideration the entire portfolio and not only individual projects; focus effort links short-term actions with long-term goals; and agile decision-making means that decision-makers can make decisions quickly. Effective portfolio decision-making is the result of interactions between evidence-, power-, and opinion-based personal styles. Because of the evidence is never complete or accurate, other forces, such as individuals' opinions and the power bases of those involved with making these decisions, it will at some point come into play in making decisions. This is especially true for more breakthrough ideas, where uncertainty in the quality of the data will be highest. These processes have benefits in that they may allow the firm to be agile in its decision making, and provide the short-term focus necessary to execute toward the long-term plan (Kester et al., 2011).

Evidence-based personal style is manifested when decision makers use objective information and empirical evidence to make founded decisions. Power-based personal style is manifested when individuals use their hierarchical condition to reflect their personal interests. Yet opinion-based personal style occurs when feelings and personal experience comes to play in portfolio decision situations.

Kester et al. (2011) argue that decision-making processes dominated by power- and opinion-based processes may be more agile, while processes dominated by evidence-based processes may be less agile. Trying to expand the understanding of how these personal styles affect portfolio agility, this research developed four propositions to this end. The first proposition investigates the influence of evidence-based personal style on portfolio agility when there is lack of information, because it is expected that this personal style tends to require substantial information to make any decisions:

P1: Personal evidence-based style leads to lower portfolio agility when there is lack of information.

Since opinion- and power-based personal styles tend to don't get stuck waiting for a complete set of information and to don't follow formal processes to make their decisions, this could lead to a lower quality of the decision-making process. Proposition two was elaborated to investigate this circumstance:

P2: Personal opinion- and power-based styles lead to lower decision-making quality as they tend to shortcut formal processes.

In a follow-up study, Kester et al. (2014) investigated not how to achieve decision-making agility, but the effect of this capability on firm's market performance. Their results show that all three dimensions of NPD portfolio decision-making effectiveness (i.e., portfolio mindset, focus, and agility) are associated with achieving the three dimensions of NPD portfolio success (i.e., strategic alignment, maximal NPD portfolio value, and portfolio balance), which in turn influences market performance (Kester et al., 2014). In regarding with portfolio agility, results suggest that firms that are fast and flexible in making and implementing portfolio decisions may be more capable of quickly eliminating those projects that are no longer interesting in light of a changing environment. Hence, agility can help free up resources in the portfolio, which contributes to achieving NPD portfolio balance. Moreover, agility helps firms quickly respond to strategic opportunities in the market and incorporate projects in the portfolio that reflect those opportunities. Finally, the combination of a portfolio mindset and agility helps firms to develop NPD portfolios that deliver maximal value (Kester et al., 2014), which is one of the three main objectives of a portfolio management (Cooper, 1999).

Antecedents to decision-making quality and their influence on portfolio agility were further investigated by Kock and Gemünden (2016) in a quantitative study. Based on a decision-making framework, their study empirically investigates which features increase transparency, stability, effectiveness, and agility of strategic and operational decisions in innovation portfolio management. According to their findings, decision-making quality and agility are increased by a clear innovation strategy, formal portfolio processes, frequency of portfolio monitoring, and a climate fostering innovation and open communication of risks. Kock and Gemünden (2016) argue that a firm's agility in IPPM is mainly affected by decision-making quality, then they proposed and validated the hypothesis that decision-making quality is positively related to agility in IPPM.

Moreover, in turbulent environments, where there is a high frequency of environmental changes, formal organizing becomes less important for decision-making quality and agility, whereas monitoring frequency and innovation climate become more impactful. Process formality has strong influence on decision-making quality and decision-makers who demonstrate a higher decision-making quality to adapt their innovation portfolios more quickly to changing situations. Kock and Gemünden (2016) argue that for making better founded decisions does not imply that decision-makers need more time to make their decisions, justifying that good decision-makers have developed better coordination systems, which make

them more agile, and they also appear to foster innovation and risk climate that motivate people to deliver more and higher quality information.

What remains unclear is if urgent situations can force decision-makers to make faster decisions ignoring information availability that in cases it would be available. Making a faster decision means that the time to make a decision is reduced when compared to the time that the decision would take in case of following the formal process. In order to investigate the behavior of decision-makers in those turbulent situations, proposition three was developed:

P3: Decision-makers tend to make faster portfolio decisions under high environmental turbulence.

In case of P3 be valid for high quality decision-making processes, it would mean that any required information according one specific decision-making process could be overlooked for the benefit of having a decision in place, which leads this study to state a fourth proposition:

P4: Environmental turbulence leads decision-makers to shortcut formal decision-making processes.

Overlooking or making a decision ignoring the formal process in order to respond fast to an urgent situation may signify that the quality of the decision-making process can be affected negatively by this lack of process abeyance. Thus, as a consequence of P4, a fifth proposition can be investigated, which states that:

P5: Environmental turbulence leads to lower decision-making quality.

Both studies, investigating the relationship between decision-making quality with portfolio agility, took place in the U.S. and Europe, mainly in Germany. Kester et al. (2011) qualitative study investigated four companies, being two in the U.S. and two in Europe. Kester et al. (2014) quantitative study investigated 189 German firms. Yet Kock and Gemünden (2016) quantitative study investigated 179 medium-sized and large German firms. No other studies investigated these subjects in other regions.

Putting together Kester et al. (2011) and Kock and Gemünden (2016) findings about the influence of the decision-making quality on portfolio agility, it is plausible to affirm that the later generalizes the concept that a quality decision-making process delivers higher portfolio

agility while the former establishes conditions to that based on personal styles, i.e., power- and opinion-based processes may be more agile, while processes dominated by evidence-based processes may be less agile. In order to enlarge the understanding of this relation, this study developed the proposition six, which states that:

P6: Decision-making quality influences innovation portfolio agility.

The quality of the decision-making process and portfolio agility is a pretty new field of research and the adoption of the DC framework to investigate them are rarest; subject which is explored in the next subchapter.

2.3 DYNAMIC CAPABILITIES FRAMEWORK ON IPPM

For a long period, strategy literature has been dominated by approaches focused on external competitive environment such as Porter's competitive forces (Killen et al., 2008) but these approaches do not fully explain why some organizations are more successful than others (Teece et al., 1997). The Resource-Based View (RBV) focuses on an internal organizational view and how firms can create and sustain competitive advantage. Actually, internal and external approaches are to complement each other (Killen et al., 2008). The RBV assumes that resources are not uniform across firms and uses this heterogeneity to explain the different organizational success rates (Barney, 1991). As a development of the RBV, the DC framework came up to identify and focus on the specific class of organizational capabilities or routines that provide advantages in dynamic environments.

2.3.1 Resource-Based View

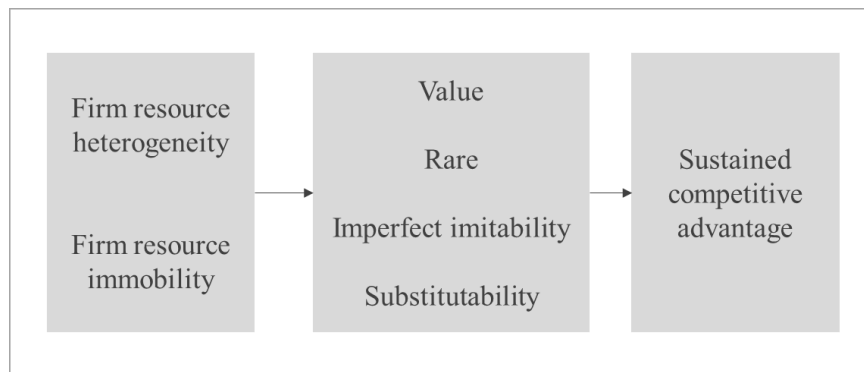
In his seminal paper of 1991, Jay Barney presented the Resource-Based View model that connects firm resources and sustained competitive advantage, as well as he explores the four empirical indicators of the potential of firm resources to generate this sustained competitive advantage: value, rareness, imitability, and substitutability.

Three concepts are central to understand the RBV: firm resources, competitive advantage, and sustained competitive advantage. Firm resources are assets, capabilities, organizational processes, firm attributes, information, knowledge, etc. controlled by a firm that enable the firm to conceive of and implement strategies that improve its efficiency and effectiveness. These resources can be classified into three categories: physical capital resources, human capital resources, and organizational capital resources. Competitive advantage means

that the company has implemented a value creating strategy not simultaneously being implemented by any current or potential competitors. Yet sustainable competitive advantage means that, in addition to implementing a competitive advantage, the other firms are unable to duplicate the benefits of this strategy.

A simplification of the framework presented by Barney's (1991) research is depicted in Figure 3.

Figure 3: Simplification of RBV framework.



Source: Adapted from Barney, 1991, pg. 102.

In order to explain why some firms perform better than their competitors within a specific industry though the implementation of sustained competitive advantage, Barney explains that firm resources are heterogeneous and immobile, concept that goes against some assumptions adopted by other researchers when investigating how external forces influenced specific firm and industry performances.

This framework suggests the kinds of empirical questions that need to be addressed in order to understand whether or not a particular firm resource is a source of sustainable competitive advantage: is that resource valuable, is it rare, is it imperfectly imitable, and are there substitutes for that resource? (Barney, 1991, pg. 115).

RBV served as a basis for the development of the DC framework, which, in turn, can be used to help answering the research question of this study.

2.3.2 Dynamic Capabilities (DC)

Many large organizations have relied on the RBV and built valuable assets, however, there have been demonstrated that this strategy is not enough to sustain competitive advantage because these companies not always properly have made use of these resources.

Winners in the global marketplace have been firms that can demonstrate timely responsiveness and rapid and flexible product innovation, coupled with the management

capability to effectively coordinate and redeploy internal and external competencies (Teece et al., 1997). Teece et al. (1997) refer to this ability to achieve new forms of competitive advantage as dynamic capabilities, which the term “dynamic” means the capacity to renew competencies as a way to achieve congruence with the changing business environment and the term “capabilities” means the key hole of strategic management to adapt, integrate, and reconfiguring internal and external organizational skills, resources, and functional competences to match the requirements of a changing environment.

During the following years, Teece and other authors have developed and updated the DC concept. In 1997, Teece et al. defined DC as “*the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments*”. The definition of DC presented in a 2006 by Teece et al. states that “*Dynamic capabilities refer to the particular (non-imitability) capacity business enterprises possess to shape, reshape, configure, and reconfigure assets so as to respond to changing technologies and markets and escape the zero profit condition*”. This updated definition gets the DC concept closer to market and financial results. Yet in a recent work, Teece et al. (2016) presented a slightly different concept of DC as being “*the firm's capacity to innovate, adapt to change, and create change that is favorable to customers and unfavorable to competitors*”. This new definition brings the innovation element as core to companies to battle the competition.

For analytical purposes, DC can be disaggregated into the capacity (1) to sense and shape opportunities and threats, (2) to seize opportunities, and (3) to maintain competitiveness through enhancing, combining, protecting, and, when necessary, reconfiguring the business enterprise's intangible and tangible assets (Teece, 2007). Dynamic capabilities relate to the enterprise's ability to sense, seize, and adapt in order to generate and exploit internal and external enterprise-specific competences, and to address the enterprise's changing environment (Teece et al., 2016).

This is precisely what the management of project portfolios in dynamic environments is about. Organizational routines such as IPPM practices are a dynamic capability due to the role they play in the organization's ability to dynamically adjust its portfolio of projects and resource allocation for the best innovation outcomes (Killen et al., 2008). In dynamic environments, project portfolio management may be considered as dynamic capability sensitive to the specific environment and proactive in acquiring external knowledge (Killen et al., 2012).

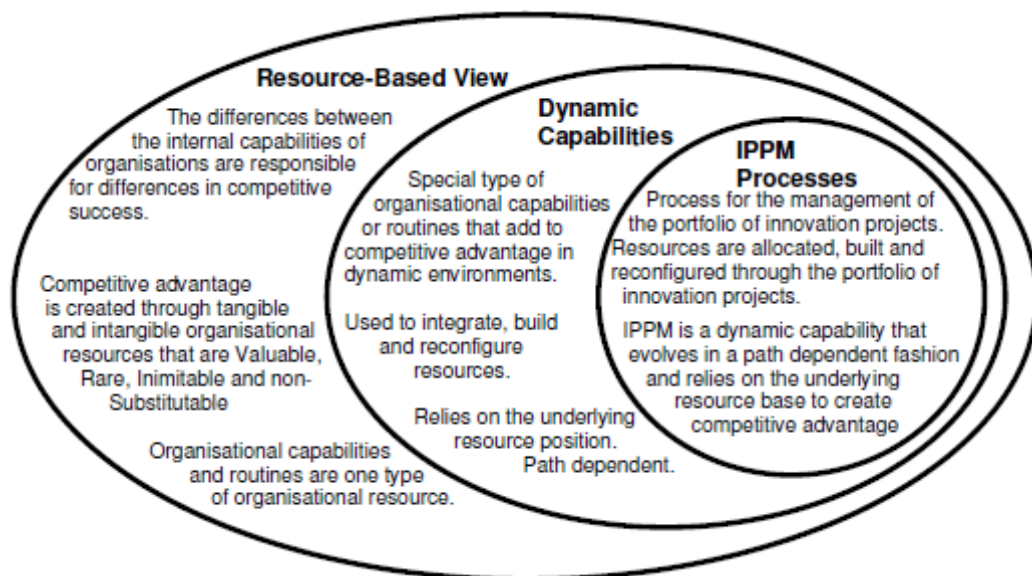
Build upon the theoretical foundations provided by Schumpeter (1934), Penrose (1959), Williamson (1975, 1985), Teece (1988), and Teece et al. (1994), Teece et al. (1997) modelled

the DC framework which can be used to integrate existing conceptual and empirical knowledge, and facilitate prescription.

IPPM research has just begun to apply strategic management theory via the DC concept (Kester et al., 2011); therefore, there have been a few studies on IPPM adopting this DC approach.

Using a RBV perspective, Killen et al. (2008) have identified IPPM practices as a dynamic capability of the organization that enhances competitive advantage through effective management of the portfolio of innovation projects. Their focus on the corporate learning and improvement processes involved in IPPM. Figure 4 shows the relationship between the RBV, Dynamic capabilities, and IPPM processes, in which IPPM practices are a body of organizational processes for the actioning of strategy that can be better understood using the dynamic capabilities approach of the RBV.

Figure 4: Relationship between the RBV, Dynamic capabilities, and IPPM processes.



Source: Killen et al., 2008, pg. 6..

Petit's (2010, 2012) research adapted Teece's framework to structure the micro-foundations of the DC used when managing project portfolios under high levels of uncertainty. His research used data of two in-depth case studies to investigate how uncertainty affects project portfolios managed in dynamic environments. The initial sequence sensing–seizing–transforming/reconfiguring, which is the basic model of DC, was used to collect data and to structure the interviews but was enhanced during data analysis in order to capture the reality that was being observed.

Teece et al. (2016) explores the application of the DC framework to develop organizational agility. Strong dynamic capabilities are necessary for fostering the

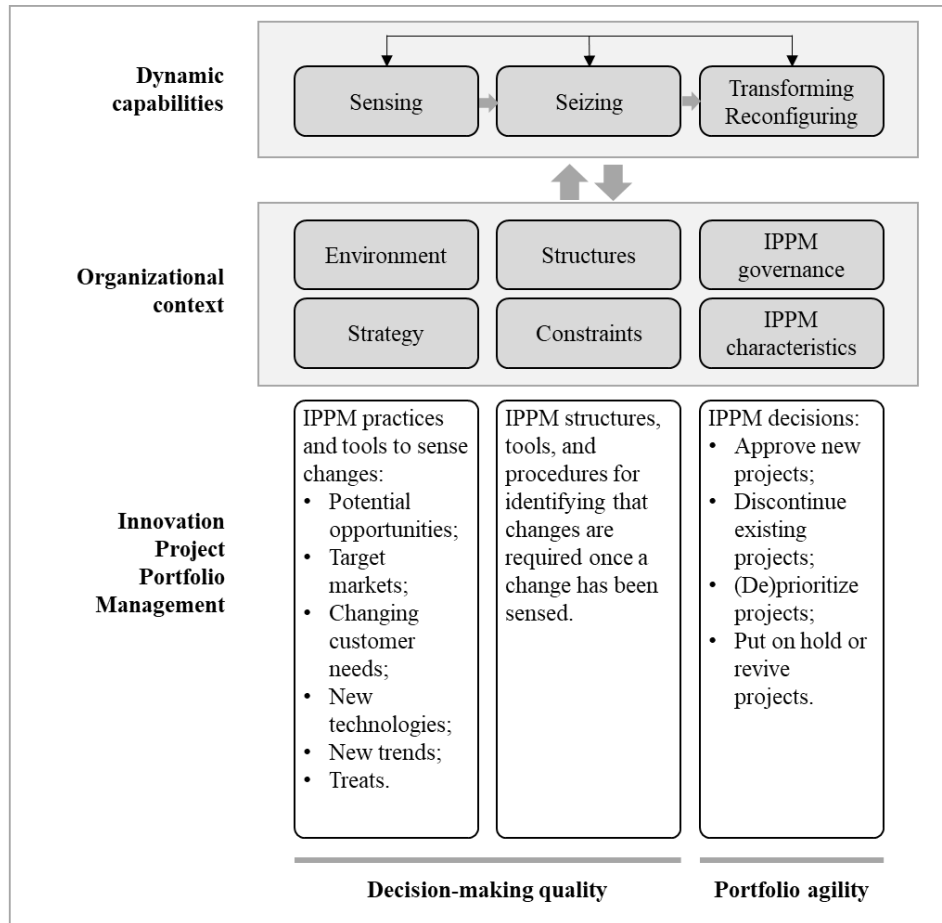
organizational agility necessary to address deep uncertainty, such as that generated by innovation and the associated dynamic competition. Although they mention the application of DC framework on product development environments, their study rely on the strategic management of the firms. According to them, many firms seek to become agile no matter the cost, however, there is a tradeoff between being agile and efficient at the same time because being agile usually requires flexibility, which, in turn, can reduce the operational efficiency. By adopting the DC framework, the authors claim to offer general guidance and some managerial principles with respect to how entrepreneurial managers can improve their effectiveness at managing the agility/efficiency tradeoffs.

2.3.3 Framework capabilities

A framework endeavors to identify classes of relevant variables and their interrelationships. A framework is less rigorous than a model as it is sometimes agnostic about the particular form of the theoretical relationships that may exist (Teece, 2007).

According to Teece (2009), the DC framework is composed by three capabilities: (1) sense and shape opportunities and threats, (2) seize opportunities, and (3) enhance, combine, protect, and reconfiguring business assets when needed. In this research, Teece's framework is adapted to structure the base of the decision-making quality used to manage the innovation portfolio under changing conditions and how it affects portfolio agility, as illustrated in Figure 5.

Figure 5: DC framework to analyze decision-making quality and portfolio agility.



Source: Author; adapted from Petit, 2010, 2012, and Teece, 2007.

In this framework, the decision-making quality is comprised by the sensing and seizing components, which in turn reflects on how quickly the innovation portfolio decisions are made. The decision itself is made in the seizing component, but the sensing component was also considered as part of the quality of the decision-making process because of its importance in providing quality information to the decision component.

2.3.3.1 Main layers of the framework

This research's framework comprises three main layers: (1) Dynamic capabilities, (2) Organizational context, and (3) the Microfoundations of IPPM. Similarly to Petit's work (2010, 2012), the organizational context is analyzed to understand why the project portfolio is put in place and under which organizational constraints it must operate. This layer has the following elements: (1) environment, related to the specifics of each region of actuation; (2) firm and innovation strategies; (3) organizational structure, to understand how portfolio decision-making processes are structured in different regions; (4) resource and financial constraints, (5) governance rules and guidelines to monitor and control the different portfolios, and (6) project portfolio characteristics, such as structure of the portfolio, history and dependencies.

2.3.3.2 Sensing (and shaping) opportunities and threats

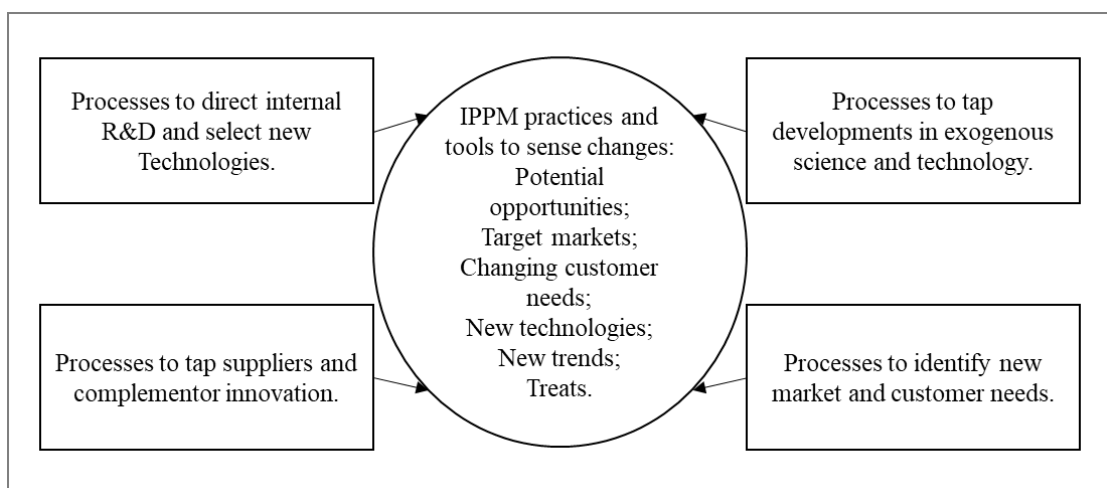
“In fast-paced, globally competitive environments, consumer needs, technological opportunities, and competitor activity are constantly in a state of flux. Sensing (and shaping) new opportunities is very much a scanning, creation, learning, and interpretive activity. There are also constraints on the rules by which competitive forces will play out. These constraints are imposed by regulators, standard-setting bodies, laws, social mores, and business ethics” (Teece, 2007: 1322-1323). Organizations need to create processes to sense these environmental changes and monitor new customer needs and market regulations.

According to Teece (2009), the micro-foundation of sensing might include the following processes: (1) to identify target market segment, changing customer needs; (2) to tap into exogenous technology; (3) to tap innovation; and (4) to direct internal R&D and select new technologies. This is related to informational systems that the company has to develop in order to detect trends, events, market needs and technologies relevant to their survival (Weick, 2001).

As noted in Teece et al. (1997), more decentralized organizations with greater local autonomy are less likely to be blindsided by market and technological developments. Because of the problem of information decay as information moves up (and down) a hierarchy, businesses must devise mechanisms and procedures to keep management informed.

Figure 6 is an adaptation of Teece’s (2007) sense mechanism and it illustrates a framework to assess the sensing practices of firm Alpha. This framework highlights the benefit of having a role to integrate all the new opportunities in order to make connections between them so as creating new solutions to customers. The related questions to assess each element are also indicated in the illustration.

Figure 6: Framework to assess the sensing mechanism of firm Alpha.



Source: Author; adapted from Teece, 2007, pg. 1326.

2.3.3.3 Seizing

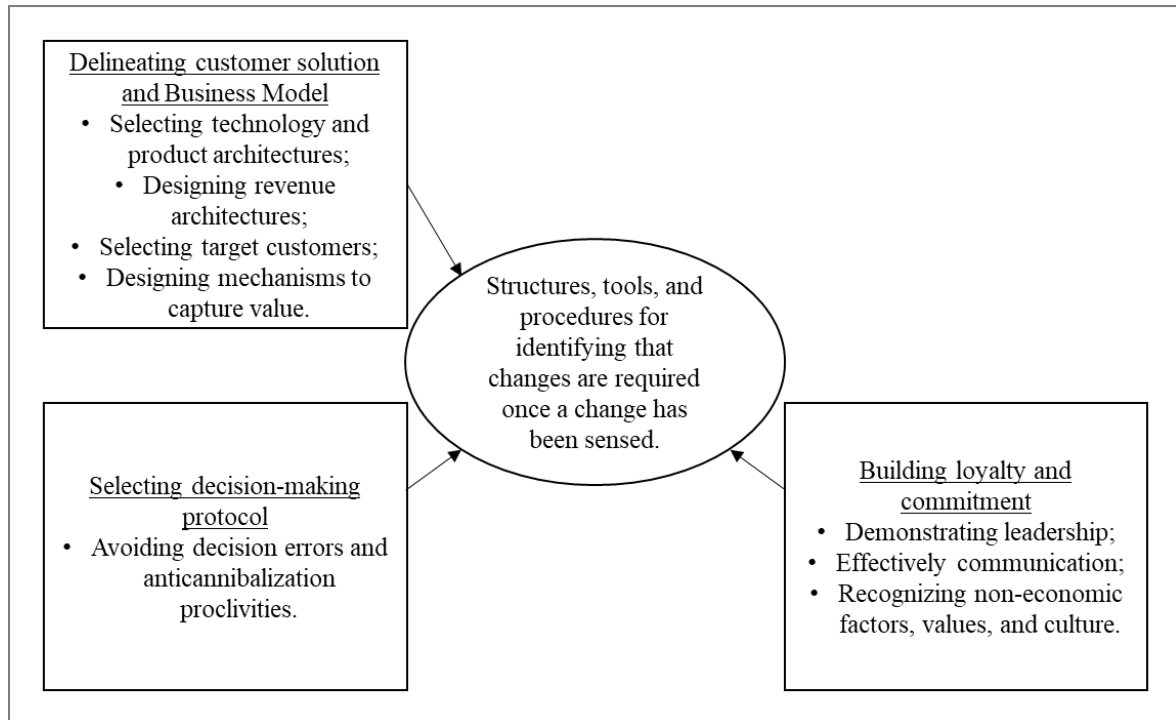
Once a new technological or market opportunity is sensed, it must be addressed through new products, processes, or services (Teece, 2007). Teece (2009) defines seizing as the structures, procedures, designs, and incentives for identifying that changes are required once a new technological or market opportunity is sensed. The management of project portfolios involves a number of decision bodies and decision rules that are normally defined in the project portfolio governance structure of the enterprise and the primary focus in this area is on how organizations seize opportunities and decide what to do in the face of change and uncertainty (Petit, 2010). This research will focus on all the decision-making processes and governance rules in place on the organization that allow portfolio managers to manage and decide on the different projects within the innovation portfolio of projects.

“The capacity to make high-quality, unbiased but interrelated investment decisions in the context of network externalities, innovation, and change is as rare as decision-making errors and biases are ubiquitous” (Teece, 2007: 1326 – 1327). One way to avoid errors and pursue high-quality decision-making is to deploy processes able to provide good and enough information to decision-makers with respect to the opportunity being seized. Well elaborated business models and business cases can empower decision-makers with sufficient ammunition to underpin sound decisions. In a qualitative investigation, Kester et al. (2011) verified that one way to improve effectiveness in decision-making process is through providing data for evidence-based decisions.

Teece (2007) indicates one benefit and one disadvantage of well-established decision-making processes in hierarchically organized enterprises involved in bureaucratic features with structured committees and requiring formal reports and written justifications for investments. While a well-established process can ensure a matching up of expenditures to opportunities, it unquestionably slows decision making and tends to reinforce the status quo. In regarding with how quickly decisions can be many under well-established decision-making processes, Kester et al. (2011) and Kock and Gemünden (2016) argues the opposite. They indicate that high-quality decision processes, which runs under well-managed rules, drive to faster portfolio decisions. So there is a conflict in the literature of decision-making quality influencing portfolio agility.

Figure 7 illustrates the framework adopted to assess the seizing attributes of the decision-making process of firm Alpha, as well as the questions elaborated to investigate during document analysis and interviews.

Figure 7: Framework to assess the seizing mechanism of firm Alpha.

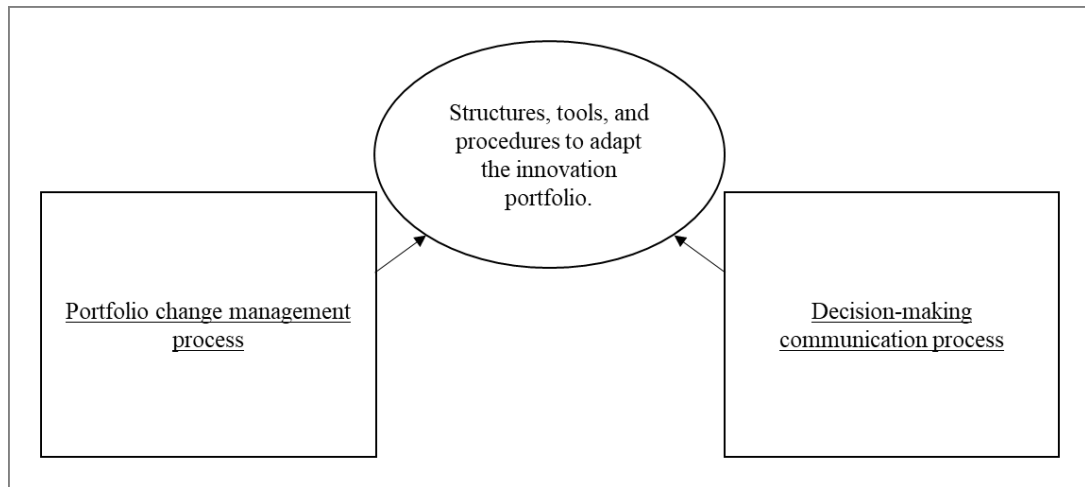


Source: Author; adapted from Teece, 2007, pg. 1334.

2.3.3.4 Transforming and reconfiguring

The third capability is related to managing and changing the routines of the enterprise. In the face of changing environments, the enterprise might have to reconfigure and reassign existing capabilities and potentially develop new ones (Petit, 2010). Teece (2007) focuses the third capability on reconfiguring tangible and intangible organizational assets. In the IPPM context, this is related to project portfolio decisions made to maximize portfolio value, to balance portfolio, and to ensure the strategic fit of the projects with the firms and innovation strategies.

Figure 8: Framework to assess the transforming mechanism of firm Alpha.



Source: Author.

2.4 SET OF PROPOSITIONS

A set of propositions have been elaborated throughout the Theoretical Background section. This aims to help answering the main research question of this study, as well as, to connect the specific goals of this research with the instrument that is presented in a subsequent chapter. Table 1 summarizes these propositions, its connection with the specific goals, and the authors who served as inspiration for their developments. Section 5 elaborates on each one of the propositions.

Table 1: Connection between specific objectives and propositions.

Specific goals	Id	Propositions	References
C	P1	Personal evidence-based style leads to lower portfolio agility when there is lack of information.	Kester et al. (2011).
C	P2	Personal opinion- and power-based styles lead to lower decision-making quality as they shortcut formal processes.	Kester et al. (2011).
B	P3	Decision-makers tend to make faster portfolio decisions under high environmental turbulence.	Teece (2016), Petit (2010, 2012), Kock and Gemünden (2016).
B	P4	Environmental turbulence leads decision-makers to shortcut formal decision-making processes.	Teece (2016)
B	P5	Environmental turbulence leads to lower decision-making quality.	Kester et al. (2011), Teece (2016)
A	P6	Decision-making quality influences innovation portfolio agility.	Kester et al. (2011)/ Kock and Gemünden (2016).

Source: Author.

3 RESEARCH DESIGN

This research design section describes the methodological characteristics of this study in Section 3.1. Section 3.2 describes the firm that was investigated during this in-depth case study. Section 3.3 describes the steps adopted to plan and execute this study, as well as, the elaboration of the instrument to guide the semi-structured interviews. Data collection is described in Section 3.4, where it is possible to understand what data was collected and how, as well as, the list of interviewees, documents, and innovation committees. Section 3.5 describes how the analysis was made.

3.1 METHODOLOGICAL CHARACTERISTICS

This is a positivist research philosophy as it believes in cause and effect of the decision-making process on portfolio agility (Creswell, 2013). The research approach can be classified as descriptive since it is describing the characteristics of a certain phenomenon. This research method is based on a qualitative method, pre-structured in a conceptual framework that evolved according to findings of the research. Qualitative approaches are useful when applying the RBV to new areas of study, such as project or portfolio management, as well as for instrument refinement purposes, because interviews help elucidate concepts by enabling researchers to gather “rich data” and insights on how participants interpret concepts (Killen et al., 2012). Yet according to Gideon (2012), the goal of a qualitative approach is to understand a phenomenon.

Due to the complex nature of portfolio management, this research uses an in-depth case study in a multinational firm. According to Yin (2003), case studies are the best method when context and phenomenon are not clear, when the focus is a contemporary phenomenon within some real-life context, and little is known about the topic. This research project also adopts a deductive approach, in which propositions are tested, confirmed or rejected (Yin, 2003).

Temporary data clipping is cross-sectional for this study, since data was collected in a short period of time. Although the preferred temporary clipping to understand IPPM systems is longitudinal data to understand the long-term effects of different methods and practices in IPPM systems (Spieth and Lerch, 2014) and also to establish the causality between social capital and exploratory innovation (Li et al., 2016). Table 2 summarizes the methodological characteristics of this study.

Table 2: Methodological characteristics of this study.

Characteristic	In this research
Research philosophy	Positivism
Research approach	Descriptive
Research strategy	Qualitative
Method	Case study
Scientific approach	Deductive
Unit of analysis	Innovation department of firm Alpha
Unit of observation	Innovation leaders involved in innovation portfolio decisions
Temporary clipping	Cross-sectional
Data collection techniques	Document analysis, semi structured interviews, and direct observation
Data analysis technique	Data source triangulation

Source: Author.

3.2 THE CASE OF FIRM ALPHA

Dynamic capabilities are especially important to multinational enterprise performance in environments that are: 1) open to international commerce and exposed to opportunities and threats associated with rapid technological change; 2) in that technical change itself is systemic in that multiple inventions must be combined to create products and/or services that address customer needs; 3) where there are well-developed global markets; and 4) that the business environment is characterized by poorly developed markets in which to exchange technological and managerial know-how (Teece, 2007).

Firm Alpha is a multinational petrochemical company that operates through multiple business units in more than 70 countries. In terms of innovation developments, firm Alpha has innovation teams and technological centers in three different regions. In its organizational context, the portfolio of innovation projects is composed by initiatives to create new or modify existing products, to reduce production costs (cost saving initiatives), to increase the production efficiency and safety, to develop new markets and technologies, to increase market share in markets where the company already plays, to develop new competencies, and to address current or future regulatory issues.

The portfolio of innovation projects has around 300 active initiatives with a potential generation of cash (Net Present Value) of 2.3 billion dollars. There are approximately 300 people full-time dedicated to innovation projects in all the three regions. High environmental turbulence is faced by firm Alpha in all regions due to strong competition. Its portfolio of products includes, among others, polyethylene (PE), polypropylene (PP) and polyvinylchloride

(PVC) resins, in addition to basic chemicals input such as ethylene, propylene, butadiene, benzene, toluene, chlorine, soda, and solvents, among others.

Different innovation departments are in place in firm Alpha, which varies from basic science activities, going through process and catalyst technologies, ending up in market close departments, such as product and market developments that have higher interaction with clients.

3.3 PREPARATION OF THE STUDY

In preparation for this research study, a theoretical background was built around the four main poles of this study, which includes: IPPM process, quality of the decision-making process, portfolio agility, and DC framework. The construction of the theoretical background helps on the preparation of this study in many ways. First, it consolidates what has been investigated on the IPPM research field and, as a further step, helps on the identification of the research gap in regarding the quality of the decision-making process and portfolio agility. Second, once the research gap has been identified, the theoretical background supports the definition of the research question and its main goals. Third, it provides ground for the elaboration of the DC framework underpinning this study, which is represented in Figure 5. Finally, the theoretical background supports the elaboration of the propositions and questions used as a guide during the document analyses, semi-structured interviews, and direct observations in innovation committees. The interview instrument (APPENDIX A) elaborated during the preparation phase of this study guide the researcher while conducting the interviews.

3.3.1 Interview instrument (Sensing, Seizing, Transforming / Reconfiguring)

This section describes the interview instrument developed to guide the semi-structured interviews. It counts on nineteen questions in total to evaluate the three dynamic capabilities of firm Alpha, distributed as follows:

- Sensing capability: six questions;
- Seizing capability: eight questions; and
- Transforming / Reconfiguring capability: five questions.

Sections 3.3.1.1, 3.3.1.2, and 3.3.1.3 elaborate on the construction of the questions to evaluate each one of the three dynamic capabilities.

3.3.1.1 Sensing capability

In regarding the Sensing capability, the six questions are distributed in three different groups to assess different aspects of it. Table 3 summarizes the complete set of questions elaborated to assess the Sensing capability and the references supporting each one of them.

Table 3: Summary of questions to assess the Sensing capability.

Code	Grouping	Sensing questions	Reference
SS01	Information sensing	How and from who do you get the information about new opportunities and threats?	Kester et al. (2011); Teece (2007).
SS02		Is the information sensing mechanism, which you are involved in, a formal process or you have to search for information by yourself?	Kester et al. (2011); Teece (2007).
SS03		Is this a satisfactory process or you have suggestions to improve the information sensing mechanism?	-
SS04	Turbulence	What kind of uncertainties do you deal with when making a portfolio decision?	Teece (2007); Kock and Gemünden (2016).
SS05		How frequent do you face changed customer needs, changed strategic goals or any other kind of changed condition?	Teece (2007); Kock and Gemünden (2016).
SS06	Strategy communication	In case of changes in the organizational or business unit strategic goals, are they effectively communicated to portfolio decision-makers?	Teece (2007); Kock and Gemünden (2016).

Source: Author.

Under the label *Information sensing*, the first three questions are highly connected with the sensing mechanism per se. Question SS01 is intended to analyze how and from who do the decision-makers get information about new opportunities and threats. Question SS02 tries to identify if the sensing mechanism described in question SS01 is a formal or informal process; this is useful to evaluate the quality level of the sensing mechanism of firm Alpha. Question SS03 asks interviewees what are their opinions on the process described in question SS01 and if they have any suggestion to improve it. In addition to get their opinion on the sensing mechanism, this question serves also to populate a list with improvement suggestions that was promised to interviewees in order to increase their acceptance in participating on this research.

Questions SS04 and SS05 were clustered under the label *Turbulence* and they were developed to measure the level of turbulence in which the innovation department of firm Alpha is involved in. In this sense, question SS04 asks interviewees about what kind of uncertainties they face while making a portfolio decision. Question SS05 asks interviewees how frequent they face changed conditions, i.e., how frequent they have to adapt the original scope of their developments due to change requests that can come from clients, strategy goals, or any kind of changed conditions.

Question SS06 is intended to analyze if changes in organizational or business unit strategic goals are effectively and properly communicated to decision-makers. This is under the label *Strategy communication* and it is targeted to evaluate if decision-makers have received the information they need to guide their portfolio decisions and put efforts on strategic markets and technologies. This also helps to understand the level of quality of the Sensing and Seizing capabilities of firm Alpha.

3.3.1.2 Seizing capability

In order to analyze the Seizing capability of firm Alpha, the eight questions elaborated to this end are distributed in four different groups and they assess different aspects of this capability. Table 4 summarizes the complete set of questions and the references supporting each one of them.

Table 4: Summary of questions to assess the Seizing capability.

Code	Grouping	Seizing questions	Reference
SZ01	Practices and processes	Is there a formal decision-making process in place to support project portfolio decisions?	Teece (2007).
SZ02		Describe how this formal process, if any, slows down or speeds up a project portfolio decision.	Teece (2007); Kester et al. (2011); Kock and Gemünden (2016).
SZ03		Do you tend to shortcut the formal decision-making process, if any, in face of environmental turbulence or urgent situations?	-
SZ04	Seized information	What are the variables you personally take in consideration when making portfolio decisions?	Teece (2007); Kester et al. (2011).
SZ05		Does the process provide all the information you need to make founded portfolio decisions?	Teece (2007); Kester et al. (2011).
SZ06		Do you tend to postpone a decision in case of lack of information?	Teece (2007); Kester et al. (2011); Kock and Gemünden (2016).
SZ07	(De)centralization	Are the decisions that you are involved in, or that affect you, taken collectively or enforced (top-down)?	-
SZ08	Personal style	How would you describe your personal style in portfolio decisions (evidence-, opinion-, or power-based)?	Kester et al. (2011).

Source: Author.

The first three questions are under the label *Practices and processes* and they explore the formal practices in place in firm Alpha, as well as, the level of obedience of the decision-makers to those practices and processes. Question SZ01 asks interviewees if there is a formal decision-making process in place in firm Alpha to govern the innovation portfolio decisions. Based on document analysis, there is a formal process in place, so this question also measures the level of knowledge of the decision-makers about this process. Question SZ02 collects

decision-makers' opinion if this formal process can slow down or speed up decisions. Their opinions on that is central to the execution of this research in the sense that it can help to understand if a formal process can have any influence on how fast decisions are made. Question SZ03 explores how turbulent and urgent situations can affect the level of process obedience, which in turn can decrease the level of quality of a decision-making process for the benefit of having more agile decisions.

Grouped under the label *Seized information*, questions SZ04, SZ05, and SZ06 explore the variables that decision-makers use to form their decisions, if the formal process provides these variables to them, and what is the effect of the lack of information on portfolio agility.

Question SZ07, under the label *(De)centralization*, asks interviewees if decisions in firm Alpha are made in a collaborative or top-down way.

Question SZ08 is used for multiple purposes in this research. Under the label *Personal style*, this question asks interviewees about their personal style when making a portfolio decision. Their answers are used to investigate propositions P1 and P2, as well as, for other adjacent analysis in this research.

3.3.1.3 Transforming / Reconfiguring capability

Five questions were elaborated to measure how fast firm Alpha adapts its portfolio of innovation developments (transforming/reconfiguring capability) to changing conditions; all of them under the label *Portfolio agility*. Table 5 summarizes this set of questions and the references supporting each question.

Table 5: Summary of questions to assess the transforming capability.

Code	Grouping	Transforming / reconfiguring questions	Reference
TR01	Portfolio agility	How long do you take to adapt your portfolio of projects since sensing a changed customer need or competitive condition?	Teece (2007); Kock and Gemünden (2016).
TR02		How long to you take to adapt your portfolio since sensing a changed resource situations?	Teece (2007); Kock and Gemünden (2016).
TR03		How long do you take to adapt your portfolio since sensing new technologies?	Teece (2007); Kock and Gemünden (2016).
TR04		How long do you take to adapt your portfolio since sensing to changed strategic goals?	Teece (2007); Kock and Gemünden (2016).
TR05		How long do you take to adapt your portfolio of projects since seizing a changed condition?	Teece (2007); Kock and Gemünden (2016).

Source: Author.

The first four questions measures how long does firm Alpha take to initiate a development since an opportunity or threat has been sensed, and the fifth question measures

how long does it take to start, put on hold or discontinue one development after it has been seized, i.e., how long does it take to mobilize or demobilize a project team since the decision has been made during the seizing mechanism. Which one of the first four questions assess different situations or sources of opportunities and threats. Question TR01 asks interviewees about sensed changed customer needs or competitive condition. Question TR02 asks interviewees about changed resource situations, that is, considering that someone left one development for different reasons, how long do they take to replace the resource or how long do they take to discontinue or put on project due to this lack of resource. Question TR03 is target to situations in which new technologies are sensed. For instance, how long does it take to have developments in place since a new technology has been detected as being adopted by a whole industry? Question TR04 measures this time since the organizational strategic goals have changed and that can affect the set of innovation projects due to new organizational directions.

The last question of this group, TR05, is targeted to measure how long firm Alpha takes to mobilize or demobilize a project team since a decision is made during the Seizing mechanism.

All these five questions are difficult to be answered in an objective way because conditions may vary from project to project but answers can point out a direction towards the perceptions of the decision-makers if the company is slow, average, or fast compared to the competition.

The interview instrument consolidating all the questions to analyze the three dynamic capabilities of firm Alpha is available in Appendix A.

3.4 DATA COLLECTION

The unit of analysis is the innovation department of firm Alpha because it is at this level that portfolio decisions are made (Cooper et al., 2001).

Three data collection techniques were adopted by this study:

- Semi-structured interviews;
- Document analysis; and
- Direct observations in innovation committee.

The formal interview instrument described in section 3.3.1 was used to minimize reactivity bias in which this kind of data collection is subject to (Maxwell, 2005). Document analysis provides information about the formal process in place to manage the innovation developments of firm Alpha, as well as, information about the different teams belonging in this

environment. See the full list of documents in Appendix C. Direct observations in innovation committees were adopted to triangulate document and interview data.

Table 6 summarizes the list of documents that were analyzed and Appendix C describes each one of them.

Table 6: List of documents analyzed.

Code	Document name	Scope	Type	Size / pages
D1	Overall Innovation Governance Process V04	Global	PowerPoint	123 slides
D2	PR 2010-00006	Brazil	Word	14 pages
D3	Global Innovation Dashboard	Global	Excel	1 tab
D4	IPAC gate meeting	USA	PowerPoint	5 slides
D5	Virtual Committee Process – rev06	Global	PowerPoint	7 slides
D6	I&T 3rd Quarter Report 2019	Global	PowerPoint	8 slides
D7	2019 I&T KPIs (PA Version)	Global	PowerPoint	6 slides
D8	Financial Worksheet V2.3	Global	Excel	3 tabs
D9	Microsoft Project Online	Global	Informational system	Multiple pages

Source: Author.

As shown in Tables 3, 4, and 5, the interview instrument was created mostly based on Kester et al. (2011), Kock and Gemünden (2016), and Teece (2007) studies, as well as, from the strategic decision-making and IPPM literature.

The sample of interviews consists of twelve innovation leaders involved in innovation portfolio decisions, that is, decision-makers of firm Alpha that can make decisions to start an investigation or an innovation project, to prioritize and deprioritize resource allocation, and to discontinue or put on hold active innovation projects. Eight out of these twelve decision-makers play a global role while four of them play a regional role, that is, there are leaders responsible for portfolios in multiple regions and leaders responsible for portfolios in one single region.

Using multiple informants with different perspectives on the phenomena of interest enhances convergent validity of the measurement instrument (Eid et al., 2008). To reduce potential common bias problems, interviews were made with multiple informants using purposive sampling (Miles and Huberman, 1994). Firm Alpha has innovation departments in Brazil, United States of America, and Germany, and these twelve leaders are located as follow: six in Brazil; four in the USA; and two in Germany. There are other four innovation leaders that are not directly involved in portfolio decisions, therefore, they were not interviewed. Table 7 presents the list of interviewees and complimentary information.

Table 7: Profile of interviewees

Code	Gender	Age	Educational level	Role	Location	Interview duration
IN01	Male	34	PhD	Regional leader	USA	1h00
IN02	Male	41	MSc	Regional leader	Brazil	1h16
IN03	Male	49	MBA	Global leader	Brazil	1h03
IN04	Male	50	PhD	Global leader	USA	0h39
IN05	Male	39	MSc	Regional leader	Brazil	1h11
IN06	Female	44	PhD	Global leader	Germany	1h19
IN07	Male	48	PhD	Regional leader	Germany	0h55
IN08	Male	41	PhD	Global leader	Brazil	0h59
IN09	Male	58	PhD	Global leader	USA	0h50
IN10	Female	45	MBA	Global leader	Brazil	0h49
IN11	Male	53	BE	Global leader	USA	1h33
IN12	Male	52	BE	Global leader	Brazil	1h03

Source: Author.

Interviewing people from multiple departments produce multiple perspectives and reduced informant bias (Maxwell, 2005). Diagnostic reports were promised to the interviewees in order to improve their acceptability to participate in the interviews and increase their interest on this study. All the interviews were virtual through the utilization of the Microsoft Teams software, which allows users to share their screens and record the meeting while speak. Interviews lasted 63 minutes on average.

Firm Alpha holds regular bi-monthly meetings in order to review the portfolio of innovation projects and to evaluate requests to move ideas and projects to next stages throughout the Stage-Gate® process, to discontinue, to put on hold, and to bring projects back into an active state. These meetings are named “Innovation Committees” and each business unit has its own committee chaired by its portfolio manager and the Innovation Management team. The audience of these meeting are composed by business unit stakeholders, gatekeepers, and project teams managing innovation ideas and projects.

Observations are generally less subject to reactivity bias (Maxwell, 2005), thus direct observations in innovation committees help to triangulate the document analysis and interview data, but they were not digitally recorded to avoid reproduction of sensitive information, as well as, to let decision-makers more comfortable to act naturally. I attended seven portfolio meetings in all the three regions of investigation. Table 8 consolidates the information about the observed innovation committees. All the meetings lasted 2h40 on average and around five ideas or projects were presented and evaluate in each meeting.

Table 8: Observed innovation committees

Code	Participation method	Country	Duration	Number of ideas/projects
C1	In-person	Brazil	4h00	4
C2	In-person	Brazil	3h00	5
C3	In-person	Brazil	1h30	3
C4	Virtual	Germany	3h15	10
C5	Virtual	USA	2h	6
C6	Virtual	USA	2h	4
C7	Virtual	Germany	3h	7

Source: Author.

3.5 DATA ANALYSIS

Data analysis started by interviewing those leaders directly involved in portfolio decisions. The information provided by them are later compared with documents and direct observations in innovation committee within each business unit. Differences and similarities in the different businesses units and regions are highlighted in regarding with decision-making processes and tools, business unit and personal styles, portfolio agility effectiveness, organizational culture, and portfolio characteristics.

Document analysis allows to understand differences and similarities between business units in terms of decision-making process maturity and formality, past portfolio decisions, and portfolio characteristics, such as, the type of each innovation (incremental versus disruptive), how long or how many interactions is needed to make portfolio decisions, the type of data required to make decisions and how long does it take to be available for decision-makers, and how strategic each project is.

Direct observations of innovation committees are useful to triangulate information provided by the interviewees and document analysis. These observations can validate if the decision-making processes and tools described in formal documents are really being followed by decision-makers. Another possible validation is related to the business unit and personal styles, double-checking if information provided during interviews match with the reality. A final benefit of participating in innovation committees is to understand and double-check the information required to make decisions, how detailed it is, and if decisions are made based on evidence-, power- or opinion-based.

The next section presents the analysis of the results of the data collection.

4 ANALYSIS OF RESULTS

The purpose of this section is to present and analyze the results of this research. This is structured according to each dynamic capability, that is, the analysis is grouped and sorted by the Sensing, Seizing, and Transforming/Reconfiguring capabilities. The results of interviews, document analyses, and direct observations in innovation committees are mixed within each capability to allow a triangulation between these three different sources of data thus providing an integrated analysis of them.

For the sake of understanding on how and where the dynamic capabilities are inserted in the governance process of firm Alpha, firstly an overview of the innovation management program of that firm is provided before entering in the analysis of the dynamic capabilities itself.

4.1 INNOVATION MANAGEMENT PROGRAM OVERVIEW

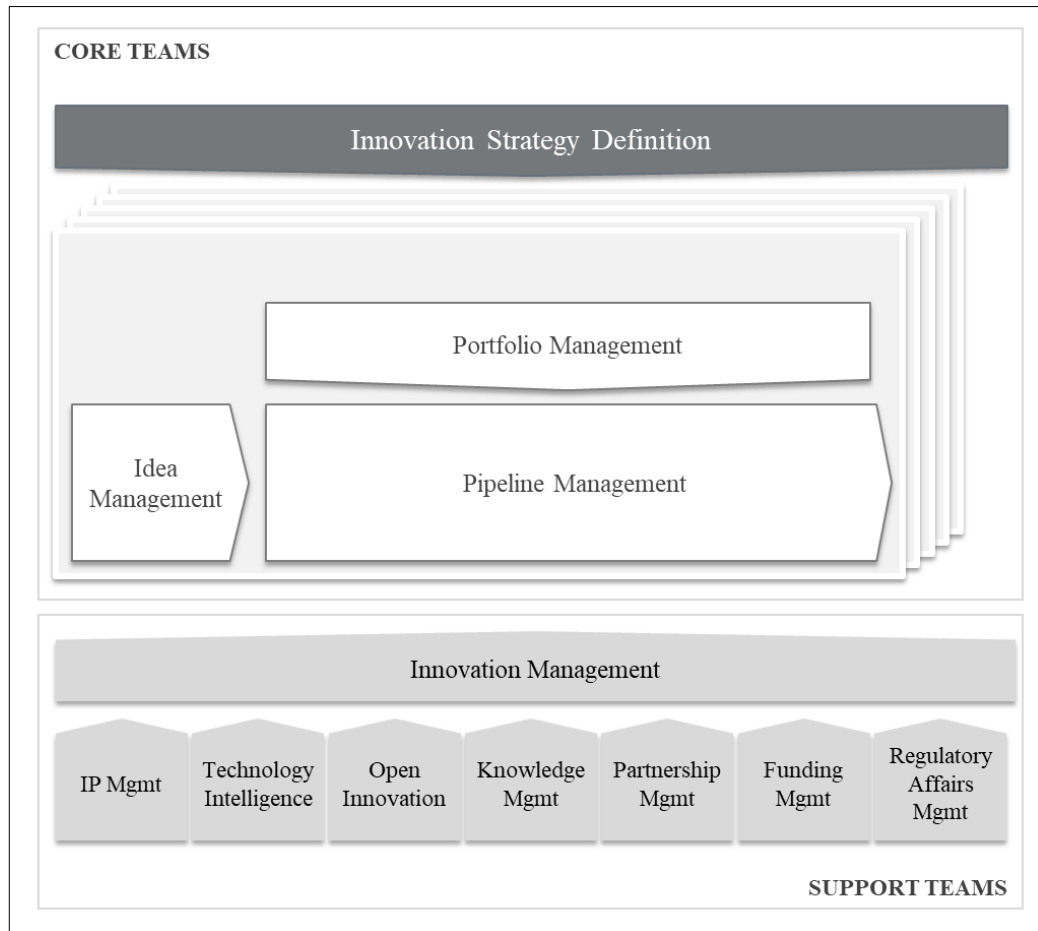
This section put together an overview of the innovation management program of firm Alpha in order to develop a background for the analysis of the results. This has been based on the analysis of the documents, and most of them could be confirmed during interviews and direct observations in innovation committees.

This section starts by presenting the organizational structure of firm Alpha, goes through the Stage-Gate® system, which is the backbone of this program, and finishes by exploring the IPPM tool, which is an informational system that handles all the innovation initiatives.

4.1.1 Organization structure of the innovation teams

This section explains the organizational structure of firm Alpha. The innovation teams are subdivided in two main groups of people, as depicted in Figure 9.

Figure 9: Structure of the innovation teams of firm Alpha.



Source: Firm Alpha document D1, pg. 6.

The core teams are responsible for developing the innovations initiatives itself, while the supporting teams are responsible for assisting the core teams in developing these initiatives (D1). The benefit of this separation of roles and responsibilities is that the core teams can stay focused only on the technical and market activities while the supporting teams provide them with expertise on Intellectual Property (IP), Product Stewardship (PS), Funding, Partnership, and Technology Intelligence subjects among others. For example, the core teams do not need to master in IP or PS because there are Subject Matter Experts (SMEs) that will perform these activities to them throughout the project development lifecycle, i.e., this separation of responsibilities promotes specialization of competencies, which may result in more quality and agile execution of project activities when well synchronized by the project manager.

In this sense, the Innovation Management (IM) team aims to facilitate the integration of both teams by providing tools and processes that allow project teams to request the services of these supporting teams and manage this knowledge in a formal and appropriate way (D02). The tools and documents in this regarding are found within the informational system (D09).

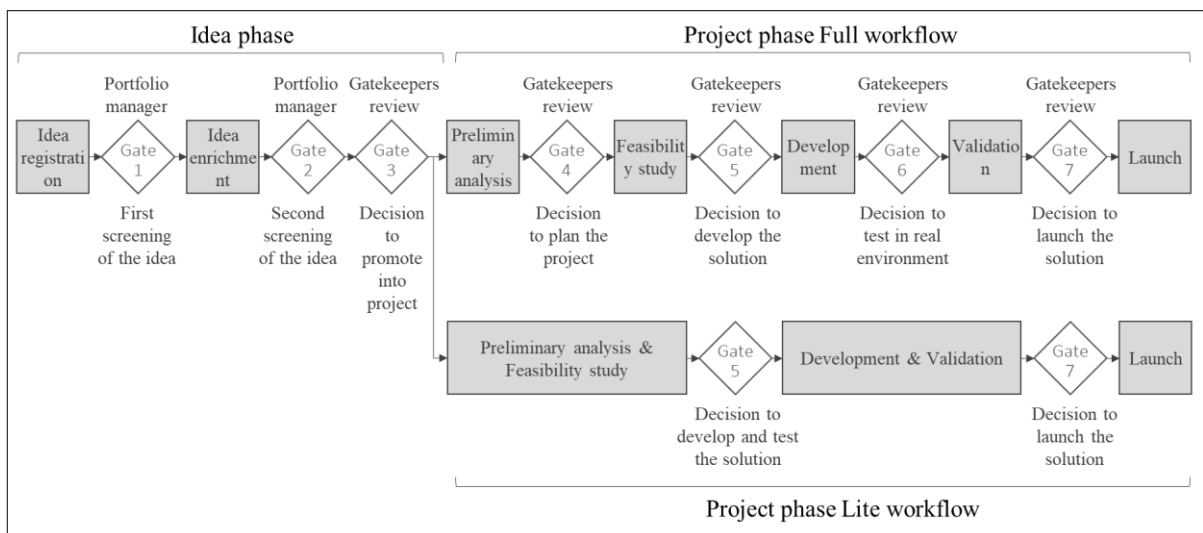
All the innovation initiatives are developed and managed by the teams based on a set of governance rules established in their innovation management program. The main objectives of this innovation program are intended: to foster innovation culture and agile mindset; to establish global innovation practices among different regions of actuation; to ensure the strategic fit of the innovation projects; and to manage the portfolio of innovation projects. Through these objectives, the expected outcomes are: a sustainable flow of product innovations, avoiding isolated spurs of launches; a maximization of profits; a company growth; and an image building of an innovative company (D1).

All the planning, executing and closing activities are distributed over the project lifecycle and all of them are performed by the Core or Supporting teams throughout the *Stage-Gate®* process, which is explained in the next section.

4.1.2 Stage-Gate® process

This section analyses what could be considered the backbone of the innovation management program of firm Alpha, the *Stage-Gate®* process, which was developed to ensure that only the most attractive developments from the market and technical standpoint move on through their development lifecycle. Figure 10 provides a high level view of this process. It is comprised by two main phases, idea and project, and each phase has multiple stages with gates between them (D1; D2).

Figure 10: Stage-Gate® of firm Alpha.



Source: Adapted from firm Alpha document D2, pg. 7-8.

The Stage-Gate® process is an idea-to-launch system created in the 1980s based on an in-depth study of successful entrepreneurs within major corporations as they drove successful

new products to markets and, over the years, this system has evolved and incorporated many practices (Cooper, 2014). At the beginning of the development lifecycle, the new opportunities that have been identified are categorized as an “idea” and the most promising ones are prioritized to be developed and promoted into a “project” category.

When one company decides for implementing a standard process that represents the lifecycle of innovation ideas and projects, these companies usually end up drawing a *Stage-Gate*® process (also referred as a phase-gate process), which is a linear decomposition of the stages that an innovation idea or project undergoes until being launched to the market. In order to make sure that only the most attractive and promising ideas and projects will continue receiving organizational resources, intermediate gates are placed between each stage of the lifecycle so that gatekeepers evaluate the developments and deliberate whether or not it must be discontinued, put on hold, or move on to the next stage of the process.

Firm Alpha developed a *Stage-Gate*® process based on the Cooper researches and there are two types of possible workflows that one project may follow: the “Full” workflow, which contains five stages within the project phase; and the “Lite” workflow, which contains three stages within the project phase, as represented in Figure 9.

The decision for one development going through workflow “Full” or “Lite” depends on how complex, risky, and strategic one development is. High complex, risky and strategic projects go through the “Full” workflow as they may require a higher level of monitoring from stakeholders and decision-makers. This portfolio of projects are usually composed by basic science and strategic projects. On the other hand, in case of simple developments, these projects go through the “Lite” workflow as they do not need higher coordinating and monitoring levels; in these cases, the number of gates between the stages are reduced so the projects can perform more activities without having to request approval to each of them.

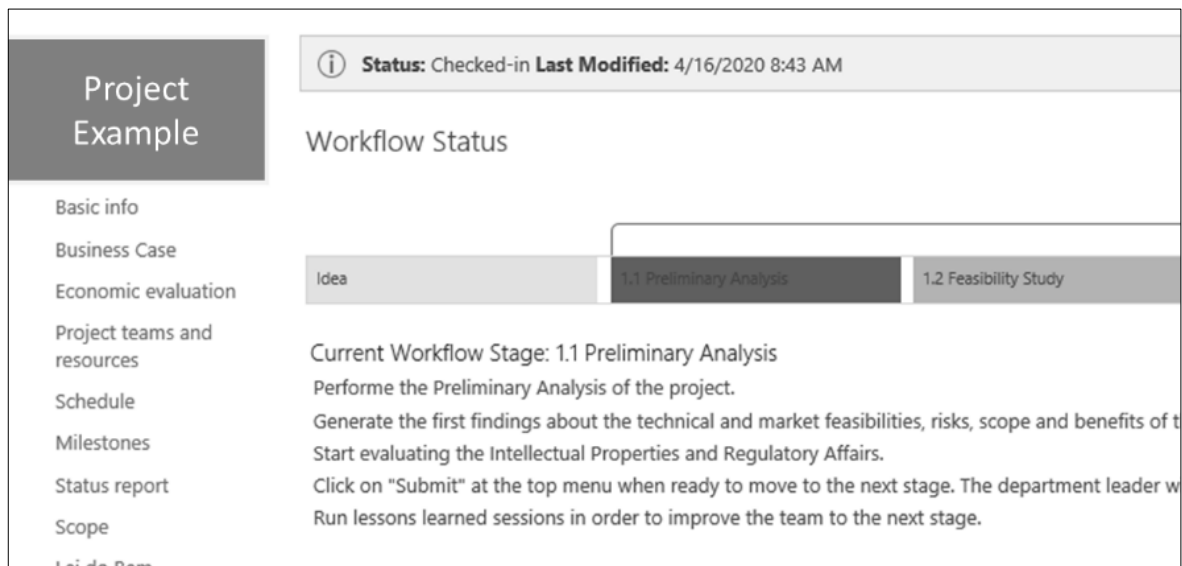
This *Stage-Gate*® process was configured in the Informational System that contains all the innovation initiatives and a set of governance processes.

4.1.3 Informational System (also known as IPPM tool)

Firm Alpha implemented an informational system in order to consolidate all the innovation initiatives in a single database and implement a set of automated governance rules (D09). According to the document analysis (D02), any new idea gets registered in this informational system in order to enable portfolio managers to perform an initial analysis of the opportunity or threat that has been identified. If the new idea fits with the innovation strategy,

a portfolio manager approves it for a further enrichment of information and project teams can start gathering these information in this system and make use of their project management features, such as, project scheduling, risk management, and financial benefits calculation (D08). All the phases, stages, gates, and mandatory information have been configured within this system. Figure 11 shows a project home screen of the informational system, where the stages of the Stage-Gate® process are visible, as well as, the project management features at the left menu.

Figure 11: Project home screen of the IPPM system of firm Alpha.



Source: Screenshot of the IPPM tool of firm Alpha D9.

After providing an overview of the main characteristics of the innovation management program of firm Alpha, the next sections explore the dynamic capabilities of it.

4.2 SENSING

This section analyzes the results of the interviews, document analyses and direct observations in innovation committees in regarding the Sensing capability of firm Alpha. For structuring purposes, this section is divided in three subjects: information sensing, turbulence, and strategy communication.

4.2.1 Information sensing

This section analyzes the flow of information and level of formalization in regarding the processes to identify new threats and opportunities. According to interviewees, the flow of information (SS01) is pretty much an organic and people-based interaction activity. For those more incremental developments, Market Development and Technical Service teams, so-called

front-end teams, are in constant interaction with clients in order to identify their new product and application needs, as declared by IN01, IN02, IN03, IN05, and IN07.

Voice of Customer; we have relationship with clients and they bring their needs to us. New ideas come organically and we try to make a connection with the business. Business Development team brings needs from the market. The commercial team provides most of the data about new volumes (IN01).

New ideas in mostly cases come from demands sensed by the front-end teams, especially for Product Development department requests (IN02).

The daily needs come mainly from the business departments via relationships (of the innovation teams) with them and meetings where we have market needs brought up by our business department (IN03).

I believe as the firm is very close to the market, we have a lot of information from our clients about opportunities and threats (IN05).

Nowadays, if you are thinking in development of projects, they come usually from the market. When I say market, they come mainly from the Technical Service (team) and from sales (people) because they are close to clients and usually they can bring these opportunities in an assertive way (IN07).

Production process improvement needs brought up from an interaction between Product Development and Process Technology team members with the industrial teams.

There is also demands from industrial and operational mainly in aspects of production optimization, to increase the production volume or to save production costs (IN03).

Front-end and R&D teams monitor the competition as a way to identify threats and opportunities, as mentioned by IN07.

Another way to capture (opportunities) are usually from releases; you look at Internet advertisings, from competitors (IN07).

Ideas for sustainable products are usually identified by social claims and regulatory issues are raised by the Regulatory or Product Stewardship teams.

Sustainability and Circular Economy identifies needs from social claims. Volumes come from feedback from the clients and from current sales, depending on the project type or situation (IN01).

The impact comes from the media, from the Regulatory (team) about legislation, and also from consortiums where I have contact with other companies that also have the same problem (IN06).

Yet according to IN01, homologation of secondary sources of raw material and additive package suppliers are usually requested by the Supply team members.

Procurement team requests for projects in order to develop or homologate new suppliers when needed (IN01).

In addition, for those departments that work with more disruptive innovation, the identification of opportunities and threats is done through reading specialized literature, participating in conferences, and interaction with external entities. Half of the interviewees mentioned that their sources of more disruptive innovation come from conferences, reading specialized literature, news in LinkedIn, structured ideation sessions, vendors, patents, and interaction with external entities. These five answers summarize these external sources of ideas.

There are sources such as participating in congresses, reading magazines, and from workshops (IN05).

I use more opportunities from external sources reading papers, news, the impact of changes in the economy and in the politics, I have used a lot sources from McKinsey

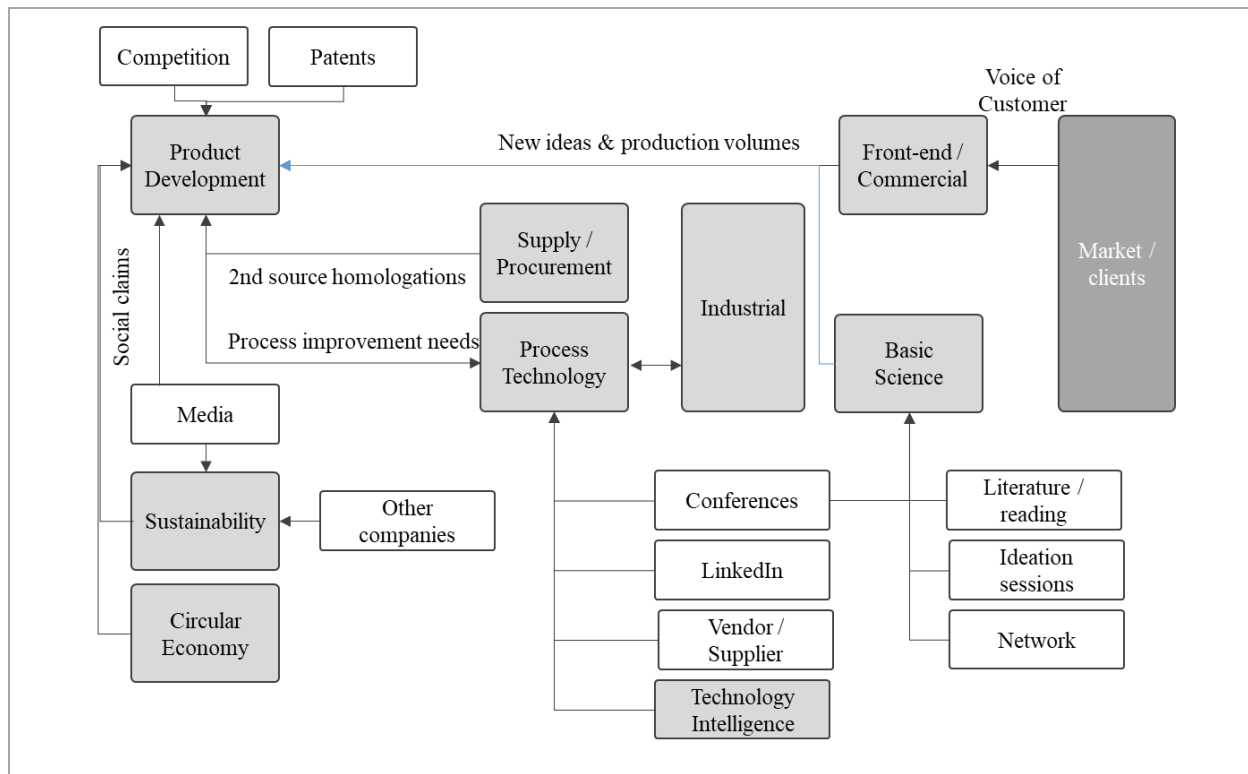
because it looks to me they compile several opportunities and they deliver a structured analysis and help to interpret what each opportunity and threat carries (IN08). Opportunities and threats are typically gather through external sources more than internal. They are from financial and market data, they are from scientific literature and patents, and they are from external resources in my network (IN09). A rich source are the contacts we have with institutions, academy, and universities. (IN10). I get information through technical exchange meetings with internal and external, vendor or supplier relationships, LinkedIn, peer-to-peer, and conferences (IN11).

The document analysis does not clearly specify how all these activities take place although the document D1 cite the different approaches and techniques to identify new opportunities. What could be found in an explicit way are two practices: (1) the Technology Intelligence team provides information about new market, technology and material trends, as well as, information about the competition and most recent patents; and (2) the Innovation Management team provides support to R&D departments through planning and executing ideation sessions. The Technology Intelligence supporting team was mentioned by the interview IN12 while structured ideation sessions by the IN04 and IN10:

We have our Technology Intelligence team which are looking for opportunities (IN12). Opportunities and threats comes I would say maybe from three different sources: conferences, literature/reading, and ideation sessions (IN04). One source of idea are the ideation sessions of the company (IN10).

Figure 12 puts together the high level sensing mechanism of firm Alpha, which clearly reinforce the interaction with clients and between departments.

Figure 12: Sensing mechanism of firm Alpha.



Source: Author.

In Figure 11, the light grey boxes represent the internal departments of firm Alpha and the dark grey their clients.

It was not possible to evaluate the sensing mechanism in the direct observations in innovation committees since these meetings are not intended to raise new ideas but to evaluate them. However, it was possible to notice eventual new ideas coming up during these meetings as a result of deliberations on existing ideas or projects being presented to the gatekeepers during those meetings, representing another sensing mechanism but also in an informal and unstructured way.

In summary, the sensing mechanism of firm Alpha is an organic process extremely based on people interaction at first, then registered in the IPPM tool in a second moment to present it to gatekeepers, which deliberate and decide whether it worth being developed or not (SS02). I.e., this is an informal process, as reinforced by interviewees, but they recognize the importance of having a more formal process, as cited by six interviewees.

The sensing mechanism is informal in a firsthand then we register the opportunities and threats in the IPPM system. I think we always have chance to improve the process but I think it is satisfactory. Maybe the registering of the opportunities could happen early (IN05).

The process is not yet formal but we are working on the process internally (IN06).

This (sensing) process is very informal (IN08).

You have the beginning of formal processes; you do not have a formal process. Our systems are forming but our processes and use of those processes isn't as robust as others (IN09).

Yes, it is informal but the technical exchange meetings are formal (IN11).

We need a more formal process; not a bureaucratic one but something formal that is very quick and agile (IN12).

IN03 mentioned that there were some structured investigation in the past with the purpose of identifying opportunities but this was not happening in a regular or recurring base. According to this interviewee, these spot initiatives brought good results and that it could be done again.

A structure endeavor to identify portfolio gaps happened in some moments in the past but it was somewhat sporadic (IN02).

Some suggestions on what could be improved in the sensing mechanism (SS03) were pointed out by interviewees. A prioritization process for the incoming ideas was pointed out as another suggestion to improve the Sensing process; actually, this is between the Sensing and Seizing capabilities. The interview IN02 suggests to establish clear rules to determine what ideas should be enriched first.

My concern is related to the first screening prioritization process to move one new idea to enrichment stage: Is the decision to move one idea ahead based in a FIFO (First In, First Out) rational or based on a more strategic portfolio analysis? (IN02)

Interviewees IN04 and IN07 suggested that the IPPM tool could be rolled out to the whole company and not restricted to innovation team members.

Having a mechanism to gather and focus the information or intelligence for the whole company would be helpful (IN04).

I think there is a gap because we could capture and register ideas in a faster and efficient way. It would be great if everybody could register ideas in a system (IN07).

Interviewees IN05, IN10, and IN11 mentioned that structured ideation sessions could be made in a more regular base.

The segment meetings with the commercial team are very rich but focused in the short term. These more out of the box ideas I see mega events but maybe we should have smaller but frequent events (IN05).

We realized the actions that most brought results to generate ideas were the structured ideation sessions. The best practice of these sessions were the ample space of time to generate ideas and not only one-day session (IN10).

One of the things I think about is these lunch and learning where the vendors come out, we bring some barbecue and sandwiches, and then we sit around for the next hour listening to a vendor's latest technology offerings (IN11).

Interviewee IN12 mentioned their strategic partnership with external entities and suggested to having a group of people focused on the interaction with these organization to make better use of them.

I don't think we do enough of having some strategic partnership that we really make good use of; MIT for instance is one of those environments. We have to have people who have the time to immerse themselves in these environments; I think we don't make a good use of those things because we don't have a group of people with this as they primary role (IN12).

Environmental turbulence is a circumstance that can shake with the flow of information because this is felt by and influence the people working on to sense new information. This subject and its effect is analyzed in the next section.

4.2.2 Turbulence

Environmental turbulence can be generated by many sources and influence the Sensing mechanism of any firm. This section identifies what types of turbulence and uncertainty that firm Alpha is susceptible for and its effect on the Sensing mechanism. The document analysis and the direct observation in innovation committees found no evidence about what types of turbulence and uncertainty that firm Alpha deals with nor the mechanisms they may have to handle this kind of scenario, indicating that this is a people-based activity. Therefore, this analysis rely on the findings of the semi structured interviews whose instrument counts on two questions in that sense.

When asked about what type of turbulence or uncertainty (SS04) the interviewees face when evaluating new opportunities and threats, or when (de)prioritizing active developments, they cited some typical concerns of innovation developments, such as, technical and market uncertainties and trends. Other uncertainties not-so-exclusive of innovation initiatives have also been mentioned, such as, difficulty to find the strategic fit of the new ideas and if there is available resources to treat them.

Three of the interviewees mentioned technical aspects as source of uncertainty while making portfolio decisions.

There is uncertainties if the idea is feasible (IN05).

It is related to how feasible an idea is (IN07).

There is always the uncertainty of technology itself (IN12).

In addition, IN03 mentioned that it is difficult to identify what will be the penalties when introducing a new product to the market. There may have some production cost increasing and some penalties to the production run rate that are not easy to evaluate beforehand. This is somehow connected to technical uncertainties as well.

Sometimes we identify a good idea but we don't see all the penalties it can bring to the company. For instance, penalties to the Procurement team and on the production run rate (IN03).

Market uncertainties were cited by two interviewees.

First one is market uncertainty; what is happening to the market over time. We can have a point of view about what the market would be in five years from now but there is uncertainties built into that (IN04).

Market opportunity (IN07).

Somehow connected to market uncertainties, a clear vision for long term developments and megatrends are two additional types of market aspects that bring turbulence and uncertainty to portfolio decisions.

I think the other place where there is a lot of uncertainty are these things we call megatrends (IN12).

When you develop something disruptive, this is very difficult to be valued, this is one of my main difficulties to understand to make a portfolio decision (IN10).

This uncertainty is increasingly critical in case of projects that require huge investments, because of the financial impact of a wrong decision.

The biggest problem we have in the company is that the new ideas about sustainability are of long term like 2050 and we are in 2020. Another characteristic is that sustainability ideas require high investments. Thus, this is my biggest problem: long term and high investments (IN06).

According to three interviewees, it is hard to find the connection of some new ideas with the organizational strategy. IN04 mentioned uncertainties about what to do when the competition launches a new products. IN10 has difficulties in connecting strategic aspects with financial benefits.

Competitive uncertainties; what is our competition doing and what should I do to counter that (IN04).

I think the main difficulty is to understand how that (ideas) connects with our business. Another thing is to understand what the main pain points are for the company. To me, the perfect portfolio of projects is that one that matches newness, technology, and problems (IN08).

It is hard to find those initiatives connected with the business strategy when you focus on NPV (IN10).

Interviewee IN02 highlights the divergence of opinions between different portfolio managers in a way that sometimes it is hard to end up with consensus.

Each project was connected to one market segment, and we could have segment leaders with different point-of-views. Therefore, we could have divergence of opinions, bringing uncertainty to the projects (IN02).

The uncertainty about availability of resource and funding to innovate was mentioned by IN05 and IN09; their concern is regarding to start an investigation and find out later on the development that the company will not approve eventual required investment:

There is uncertainties if there will be resources to investigate an idea, if this will not conflict with existing developments (IN05).

Uncertainty is more about funding and resource capability of the corporation (IN09).

Finally, IN11 mentioned that the formal process ask for a business plan to decide on an idea, but he argues that if it is possible to build a business plan, it may mean that it is too late to go to the market.

We want to have a NPV and we want to have a business plan but sometimes if you can create a business plan it is probably too late because someone is already in the market space (IN11).

In terms of frequency of changes throughout the development lifecycle of an innovation initiative (SS05), the answers were diverse, ranging from low changed situations to high frequent change requests. For those teams that develop more incremental innovations, such as the Product Development department, they mention a high frequency of change, mainly caused by changed customer needs.

This is 20% to 30% of our projects face changed customer need. What does happen is that the technical approach needed to address the need will change (IN01).

We are very impacted by changed customer needs (IN03).

We face a lot of changes mainly when the idea is at early stages of investigation; this is normal (IN05).

Yes, we do face changes due to two conditions: when the dialog with the client begins by the buyer and they have not talked with the technical team; and second, there happens that the own technical team does not want to change. This is (the changes) less than 50% for incremental innovations and more than 50% for more innovative projects, because they have more ambiguity and uncertainty (IN07).

The business does not know what their needs to the future. In addition, they change their mind with the changing market condition. My team needs the ability to have some consistency and move forward and make achievements in the projects as they are designed (IN09).

Basic science, Sustainability and Process Technology departments indicated a low level of scope changes during the development. This may happen because they are freer to innovate and they are not so close to clients.

I would say few. In general (the scope) does not change that often (IN08).

The scope changes but from a big picture point-of-view I don't think the scope changes that much. Frequently, customers may ask for something different at different stages of the process, but if you really dig deep, they are not changing their demands (IN04).

Usually, I would say that it is not changes in scope. It is not drastic. For most of the cases we change the scope, we end up reducing the scope to keep the project alive but not changing it. I think in our department it is not that frequent (IN10).

Not enough that it stress me out (IN11).

Since the company is very client-oriented, these clients can generate uncertainties and turbulence as we change our priorities based on what they ask us. We need to address

their concerns and provide the service they need, but making the right decisions for the long term strategy of the company (IN12).
 Since sustainable developments count on large scope, the developments do not face frequent changes (IN06).

Interviewees IN02 and IN04 complements that, in some cases, these scope changes happen not only by external requests but due to internal inability to clearly identify the project requirements in order to state the scope in an effective way.

Changes are more common than we would like, even trying to mitigate it. Eventually, it can be generated due to a lack of ability to identify the requirements the clients need. (IN02).

A lot of times the customer come and say they want some specific property [hidden due to sensitive data] and our approach frequently is to make a great product with that property but we never ask the client why. In most instances we are not understanding the problem we are trying to address (IN04).

External sources of uncertainties could be tricky to avoid but this report highlights the importance of a mature project management skill related to scope definition at the very beginning of any project in order to reduce the amount of avoidable uncertainties generated by internal sources.

4.2.3 Strategy communication

Since the communication of the business strategy can be seen as a guide to drive sensing mechanisms, I've asked interviewees if eventual changes in the business strategy are properly communicated (SS06) to them in a way that they can take appropriate actions to adapt their portfolios to those changes. For seven of them, the communication of these changes is deficient in speed and coverage, i.e., it could be communicated faster and reach other levels of the organization.

I would say it (the communication) is not. So I don't see that. Maybe at higher levels it is communicated, but I don't it even the business unit strategies (IN04).

I think (the communication of strategic changes) must have to be better managed.

I think that Human Resource team tries to do their best. It could be better than it has been done. Some changes are fast but the changes of internal systems are taking longer (IN06).

The communication has a deficiency. There is a timeframe to reorganize the business and only after this reorganization you start to validate the projects. The reorganization lasts from six to eight months. There is a huge delay on this (IN07).

The strategy breakdown I don't know that much (IN08).

No, I would say that the business unit goals are not communicated very well because they don't view R&D anything than a service provider (IN09).

In my opinion it (the communication of strategic changes) does not work properly. I usually say that our inability in managing the knowledge in organizational changes brings recurring back and forth, mainly because we are not good in discontinuing developments (IN10).

No, we did a below average job in this last movement in communication. I think it is not only poor communication in delivering, but I also found a lot of evidence of poor listening skills (IN11).

On the other hand, IN01, IN02, IN03, and IN12 think the organizational changes are satisfactory.

Big changes do not happen that often and they have been communicated. My ongoing and steady communication is enough to keep me informed about any change. Changed strategic goals does not happen that often (IN01).

The strategy was very clear so I had no troubles in connecting the projects with the strategy. Nowadays the business is reviewing the strategy (IN02).

I think the communication reaches who needs to be informed (IN03).

I think that changes in strategy are typically communicated reasonably well. The problems is that we change the strategy too often (IN12).

Interviewee IN05 mentioned that although there is frequent changes, it is a Project Manager's responsibility to look over these changes and work proactively to understand its effect on their project scope.

There are frequent organizational and strategic changes. I think it is also a project leader's responsibility to bring the projects for discussion to make sure they have strategic fit once project leaders notice a change in the organization (IN05).

Although seven of the twelve interviewees mentioned that the strategy is not well communicated, the document analysis found processual practices specifying the strategy of each business unit. It was clear to find the connection between the businesses strategies and the actual portfolio of projects, indicating that there is a process in place to establish the strategies and that the outcomes of this process are translated in innovation developments. The strategy is sometimes mentioned during innovation committees but this is not a standard practice to revisit or go through it during these meetings.

Sensing is the first capability a firm must hold in order to identify new opportunities and threats. These new information needs to be evaluated through the use of seizing capabilities, which is subject of the next section.

4.3 SEIZING

This section analyses the results of the interviews, document analysis, and direct observations in innovation committees in regarding the Seizing capability of firm Alpha. For structuring purposes, this section is divided in four groups of questions based on the interview instrument: Practices and process, Seized information, (De)centralization, and Personal style, counting up eight questions in total.

4.3.1 Practices and processes

This section analyses the formal processes in place in firm Alpha to govern the innovation developments. Transparency, stability, comprehensiveness, and rigorous are adjectives of a quality decision-making process, as cited in the Theoretical background section. By analyzing the documents of firm Alpha, there were found multiple formal processes to govern its innovation portfolio which emphasize the characteristics of a quality decision-making process.

The Stage-Gate® process, highlighted in section 4.1.2, seems to be the backbone of the innovation program of firm Alpha to manage any individual innovation initiative, going from an idea stage until its completion or launching to the market (D1). As already mentioned, multiple gates are placed between each stage of development of an initiative with the purpose of ensuring that only the most attractive initiatives move forward on its development, as well as, to increase the level of monitoring by the internal stakeholders. Any change in the status of an innovation initiative must be approved by gatekeepers, such as, to discontinue a development, to put on hold, to move ahead throughout the Stage-Gate® process, or to bringing an initiative back into an active state (D02).

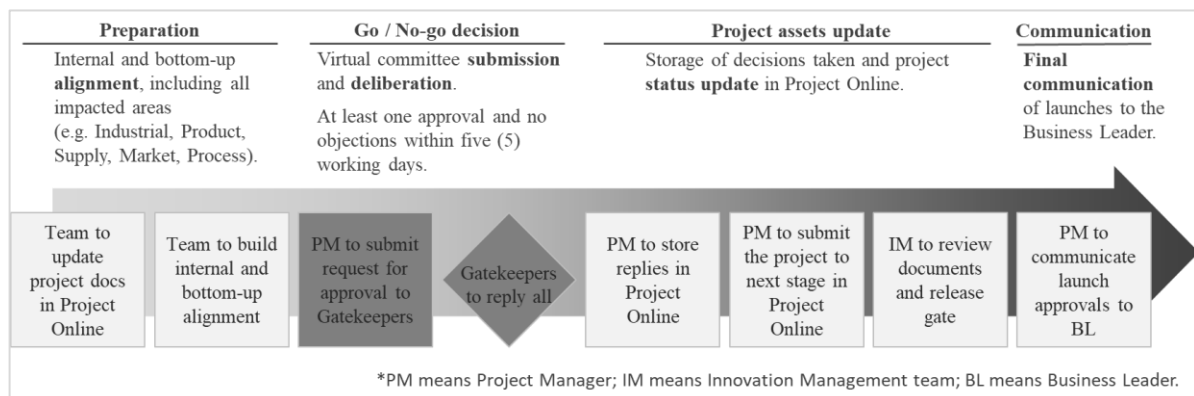
There are two way that project teams can follow to request gatekeeper’s approval to change the status of a development or to move it to the next stage; these paths are the “In-person” and the “Virtual” committees (D05).

In-person committees occur every two to three months in each region and business unit. In this In-person committees, a set of ideas and projects are presented to gatekeepers and stakeholders, and the requests are then deliberated, approved or rejected during the meeting followed by eventual recommendations to project teams.

Since these In-person committees occur only every two to three months, firm Alpha established the so-called Virtual committees as an alternative way in which project teams can request changes in their initiatives. By doing that, portfolio decisions are accelerated because they do not need to wait until the next In-person committee to take place to make their requests.

These Virtual committees are standard e-mails that the responsible for one idea or project can send to specific gatekeepers, making the desired request to change the development status or to move it to the next stage of the workflow. Figure 13 illustrates the Virtual committee process established in firm Alpha.

Figure 13: Virtual committee process

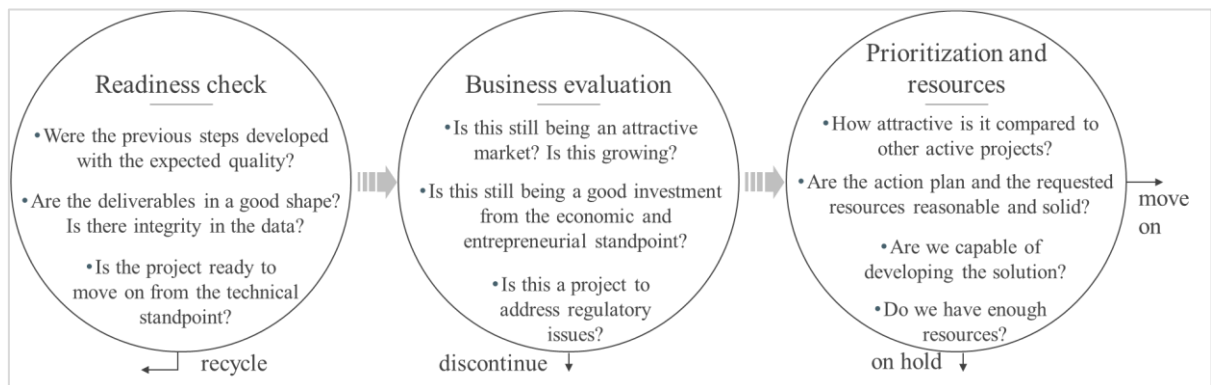


Source: Firm Alpha document D5, pg. 2.

The approval request process starts from a bottom-up alignment between the project team and most involved stakeholders about the request that the team wants to propose. After requesting the approval to update the project state, decision-makers deliberate between them and vote via e-mail for their final decision. The project team stores the decisions in the IPPM tool for audit and knowledge management purposes then the innovation management team reviews the mandatory documents and updates the IPPM tool according to the final decision.

In order to assist decision-makers on the aspects that they must consider during a gate approval request, the governance process of firm Alpha provides a best practice based on the “Decision diamond” technique proposed by Cooper (2011), which consists of a three-step process evaluation. Firstly, gatekeepers may evaluate how ready the idea or project is at a specific gate, taking in consideration that each gate has its own mandatory deliverables; secondly, gatekeepers may evaluate if the business or target market of the idea or project is still promising; and thirdly, gatekeepers may evaluate if the company has the required resources to still developing the solution or if they should allocate their resources in other more promising developments (D6). Figure 14 illustrates this best practice.

Figure 14: Best practice to evaluate gate requests.



Source: Firm Alpha document D5, pg. 7.

After analyzing the documents that describe the formal governance process of firm Alpha for innovation portfolio management, interviewees were asked if they were aware of any formal decision-making process. This question (SZ01) helps to confirm if the aforementioned process is known and in use by decision-makers, therefore, serving as one parameter to determine the quality of the decision-making process of firm Alpha. Most of the interviewees agreed that there is a formal process in place, providing examples and evidences that this process is followed by them.

There is a decision-making process to approve projects, industrial trials, sampling etc; innovation committee to approve new ideas. The Innovation Program as a whole, dashboards, etc (IN01).

Yes, we do have a process to make decisions, as an example, our flow of approvals for the Stage-Gate® (IN02).

Yes, some people can think that we don't have but we've built this process over time (IN03).

I would say the most formal process is the launching of projects; I think this is very formal and we demand approvals from the adequate level. Before this stage, I believe that it depends a little on each department (IN05).

Yes, it exists. We are using RAPID (decision-making framework) (IN06).

There exists. It is transparent. The projects are there for those who want to look at and discuss them, mainly for the project team (IN07).

Yes, I think the manager does a good job. The structure is in place to do it and what we need is to make it more robust and to use it (IN09).

There exist a decision-making process that is mostly known by the leadership level but at the engineering level. I think the company has robust process, I just think the company has to be more incisive on it (IN10).

The more I learn about it the more I think we have a good practice. (IN11).

Some of our department have had better formal processes than others. I think in our intention to adopt the RAPID (decision-making framework) process, each business can decided who the people are making their decisions, but the process will be the same, I think this is going to be quite good for us (IN12).

Only two interviewees (IN04 and IN08) did not recognize or had this process in mind while answering this question.

No, I don't think we have a formal process but the way I like to make decisions is to gather a few people and debate the pros and cons (IN04).

We do not have a defined process; it happens on demand. We do not follow the Stage-Gate® because our portfolio of projects are very basic science (IN08).

Both of these interviewees that did not recognize the process are from a department involved in very basic science activities that are distant from the external clients and some of the mandatory information, such as, NPV calculation, which are hard to determine because their initiatives are usually targeting not-yet-existing markets.

The decision-makers' perception whether the firm Alpha's decision-making process can accelerate or slow down portfolio decisions is central to this research. As cited in the Theoretical Background section, there are two slightly different views in the literature about that: the Kock and Gemünden's (2016) more generalized view; and the Kester et al.'s (2011) more conditional view based on personal styles. When explicitly asking if the formal decision-making process of firm Alpha can slow down or accelerate decisions (SZ02), four out of the twelve decision-makers think that the process can slow down decisions, such as highlighted by interviewees IN01 and IN05.

When we have an approval process in place we need to go through this process and this can delay the decision. There are some mandatory activities in the process that take some time to get ready such as Product Stewardship and IP (IN01).

Usually a formal process delays decisions. Any formalization process, approval, committees, or stages delay the decisions but it gives robustness to the decisions. For sure, if you don't have a formalization process you can do it faster but may have a high level of rework and error (IN05).

IN12 says that all the alignments that need to be built within the first layers of the organizational structure take time and delay decisions. This is somehow in line with one of the

Kester et al.’s (2011) findings, whose argues that the most agile firm of their sample is the one with short decision-making lines.

You have to go at high levels of the organization to make a decision (IN12).

IN03 is the fourth decision-makers that thinks the process can slow down decisions but for the benefit of having a more effective and assertive result.

I have the impression it (a formal process) slows down but it deperates decisions. You can take a decision in a fastest way but giving up accuracy (IN03).

In a similar vein, IN07 also thinks that a process brings the benefit of having more robust decisions but this interviewee does not see the process as having any effect on how fast they make decisions.

The decision will be made with or without process. With process you will have lessons learned and your decision tends to have less error. The problem is that without process one decision tends to be catastrophic in some cases. I don’t think it accelerates. There are other things that delays decisions; it is not the process. I don’t see how the process can delay a decision (IN07).

Interviewees IN09 and IN11 have a neutral opinion about the process slowing down or speeding up decisions.

The process we have is fine; it is essentially the same of our competition: the Stage-Gate®. What is lacking is an understanding from the R&D community of how to utilize that process and what they should be doing in it (IN09).

I don’t see the things that we are working on are getting slow down. I think the biggest thing that can slow down are our lack of business involvement. I don’t know if having a better process can make us moving faster (IN11).

In addition to interviewees IN09 and IN11, IN04 and IN08 mentioned that decisions can be made faster if it depends on a few number of decision-makers.

I think a formal process can help if this is a small team and stakeholders (IN04).

For my department the process ends up not affecting the speed of the decision-making process. I just think that when there are many people the decision-making process is not good because it tends to be less efficient but in general terms I think we have a good process (IN08).

Interviewees IN02, IN06, and IN10 believe that the process accelerate decisions.

I think it accelerates the decision-making process. I don’t see it as a bureaucracy. I think it runs well (IN02).

I think it accelerates. I think process is important. What I think that could be a problem is when there is not a clear line of alignment (IN06).

One facilitator I see is when you can request off-line requests (Virtual committees). This is valuable for quick projects but for long-term projects is has no effect on the development lifecycle (IN10).

Table 9 consolidates the opinions of the twelve interviewees about the effect of the decision-making process on the time taken to make decisions.

Table 9: Interviewees' opinion about the effect of the process on portfolio decisions

Opinion	Interviewees	(%)
Accelerate decisions	IN02, IN06, IN10	25 %
No effect or no opinion	IN04, IN07, IN08, IN09, IN11	42 %
Slow down decisions	IN01, IN03, IN05, IN12	33 %

Source: Author.

Stability and rigor are two characteristics of a high quality decision-making process and they are tightly connected to having project teams and decision-makers following established governance rules. The process document of firm Alpha clearly states that any change in project status has to be submitted to gatekeeper's approvals (D2), either via "Virtual" or "In-person" committee. When asked if decision-makers tend to shortcut the process in face of urgent needs (SZ03), i.e., in situations in which an action has to be taken immediately in order to not lose the timing of an eminent opportunity or to make strategic moves to defend themselves against an threat, six out of twelve mentioned that they do tend to shortcut it but usually looking for a formalization later on in an retroactive way.

I think we've already performed some actions in an informal way but we try to formalize it later on (IN02).

Yes, we can and you see this in many places, a lot of times you make the decision but you get the formal approval for the decision at a later time (IN04).

I don't completely bypass (the process). I would get an approval from the responsible for a specific organizational resource and an approval outside the gate meeting but I would get the approvals (IN06).

I think we do that (bypass) in early stages of the process. For pilot plants and industrial trials I don't see it happening (IN07).

Yes (, I tend to shortcut the process) (IN08).

I don't get encumbered by the process (IN09).

Three of them mentioned that they shortcut the process but not for critical activities or decisions that can have a huge impact on the organization.

I couldn't say that I don't bypass the process but only for not critical decisions. But I don't like and I reinforce it is important to follow the processes (IN03).

Yes, but not for critical activities (IN10).

We don't shortcut this very often, only in extraordinary situation. I think in most cases people shortcut processes because they are slow and inefficient. The solution is to make the process fast and robust (IN12).

Completing the group of interviewees, three assert that they follow the formalization rules regardless of the emergency situation.

We have a process directed for urgent issues. This is a shortcut process but this is formal. So no need to shortcut the process in an unofficial way (IN01).

If this is a formal process, I don't shortcut it (IN05).

In general, we do not bypass the process. When we do that, we always get an approval from the department leader letting clear what are the risks associated with this bypass (IN10).

It was be possible to witness some situations of retroactive formalization during the direct observation in innovation committees. Most of the cases were related to preliminary investigation and planning activities that have been started without any formal approval (C1 and C3) and, in a few cases, project teams were looking for making official more resource consuming activities performed in the past, such as, pilots and industrial scale trials (C7). In any case, despite of not having an approval from the decision-makers according to the formal governance process, the interviewees mentioned that they got informal approvals from sponsors

and other resource managers responsible for the organizational resources that had been consumed.

After analyzing the formal governance rules of portfolio management and the tendency of decision-makers to shortcut it, the next section of this study analyses the information used by portfolio managers to make their decisions and the effect of them on the processes.

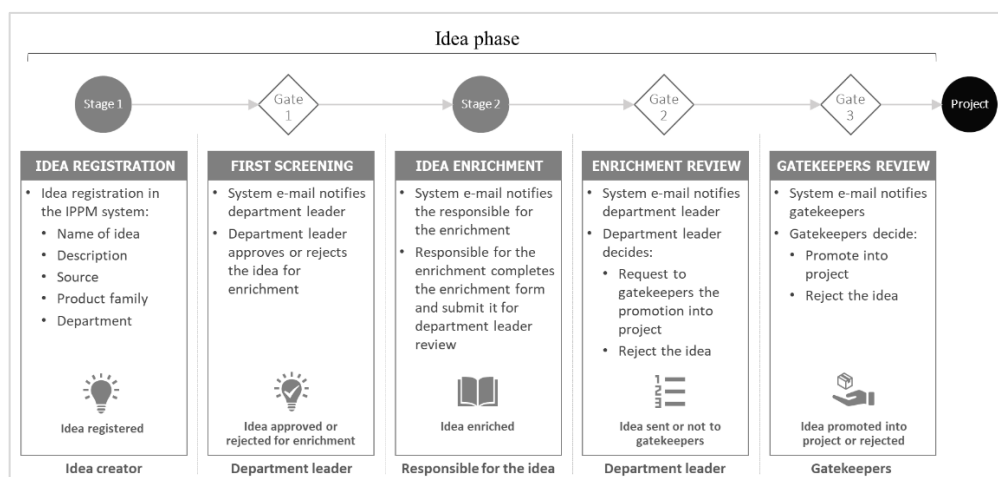
4.3.2 Seized information

This section analyses the information that decision-makers take in consideration while making decisions, if the formal process in firm Alpha provides these information, and if decision-makers tend to postpone a decision in case of lack of information.

The analysis of the process documents of firm Alpha describes the information that needs to be completed by project teams in order to move any initiative throughout the Stage-Gate® process, since from an idea phase until the completion of the project, as well as, to make any other type of change in the project situation.

During the registration moment, the IPPM tool requires a very few information about the new idea that is being registered. Basically, the ideator has to give a name for the idea, a brief description of the idea, the inspirational source of the idea, the related product family, and the department that may evaluate the idea. These information flows up to a department leader to perform a first screening of the idea, basically to make sure the proposed idea has fit with innovation initiatives or if the idea must go to another department outside the innovation team. Heretofore, the description of the idea is basically what the department leader in order to evaluate if it needs to be enriched with additional details. This basic flow is depicted in Figure 15.

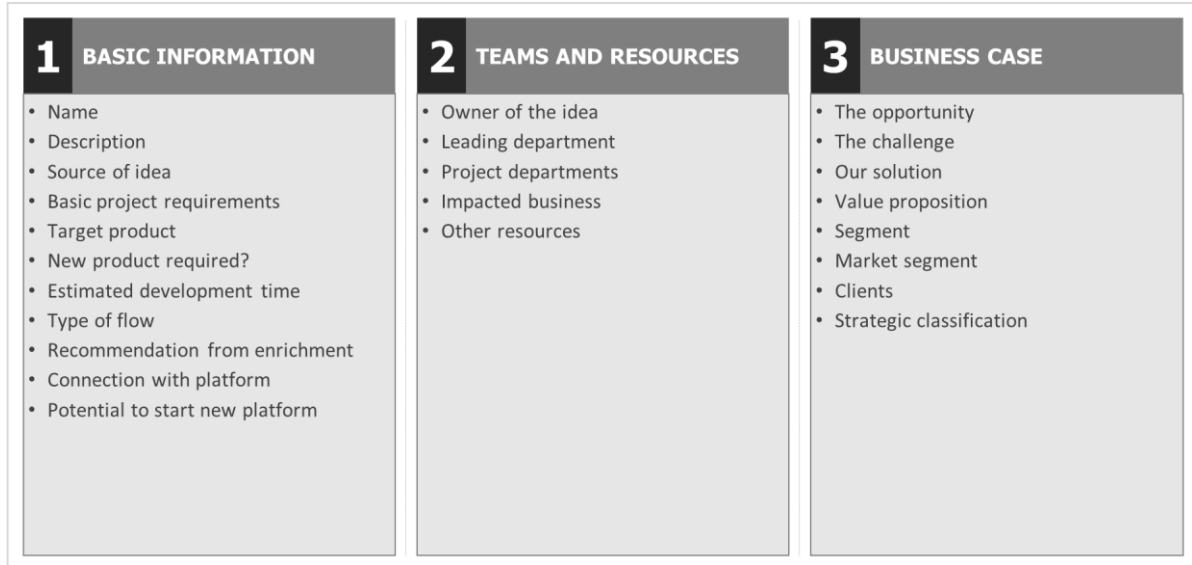
Figure 15: Idea phase workflow in detail.



Source: Firm Alpha document D1, pg. 30..

If the department leader approves the new idea to be enriched, this leader assigns someone from his/her team to be responsible for the idea enrichment. This enrichment stage demands multiple information about the opportunity or threat that is under evaluation. Figure 16 highlights the three groups of information that need to be completed by the responsible for the enrichment during this stage.

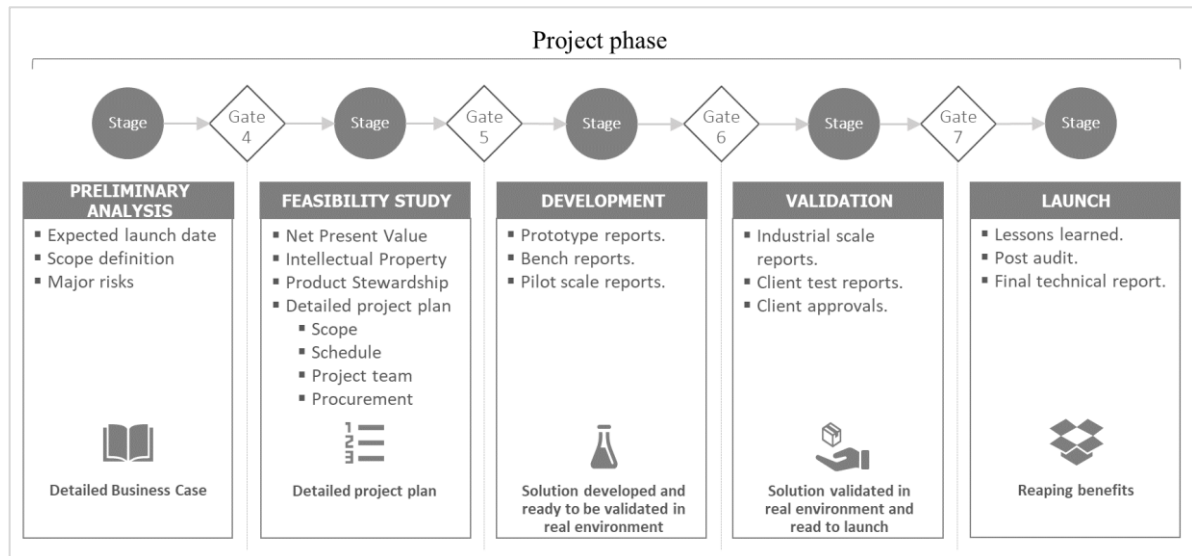
Figure 16: Information completed during idea enrichment stage.



Source: Adapter from Firm Alpha document D1, pg. 30.

After the idea is approved by the decision-makers to be promoted into project, a new set of information is required by the IPPM tool depending on each stage of the project lifecycle, as shown in Figure 17.

Figure 17: Project phase workflow in detail.



Source: Firm Alpha document D1, pg. 40.

As an outcome of the Preliminary Analysis stage, the project team puts together the business case and state the scope of the project. This will be paramount for gatekeepers to make the appropriate decision whether the project must continue to the planning phase or not.

The Feasibility Study stage is intended to create a detailed plan for the project, which is necessary to understand how the project team will develop the solution. With the project plan in place, the gatekeepers will have the first guess about the expected completion date of the project, the required resources to execute the project activities, the expected financial benefit that the project may deliver to the company, and intellectual property constraints and opportunities.

The Development stage is intended to develop the solution itself. It is expected by the gatekeepers to receive lab results and trial reports indicating that the solution is ready for scale up and to be tested in real environment.

The Validation stage scales up the solution up to the real environment. As an outcome of this stage, gatekeepers may receive trial reports and the final approval from the client side. Once the validation is complete, the project team is ready to request approval from gatekeepers to launch the solution.

During the Launch stage, the project team is responsible for monitoring the first productions and perform a post-launching audit in order to make sure the projected production volume and expected financial contribution margins (D8) are being met. If not, the project team has to employ actions to bring the project results back into track.

Combining the dashboards (D3) with the specific project information that have to be provided by the project team in each gate, the gatekeepers have a considerable set of information to reduce the risk of making a not favorable decision to the portfolio of projects.

When asked decision-makers what variables they take in consideration to make their decisions (SZ04), most of interviewees mentioned strategic and financial aspects, and cost-benefit, risk and development time balance.

Four interviewees mentioned that they look for those projects that bring high impact to the company in a broader view, not exclusively referring to financial impact.

Value proposition, which encompassed three different aspects: what would bring in terms of value to the person, to the environment, and financial (IN06).

Currently, the main driver we have is the impact to the business; what an idea will add to the company and to clients (IN08).

From my point of view I look at what is going to give me the biggest impact to the company and not to a given area. I then look at how feasible it is or not, the third thing I look at is do I have the right people to do that and if I don't, can I get those people. And the last but not least I look at what is some low hanging fruit that can be achieved quickly (IN09).

My team is less product and more process, they are concerned about differentiation of process capability. What project help us make products we couldn't make before or make the products we make today much more efficiently (IN12).

Two interviewees explicitly mentioned the financial impact as being the most important variable to consider while making a portfolio decision.

Level of technical complexity versus financial benefit, with emphasis on the financial benefit (IN03).

NPV is one variable that we have to take in consideration but when we talk about more tangible projects. You have the market, the technical risk of the solution you are proposing, if it is connected to the organizational strategy, you have the economic aspect, and the region in which the project is going to be developed (IN10).

Strategic fit was also highlighted by four interviewees.

Strategic clients is probably the most important factor to consider. Net Present Value is not the most important. Nowadays, high volume projects are very important due to current production objectives (IN01).

Strategic fit of the projects with the strategy; projected production volumes versus financial benefit; cost saving opportunities (IN02).

If the project has a huge relationship with what the business is needing or if the project is part of the strategic planning of the innovation (IN05).

One main variable is to make sure we are developing projects to strategic segments. Another variable is to avoid projects to only one client. Volume is not so important but the unit contribution margin is (IN07).

One decision-maker (IN04) try to balance their portfolio of projects while making portfolio decisions.

I would say a good balance between medium and long term initiatives; a good balance between high value and a high risk actions in the portfolio, and also to make sure the portfolio is addressing megatrends in the market (IN04).

These variables that are taken in consideration when making decisions are according to what Cooper et al. (1999) mentioned in regarding the objectives the a portfolio management, which are: high value projects, right balance of projects, and strategic fit of the projects with the organizational strategy.

By analyzing the dashboards available for the decision-makers of firm Alpha, they do not provide some of these information highlighted by the interviewees, meaning that this is a tacit knowledge and there is room for improvement in this sense by providing the strategic aspects and projected production volume to them. There are two dashboards that are regularly issued to stakeholders and decision-makers (D3 and D6).

The first dashboard (D3) brings a holistic view of the portfolio of projects in a way that it is possible to compare one specific project against the whole portfolio. This is extremely important by allowing the formation of what Kester et al. (2011) name as portfolio mindset. Comparing one specific project against the whole portfolio make possible comparing resource allocation as a whole and other strategic indicators, such as the financial benefit, strategic market segment, strategic intent, and expected launch date.

The second dashboard (D6) also presents a holistic view but in terms of performance of the portfolio of innovation projects. It does not bring the list of projects but it summarizes the launches of the year and upcoming years, the performance in terms of agility of the portfolio, the key open innovation metrics, Intellectual Property metrics, and other general key performance indicators to measure how health the management of the portfolio is.

When asking interviewees if the existing process provides all the variables the portfolio managers need to make their decisions (SZ05), the general answer is that they do not provide all the information they need except for two decision-makers (IN02 and IN07) that answered positively to this question. On the other hand, one interviewee mentioned that the deliberations during formal innovation committees cover the information required to make decisions.

I think (the process) does provide all the information (IN02).

Not (provide) all the variables. We need to pursue the information we need to make decisions (IN03).

No (it does not provide it) (IN04).

No (it does not provide it) (IN05).

Not yet, but that is what we are working on (IN06).

The system gives me the information I need but there is room for improving the system in this sense (IN07).

To be honest the decision to start a project is very based on feelings, deliberations, and discussion with business leaders. The process to start a development I see it as very informal (IN08).

No, I basically at the political landscape and project information and it is pretty clear what make sense or not (IN09).

Not all the information are available by the process (IN10).

The system does not provide the information (IN11).

This lack of information, in most cases, tend to make the decision-makers to postpone their decisions (SZ06), as highlighted by six interviewees, which slows down portfolio decisions.

In case of lack of information you take the decision to not forward the project to other stages (IN02).

Yes (, I tend to postpone decisions). I think there is a lot of good ideas that we end up not making any decision because there is no information about the client, the (production) volume, the financial benefit, which requires a large effort of enrichment of the idea. (IN05).

I keep the ideas in a pull of ideas but I will work on an idea only when I have the minimum set of information. Currently, to make a decision, there is several information that needs to be available but I don't let ideas die (IN06).

For sure (I tend to postpone a decision in case of lack of information) (IN07).

Yes, I think a lack of information for one project tends to delay decisions (IN08).

If the information is unavailable, and it is a high risk project, you typically have to put it on hold until you can get enough information to make a good decision. But if you talk about a low risk project, you can just guess (IN12).

Four of them mentioned that they don't tend to postpone decisions.

Not anymore. I instigate project leaders to learn how to make project decisions in case of lack of information (IN03).

No (I don't tend to postpone a decision) (IN09).

I don't tend to postpone decisions because we should utilize more the opinion if we want to innovate (IN10).

I am comfortable in not having all the available information. But I feel the company postpone decisions because of that (IN11).

Two of them didn't answer this question.

The next section analyses how centralized or decentralized the decisions are made in firm Alpha.

4.3.3 (De)centralization

This section analyses if the decisions are made in a collective way or if there are situations in which the decisions are pushed by superior layers of the organizational structure (SZ07). According to document analysis (D2 and D4), the innovation portfolio is managed in an integrated way by a corporative PMO but each region or business unit handle their individual innovation committee. When a new idea is proposed or a solution is being designed, whenever it is possible, the local team exposes these information to other regions and business units in order to evaluate potential use of the project's product by these other businesses and to avoid overlapping of developments. Most of these verifications are made during the In-person committee that, despite its local characteristic, counts on the participation of members of multiple regions.

As mentioned by eight interviewees, the In-person and the Virtual committees are participative decision-making processes and they have authority to made de decisions by themselves, not needing to ask permission or double-checking their choices with their hierarchical superiors.

Historically, firm Alpha has acted as local firm in each region but we are trying to implement a global mindset; this is in progress. All local decisions can be handled by ourselves but for global decisions we need to make sure this makes sense for the whole company. This is a participative decision-making process and I have authority to make these decisions but in case of doubts or questions I can talk to my leader (IN01).

I tend to say (portfolio decisions) are more collective decisions. It can have a few top-down decisions but it is a more collective (IN02).

I think for the most part in the company they are collective decisions (IN04).

Decisions are taken in a collective way. Some top-down decisions sometimes tend the collective decisions to be discussed again (IN07).

I see a lot of collective (decisions) in the company. We have a lot of room to question but I think when a decision comes top-down it usually comes from someone that has a high ability to judge (IN08).

They are collective decisions (IN10).

I have a very collaborative discussions with my leader. I don't feel like there is a lot of that but others may (IN11).

We need to build bottom-up alignment (IN12).

In general, regular decisions are made in a collective way, but for more strategic decisions or in situations that require huge investments, the decision-makers tend to pull a decision from higher levels, as mentioned by four interviewees. It does not mean that those are

top-down or enforced decisions; it means that superior layers are sometimes consulted and asked to agree with the decision made by the group of gatekeepers.

In general, I see decisions being made in a collective way but exceptions happen for strategic developments (IN03).

The ((de)centralization) depends on the decision. I think regular decisions are made in a collective way. In case of conflict of opinions or in case of projects requiring large investments, the decision is still not being top-down but bottom-up; we bring it up for discussion and call for a decision in higher levels. I think there is a good delegation in terms of project decisions (IN05).

It depends a lot on the type of the decision. I think we follow the process. What is most complex in the company are decisions that require investments. When we say, let's invest in something strategic, then this is some more complex (IN06).

The director is very collaborative; there are certain instances when things are top-down but that is by the nature of needing some specific outcome. The decision-making process within R&D is a good one (IN09).

This collective characteristic were clearly noticed during all the innovation committees that were observed. In the dynamic of these meetings, decision-makers deliberate and make their decisions based on consensus. Only in case of projects demanding high amount of organizational resources that the decision is pulled from higher hierarchical levels.

The next section identifies the personal style of the decision-makers. This is the last aspect analyzed within the Seizing capability.

4.3.4 Personal styles of decision-makers

This section looks at the personal styles adopted by the gatekeepers while they make their portfolio choices. The literature (Kester et al., 2011) says that there are three types of personalities involved in decision-making situations; they are the evidence-based, the opinion-based, and the power-based personal styles. The governance process of firm Alpha establishes some rules that ends up promoting that decisions may to be made based on evidence, leaving small room for the manifestation of opinion- and power-based stiles (D1 and D5). When asked interviewees about their personal styles while making decisions (SZ08), seven of them mentioned that they adopt an evidence-based style as much as possible, but adopting opinion when needed.

80% evidence-based; 20% opinion-based; 0% power-based (IN01).

For sure (I classify myself) as an evidence-based person and opinion-based in a few cases. When I have an opinion I try to find additional data to underpin my opinion (IN02).

I use evidence and opinion. Power-based is what I use least. (IN03).

I think I would put myself somewhere between evidence and opinion, maybe leading a little bit towards evidence (IN04).

This is something that I am actively pushing within the company; it is a conscious decision on my part to be evidence-based and the reason for that is that it is a reaction to what I've seen as an over reliance on opinion because of two reasons: one is due to the inability to access information because you are denied from your vendors; and that was reinforced by the unwillingness to invest in the time and the money it took to get evidence (IN09).

I change my style based on the situation at hand. I use all the styles (IN11).
I tend to be evidence-based with a hint of opinion (IN12).

Five interviewees mentioned that they resort on their opinion while evaluating very incipient ideas or at the very beginning of certain developments, in which there is not yet an abundance of data.

My personal style varies between evidence- and opinion-based. I would say when the project is at the beginning of the development, I like to be more intuitive, but since you are allocating many resources you need make decisions based on evidence. Power-based is not me (IN05).

I think that when it is at the beginning of the development I adopt opinion but the opinion is based on previous evidences about past readings and experience. In case of projects already being developed I adopt evidence (IN06).

I am totally evidence-based. Opinion in second place. I use power-based when I see that people are not taking in consideration the evidences and opinion. At the beginning of developments I use opinion a lot and evidence in later stages (IN07).

I think early stages have a more opinion and it migrates to evidence. I would say that it is a mix between opinion and evidence that goes increasing the level of evidence until to become purely evidence and a very little power-based (IN08).

I am more opinion-based at the beginning of a development with a little of evidence-based as the development moves on (IN10).

During the observation of innovation committees it was noticed that the abundance of data about any ideas and projects grows as the initiative progress throughout the Stage-Gate® process. This higher availability of data in later stages somehow contributes to the manifestation of evidence-based personal styles, promoting less vague discussions and leaving small room for opinion and power-based styles.

Table 10 puts together the answer for the questions SZ03, SZ06 and SZ08, which is helpful to analyze the connection between personal styles, tendency to postpone decisions in case of lack of information, and tendency to shortcut the process in case of urgent situations, which, in turn, helps to elucidate propositions P1, P2, P4 and P5 in section 5.

Table 10: Personal style versus Tendency to postpone versus Tendency to shortcut

ID	(SZ08) Personal style	(SZ06) Tendency to postpone	(SZ03) Tendency to shortcut
IN01	Evidence-based	-	No
IN02	Evidence-based	Postpone	Yes
IN03	Mixed	Do not postpone	Yes
IN04	Evidence-based	-	Yes
IN05	Evidence-based	Postpone	No
IN06	Evidence-based	Postpone	Yes
IN07	Evidence-based	Postpone	Yes
IN08	Evidence-based	Postpone	Yes
IN09	Evidence-based	Do not postpone	Yes
IN10	Opinion	Do not postpone	No
IN11	Mixed	Do not postpone	-
IN12	Evidence-based	Postpone	Yes

Source: Author.

After exploring the decision-making process, the next section analyses how long do decisions take to be implemented, leading to an adapted portfolio to changed conditions.

4.4 TRANSFORMING / RECONFIGURING

This section looks at the Transforming / Reconfiguring capability of firm Alpha in regarding how long they take to adapt their portfolio after one opportunity or threat is sensed and one decision is made about it.

Connected to all the three dynamic capabilities, every new year firm Alpha establishes a set of Key Performance Indicators (KPIs) that helps to translate organizational objectives into innovation actions (D7). Items such as yearly launchings, pipeline maximization value, portfolio agility, intellectual property, open innovation, and innovation process compliance targets help innovation teams to focus on actions that may sustain the organizational competitiveness and key strategic market segments, as well as, to remain compliant with the established innovation practices. The portfolio agility KPI establishes some targets and monitors a set of information in regarding how fast the innovation departments are conducting their Sensing, Seizing, and Transforming / Reconfiguring capabilities. To give an example, the innovation teams have ten working days to perform a first screening of incoming ideas. The amount of days in each stage of the Stage-Gate® system is also monitored by the innovation leadership. The percentage of projects completed within original schedule baseline is another example of KPI. In summary, firm Alpha established a set of KPIs that measures how agile their portfolio is in terms of decision and development lifecycle. Any change in the innovation portfolio is formally updated in the IPPM tool right after the decision is made.

Five questions were elaborated to assess how agile the adaptation of the firm Alpha' portfolio is. The first four questions are related to the lasting time between sensing an opportunity or threat until it be part of the portfolio of projects, if approved; and one question is relate to the lasting time from the seizing (evaluating and deciding) moment of an opportunity or threat until it be implemented in the portfolio of projects.

In general, interviewees mentioned that small changed customer needs (TR01) are very quickly reflected into the portfolio since the sensing moment, taking a few weeks to have a project in the portfolio to tackle an opportunity or threat.

Last than a month to max two month. The decision can be made very quickly but sometimes the decision depends on a lot of things. Small impact decisions to attend one client can be made very quickly (IN01).

We do not take longer to start to work in market demands (IN10).

Five interviewees mentioned that they are fast when they have the information but slow when lacks it.

This time varies a lot. Sometimes someone comes with an idea but it is not clear the demand, the market, the size of the opportunity (IN02).

These timeframes varies a lot. There are examples of trends that we take then years to start the development and there are cases extremely fast. The problem is to start a development and not realize in a fast way that it should not be developed (IN03).

I've push us to be quicker in changing directions. If we have to start a new initiative, it take us a while to close down other initiatives to start the new ones. At the end of the day it is a balance; we have fixed resources, so you have to make choices; for one new (idea) comes into the portfolio, something old has to leave (IN04).

In cases of opportunities that are aligned with the innovation strategy and that we have the information we need to make a decision, we are very fast (to adapt the portfolio since sensing the opportunity). For projects that we have doubts (lack of information) we are slow (IN05).

It depends if the (market) segment leader understood and bought the idea, which acts as sponsor of the idea (IN06).

Interviewee IN08 mentioned that they are fast to start a development but slow when they decide to stop an ongoing project, which can delay the initiation of new developments even if the decision is already in place.

I see the teams with a high level of flexibility; since we can stop without having to explain a lot, we have flexibility. In some cases I would say that in 15 days we start the work, so I would say that in 1 month we goes from one idea to allocate someone. To start developments is easier but to discontinue a project requires a lot of work (IN08).

Two decision-makers stated that they are slow to adapt their portfolio to changing customer needs or competitive conditions.

From one year to one and a half year (IN07).

I think we are slow to do it (IN11).

In objective purposes, interviewees mentioned that they take a few weeks to update their portfolio based on changed conditions when they have all the information and the change is aligned with the strategy. In other cases, it can take years to be part of the portfolio of projects since sensed in the market.

In face of changed resource situations, i.e., when someone leave a project team (TR02), interviewees mentioned that most of the time they adapt themselves very quickly in a way that they do not need to stop an active development. This is valid when they have an overlap of competencies that allow them to quickly replace leaving resources, which appears to be are most of the cases according to six interviewees.

We are able to quickly identify another resource to replace someone leaving the project. This is true when we have a competence overlap but not when we have a competence gap. Anyway, the decision about the project is made very quickly (IN01). Depending on the scenario, the adaptation is immediate. Within a more dramatic scenario, we take around one to one and a half month to adequate the resources to the portfolio or vice-versa (IN02).

It (replacement of resources) is fast because we have people that can replace others. We have some people that hold critical competencies but it is not usual to have changed situations involving them (IN03).

There is no problem when the project is a priority or when there is a person with a similar competency within the team (IN05).

In most of the cases I believe we are very fast but does not mean that we are efficient (IN06).

I think we are fast (in replacing resources) for generic knowledge but we take longer for specific competencies (IN08).

In opposition to most of the other answers, three decision-makers assert that they are slow to replace resources and the projects can face delays due to that.

Getting one up to speed is hard. We are able to hire somebody, getting him up to speed takes some time (IN09).

I would say we are slow because we have a clean team (IN04).

No, we are not (fast) (IN11).

In terms of time to adapt the portfolio of projects to new technology availability (TR03), there is a variety of answers from the interviewees. Interviewees IN06 and IN08 say that the company is good at monitoring new technologies but there is room for improvement in the seizing and transforming capabilities.

I think we have a very good monitoring system (to sense new technologies) but I think we could evolve in how to prioritize and decide what to do with this information (IN06).

I think the company is very aware about the things that are happening and we have a lot of support to monitor what is new. I just think that we end up mobilizing quickly to monitor new technologies but sometimes we do not know what to do with that (IN08).

This behavior might be happening because the activity of monitoring of new technologies does not require a large amount of resources and no approval is required for that; this is an organic process within innovation teams.

When separating these new technologies between proven and disruptive ones, three interviewees mentioned that they are fast to incorporate those new technologies that have already been tested by the market but slow to get involved with more disruptive ones.

I think something that happens is that the companies that hold these new technologies recognize our company as a relevant player in the industry so that they get in contact with us to present these new technologies (IN03).

We are usually slow in case of technology trends but usually fast in case of proved new technologies. For instance, if there is a new technology that have already changed the market, we are fast, but if there is a lot of uncertainties we are slow because we don't like to navigate in the risk (IN05).

We are fast sometimes and slow in others (IN11).

Four interviewees mentioned that they are slow to start a development that involves a new technology no matter how mature it is in the market.

I would say it takes us a long time; longer to the competition on average (IN04).

I would say three years to start a development (IN07).

We are slow when there are new technologies because we rarely develop a technology so when we start to investigate new technologies they are already being utilized by the market (IN10).

We are much better today than we were two to three years ago, but I think most of our competitors are faster (IN12).

Question (TR04) asks interviewees about how quickly do their business units change its strategic goals and how quickly they adapt their portfolio to this changed condition. Based on the interview IN10, the incorporation of a new or changed strategy is accelerated when the strategy is clear and well defined, if not, it takes some time.

The adaptation of the portfolio of projects are fast for those people that are involved in the changes but not for those people who do not participated in the definition of the changes (IN10).

In a similar vein, IN04 says that firm Alpha is fast when the strategy is clear.

When the business strategy is not very clearly described, that is a challenge (IN04).

This IN10's answer exposes a good practice that can be adopted by any firm to accelerate the adaptation of the portfolio of projects. In moments of strategy review that can affect the portfolio of projects, companies can bring portfolio managers into the process of strategy (re)definition so that they may have a deep understanding of the changes and quickly adapt their portfolios once the new strategy is in place.

For interviewees IN01, IN02, IN03, IN06 and IN08, firm Alpha is fast to incorporate changed strategies into their portfolio of projects. IN11 mentioned that they are on average with other companies.

The big strategic goals do not change that often. The simple changes they make are quickly reflected in the portfolio (IN01).

I think this is fast to adapt ourselves to changed strategic goals. In other cases, the strategy goes changing over time so you go sensing and adapting the portfolio alongside it (IN02).

I think we are fast (to adapt our portfolio) because the company is very connected with the clients. I think our pipeline of projects is not written in rocks. We are being instigated to fail fast and discontinue projects fast. I think we are agile (IN03).

I think in terms of business support (project) we are fast but in R&D I think we are improving it through the adoption of platforms (of projects) because you put focus (IN06).

I think we are faster than before (IN08).

Only interviewees IN05 and IN07 think they are slow at understanding in strategies and adapting their portfolio of projects.

It takes some time (to revalidate the projects in case of strategic changes) (IN05).

I have difficulties in seeing projects changing due to strategic changes (IN07).

When evaluation how long do the portfolios take to be adapted since an opportunity or threat is seized (TR05), i.e., since the decision is already in place, the majority of the answers indicate they are very fast on doing that, being able to implement the decisions within few weeks if not days. Exceptions occur when there is no resource available or if the company has to wait ongoing initiatives to be completed, as highlighted by interviewees IN04 and IN06.

This is fast to adapt the portfolio of projects once you have the decision made. The project team members are somehow clear depending on the type of project. Within one month the project is being developed (IN02).

I think we are able to adapt fast our portfolio of projects. The problem would be if the company change the strategic drivers in a frequent way, but it is not the case (IN03).

It typically takes months, and I would say the biggest levitation is closing another project to start another one (IN04).

It is fast to implement a decision that has been taken. (IN05).

I think it takes longer and it depends on resource availability. We take longer to close existing projects to start new ones (IN06).

We take weeks (IN07).

I think it depends on each department. Speaking from my department I think we are very agile. The problem is that, by being agile, we do not discuss and formalize enough (IN08).

It depends on the department. Some of the part of research we have robust infrastructure other parts not (IN09).

I've seen it taking five months and I've seen it two weeks. It depends on the level of engagement of everybody else (IN11).

This set of answers, document reviews and direct observations in innovation committees' outcomes closes the analysis of results. The next section elaborates on the propositions and study objectives based on the data of this current section.

5 DISCUSSION

After the analysis of the results, discussion points were elaborated in this section to address the research question of this project, which is to analyze the influence of quality of the decision-making process on innovation portfolio agility through the use of the DC framework.

In a broad context, firm Alpha has different levels of dynamic capabilities. Sensing capability is predominantly people-based while Seizing and Transforming / Reconfiguring capabilities follow an extensive set practices and governance rules. Since process formalization leads to higher decision-making quality processes, it is reasonable to argue that firm Alpha holds superior Seizing capability in comparison to the other two dynamic capabilities under investigation; this in-depth evaluation is made in this section after the analysis of the propositions of this study.

Proposition P1 states that the personal style based on evidence leads to lower portfolio agility when there is lack of information because this style tends to demand more information to make their decisions. During the participations of the innovation committees, it could be observed that the decision-making practices of firm Alpha is largely based on evidence, partly because of the established process that requires standard information to make any gate request and partly because of the specific scenario in which each individual initiative is inserted in. Even though, in addition to the mandatory information required by the formal process, there were experienced some cases in all the three regions in which the decision-makers required additional data that were not available at the moment of the innovation committee. In most of these cases, the decisions were postponed due to these lack of information.

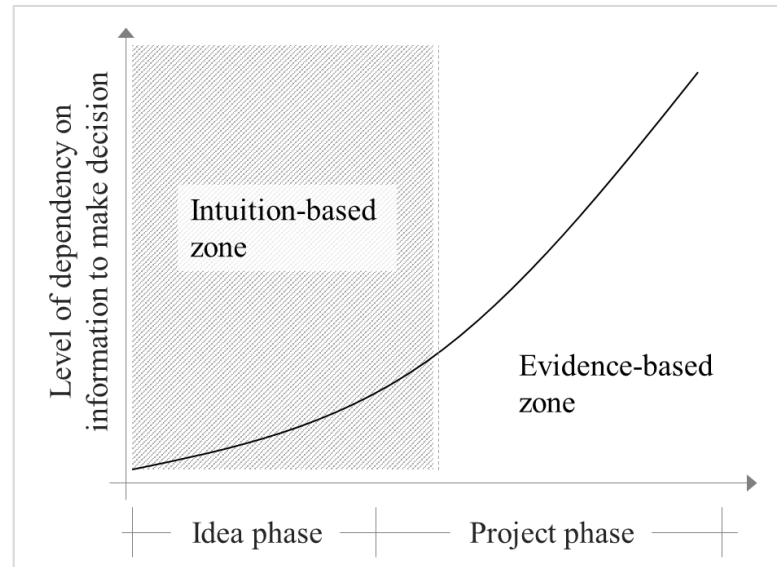
As can be observed in Table 10, the majority of respondents declared to adopt an evidence-based style (SZ08) to make portfolio decisions; only the interviewee IN10 mentioned that it has recently adopted a purely intuitive profile, under the argument that the company must be more intuitive if it wants to innovate. When asked if they tend to postpone decisions in case of lack of information (SZ06), there was a balance between the responses. In general, decision makers tend to postpone decisions, especially at later stages of development. On the other hand, when initiatives are still in the field of idea, they tend to be more flexible in the absence of information. This difference in behavior is associated, according to the interviewees, to the fact that later stages demand more organizational resources, therefore, they need to be more cautious at this point. Analyzing P1, it is possible to assert that, for this group of decision-makers, this proposition is valid only for later stages of development but fails when at early stages due to this variation in the styles of decision makers.

Proposition P2 states that opinion- and power-based personal styles lead to lower decision-making quality as they tend to shortcut formal processes. By looking at the interviewees' answers for question SZ03 in Table 10, all decision-makers who tend to bypass the formal process (SZ03) also declare themselves to be based on evidence or mixed between evidence and opinion (SZ08). The only person (IN10) who declared to adopt a style based on opinion mentioned that he tends not to bypass the process. Since none of the decision-makers declared themselves as adopting a power-based style, it is not possible to analyze proposition P2 in its entirety. Focusing only on the part of the proposition that makes reference to the opinion-based style, and considering that only one person declared as adopting an opinion-based style, and that this person also mentioned that she does not tend to shortcut the process, it is not possible to make any founded evaluation of proposition P2.

Although the majority of decision-makers mentioned adopting an evidence-based style, they confirm that they follow their opinion and bypass the process in preliminary stages of development, adopting a completely evidence-based style as development progresses, thus avoiding neglecting processes. Therefore, it is possible to affirm that the level of dependence on information increases over the development, which influences the personal style of the decision makers and, consequently, reducing their predisposition to bypass formal processes.

Based on that, it is possible to plot a graph representing the level of dependency on information to make decisions throughout the project development lifecycle. This graph is illustrated in Figure 18 and this is particularly true for innovation developments where the level of technical and market uncertainties are usually dominant at the early stages of developments. This is not represented in this graph the power-based personal style but it can come into play at any point in time during any development; it depends on several factors such as organizational culture and level of process informality.

Figure 18: Level of dependency on information



Source: Author.

The level of quality of the decision-making process in terms of information availability can shift the frontier between the opinion- and evidence-based zones. The more information the process provides, the smaller the opinion-based decision-making zone is.

Kester et al. (2011) argue that the evidence-based personal style leads to a high quality decision-making process, but they do not mention the moderating factor of the process formality on these personalities. Based on the data of this current study, there is room for arguing that the process formality and information availability are moderating factors of the personal styles that are manifested during decision-making situations; that is, the correlation could be the opposite, having the personal styles being influenced by the quality of the process: the more formal the process, and the greater the availability of information that the process provides, the more the evidence-based personal style comes into play.

According to the interviewees, regardless of their personal style, almost everyone confirms that they tend to bypass the formal decision-making process in case of urgency or turbulence (SZ03), with the aim of accelerating decisions that are necessary in moments of urgency. This is more evident for less critical decisions (IN10 and IN12) or in preliminary stages of development (IN07), but that retroactive formalization is always sought; that is, approvals are requested after the action is made in order to formalize it. According to interviewees, taking shortcuts are necessary to accelerate decisions, which is in line with propositions P3 and P4.

Proposition P5 states that environmental turbulence leads to lower decision-making quality. Answers for the questions SS04 and SS05 point out several elements that generate turbulence into the innovation environment of firm Alpha. Some technical and market

uncertainty can bring turbulence to the innovation environments mainly because of two reasons: first, the development of innovative not-done-before products, services, or productive processes sometimes carries technical uncertainty in the sense that the innovators do not always can predict the outputs of a process based on their inputs, forcing them to redo experiments until the point that they get the expected outcomes; second, innovators not always know if the product, process or service under development will meet the market requirements and will be accepted by their clients because it is not rare to find products targeted to markets that do not exist yet. Given that situation, it is acceptable to agree that firm Alpha plays in a high turbulent environment and this is an ideal case to test proposition P5.

Looking at the results of question SZ03 in Table 10, although most of the decision-makers mentioned during interviews that they recognize the importance of having a process in place, they assume that they tend to shortcut the process in case of turbulence or urgent situations. Taking in consideration the Kock and Gemünden (2016) description of decision-making quality, in which states that decisions need to be made in a transparent, stable, comprehensible, and rigorous manner, it is plausible to affirm that the quality of a decision-making process is decrease every time one decision is made bypassing the formal process. Therefore, it is also plausible to affirm that environmental turbulence leads to lower decision-making quality, thus, validating proposition P5 for this group of interviewees.

Finally, proposition P06 investigates if the decision-making quality influences the innovation portfolio agility. In order to analyze this proposition, the first required step is to assess the quality of the decision-making process of firm Alpha and how agile their portfolio is. This analysis is presented in the sections 5.1 and 5.2, and an integrated view of both assessments is given in section 5.3.

5.1 ASSESSMENT OF THE QUALITY OF THE DECISION-MAKING PROCESS

This section assess how quality the decision-making process of firm Alpha is. The IPPM governance process of firm Alpha appears to be very flexible to different situations in a way that it does not prevent idea or project teams from getting stuck for a long period waiting for decision to be made because they implemented the Virtual committee practice that accelerates gate approval requests, which is a positive aspect in terms of quality of the process when compared to traditional Stage-Gate® processes that usually make teams to wait for formal gate meetings that occur from time-to-time. In a similar vein, the Stage-Gate® process in place in firm Alpha contains two possible workflows: the Full, for high complex and strategic projects; and the Lite, for simple developments. The availability of these two workflows allows project

and portfolio managers to choose the workflow that best fits the characteristics of each project, balancing the portfolio with simple or complex developments.

Another component of firm Alpha's innovation management process that indicates a high level of quality is the list of established deliverables or outcomes per stage throughout the Stage-Gate® process. Firm Alpha interviewed their decision-makers in order to identify what would be the decision factors, data, and information they need to make decisions per stage during the project lifecycle. In an automated way, the IPPM tool prevent project leaders from requesting gate approvals without fulfilling a pre-established set of required information depending on the level of maturity of the development; it means that decision-makers should be provided with the key information they need to make decisions throughout the process. Moreover, within the Stage-Gate® process, although the Decision Diamond best practice is not a mandatory process, it gives clarity to decision-makers about what are the aspects to consider when making decisions: technology readiness, business attractiveness, and resource availability.

The innovation dashboard that is shared in a regular basis provides a holistic view of the portfolio of projects, in a way that decision-makers can easily compare projects amongst them and prioritize the most promising ones; this practice helps to increase the portfolio mindset, which is indicated by Kester et al. (2011) as being one of the characteristics to have an effective portfolio management process. In addition to this comparison functionality, the dashboard allows innovation team members to verify the performance of the innovation and their projects against organizational objectives and key performance indicators. In doing that, portfolio managers can anticipate deviations from the original plan and take appropriate actions to bring the performance of the developments back on track.

One of the tools that most impacts the innovation management of firm Alpha is the IPPM tool, which contains all the innovation ideas and projects in a way that project managers have all the features and functionalities to achieve a high level of project management maturity and portfolio managers to have all they need to manage their portfolio of projects. Any project document is stored in this tool so that project knowledge management is handled in a formal and centralized way. All the historic data about old projects can be accessed and restored when needed, and all the innovation management KPIs are available in this tool. Having an official tool with a single database simplifies and improve that management of projects and the innovation as a whole because it becomes the reference source to all data, information, and management actions.

The set of yearly KPIs established by firm Alpha is connected to all the three dynamic capabilities in a sense that: it fosters new ideas, trends and opportunities identification (Sensing); it ensures that innovation team members follow the official governance rules and practices, and establish targets to improve the process (Seizing); and it focuses on the acceleration of the implementations of decisions made (Transforming / Reconfiguring), which is subject of the next section.

5.2 ASSESSMENT OF THE PORTFOLIO AGILITY

This section analyzes how agile the portfolio of firm Alpha is. Portfolio agility means how fast decisions are made and deployed; it does not mean how fast projects are developed but it has an indirect effect on it since faster project and portfolio decisions can prevent projects from getting stuck waiting for decisions. Within this context, it does not make sense to investigate the development time (lead time) of firm Alpha's projects; in order to investigate how agile the portfolio is, this research study relied on the interviews and direct observations in innovation committees to determine how long decisions take to be made and implemented. Based on these two sources of data, it is possible to say that not all critical decisions are made and implemented in a very fast way while others more strategic and resource demanding ones can take a longer time to be implemented. For those simple and market ready projects the average time to make and implement decisions varies from few weeks up to three months after being sensed. This is an absolute number and it could be tricky to prescribe this portfolio as agile or slow because there is no reference in the literature about what could be considered an agile or slow portfolio.

Given this scenario, this research study deepened into different situations faced by firm Alpha in order to illuminate this analysis. The first situation analyzed concerns new market opportunities sensed by the front-end teams in contact with clients, open innovation campaigns, and market trends monitoring. The most common source of ideas amongst these three processes are surely the contact with clients, since most of the ideas are originated from client requests or during visits of firm Alpha's front-end teams in production lines of clients (direct observation of opportunities). In these cases, once one opportunity is identified, the idea needs to be enriched with some information that are required by the formal innovation process as reported in the Analysis of Results section of this study. These information require some time to be collected and elaborated since most of them are context specific, such as, the description of the opportunity, the challenge to implement a solution, the proposed solution itself, and some high level analysis of market, finance and technical aspects. The obligation to collect all this information for sure prevents ideas from being approved in a fast way but it gives quality to the

process in the sense that organizational resources will be allocated in a most assertive way; so this is a tradeoff that companies with limited resources has to deal with.

Exploring the open innovation campaign process of firm Alpha, one could find that the preparation, execution, and final analysis of the results of the campaigns take on average three to five months. After running the process, the most promising ideas must go through the formal approval process in order to be promoted into projects. Here it is necessary to separate the process between preparation of the campaign, collect of ideas, and analysis of them. The sense component starts only from the collection of ideas on and after that one has the seize component linked to the analysis of the results and the formal approval process. Structured ways of new opportunities identification usually take longer than spontaneous generation but the former ensures a sustainable generation of opportunities than the later. Per this analysis, this structured process takes a relative time to sense new opportunities but there is a whole process underpinning it.

Market trend evaluations in firm Alpha occurs in a structured way or by demand, when asked by project teams. The structured process follows long steps but generate sound directions to portfolio managers in the sense that the outcomes of this analysis help and drive decision-makers on what ideas to choose to be developed as projects in order to tackle trending markets and technologies. Once again, this process takes a considerable time to be executed but it clearly gives directions to the innovation teams once available; in other words, these sense and seize practices deliver quality but it is a time demanding process.

Investigating how agile firm Alpha is when analyzing and deciding customer changed conditions, interviews show that this process is quite fast and the implementation on projects are immediate. This change management process requires formal approval and proper communication but there is not a complete process established to manage changed customer situations; this is done on demand and it is people-based.

Technology changes are not a frequent situation faced by firm Alpha since production technologies available in the petrochemical industry require huge development and investment. Decision to adopt or develop a new technology is a long and strategic process. Even though, interviewees mentioned that, when decision is made by the organizational leadership, projects to implement these new technologies are quickly started.

5.3 INTEGRATED ANALYSIS

After elaborating on these two themes in an isolated way, a more integrated view is required to analyze the influence of the decision-making quality on innovation portfolio agility.

From a broad perspective, based on the result analysis one can state that: 1) firm Alpha holds a high quality decision-making process to govern its innovation portfolio because its process covers almost all the situations faced by them; and that 2) the portfolio agility of firm Alpha depends on certain situations but in general it shows a fast response to most of the cases.

There are some indications that decisions could be faster made if the Stage-Gate® process would not require some mandatory information per gate but this refers to a tradeoff between agility and quality of the decisions. Quality of decision, i.e., how effective or assertive a decision is, does not represent the quality of the decision-making process because the process can demonstrate robustness and austerity in terms of established procedures but leading to wrong directions and vice-versa. Given that, it is reasonable to assume that the quality of the decision-making process of firm Alpha causes delays in certain decision points in return to a high quality decision because deliberations are better founded on facts and data. It is possible to design a decision-making process to deal with urgent matters as highlighted during the interviews but this can represent a penalty in terms of assertiveness and quality in the result of the decision.

On the other hand, there are other indications that the way the innovation is structured helps idea and project teams to accelerate the collection of the mandatory information to make decisions. The intellectual property, product stewardship, partnership, and funding teams are examples of a complete structure that supports the development teams on gathering the required information to make founded decisions. Adopting a very restrict view, one could say that these supporting teams are not part of the decision-making process but certainly they accelerate the exactly step that delays decisions in firma Alpha, which is information availability to decision-makers. This is a characteristic of firm Alpha that helps to build a superior process to influence the firm's ability to quickly adapt its innovation portfolio.

In summary, based on document analysis, interviews, and direct observations in innovation committee, I argue that a quality decision-making process tends to slow down portfolio agility for the sake of more effective and assertive decisions, which is in line with proposition P6.

Investigating how uncertainty and environmental conditions affect the decision-making quality and portfolio agility, it was possible to notice through document analysis and interviews that the quality of the decision-making process may be compromised by turbulent environments such as in innovation departments, but this comes along with agility for the decisions. Anyway, there are ways to design a decision-making process to better deal with uncertain and changing

conditions with low lost in terms of process formality but eventually leading to a more intuitive decisions, which can also affect the quality of the resulting decision.

When investigating how personal styles influence the quality of the decision-making process and innovation portfolio agility, I found indications that a high quality decision-making process influences most the way people make decisions than the contrary. First, robust and clear governance rules prevent decision-makers from adopting a more power-based style because there are rules and formalities to obey. Second, since the decision-making process clearly states what the information to consider when making decisions, and that these information are mandatory to request gate approvals or to change idea and project states, this process reduces the intuitive load of decisions, leading to a more evidence-based personal style.

6 THEORETICAL AND PRACTICAL CONTRIBUTIONS

This research provides theoretical contributions to the academy by increasing existing literature on the quality of the decision-making process, innovation portfolio agility, and DC framework. Despite early studies, IPPM is more than just choosing decision-making support tools; a more holistic and integrated view is required to better analyze a portfolio decision-making process. This study falls into this second hall of studies as it investigates the portfolio decision-making process from end-to-end, shedding light on its entirety, not only on methods and practices adopted by IPPM processes to create, discontinue or prioritize single projects. This integrated view is important for companies to make good choices with respect to their innovation portfolio and not losing their competitive advantage (Chao and Kavadias, 2008). In addition, the improvement of a portfolio management governance process leads to a higher performance of the IPPM process, which is reflected in a better performance of the products in the market and, in turn, in a better performance of the firm within its industry.

The second contribution of this study is related to the connection between the quality of the decision-making process with portfolio agility. Extending the studies of Kester et al (2011, 2014) and Kock and Gemünden (2016), this current study investigates the components of the decision-making process and how it influences portfolio agility, which is key to analyze what factors enable firms to make better decisions and implement them more quickly and comprehensively. In an opposite way to Kock and Gemünden's (2016) finding, this study argues that a high quality decision-making process can slow down decisions in favor of assertiveness of the decision. In doing so, firms can develop competencies in the sense that they can quickly shift its development focus to incorporate a new technology into its product line, and quickly eliminate a project that either no longer strategically fits the portfolio, or that has become technologically disadvantaged (Kester et al., 2011). Moreover, in developing an agile decision-making process for portfolio management can enable the development of an agile organization (Sull, 2010).

As a third contribution, this study investigates how the environmental turbulence affects the quality of the decision-making process and portfolio agility. As noticed during the interviews, the effect of changed conditions may not have a huge effect on well-established decision-making process and portfolio agility because organizations can predict these situations when designing their processes. The contrary may not be true, i.e., low-quality decision-making processes can be affected by these environmental turbulence, but additional studies may be done to deep dive into this scenario.

A fourth contribution of this study is related to the impact of the personal style on the quality of the decision-making process. Since the governance rules of firm Alpha ties the decisions to a set of information and procedures, different styles of decision-makers could not be fully investigated because the process enforces decision-makers to follow the rules. However, one interesting contribution of this study to people designing IPPM processes is exactly the point that a well-designed governance process can mitigate power- and opinion-based decisions once ideas and projects need to be in the right level of maturity to move on throughout the Stage-Gate® process.

As a final theoretical contribution, this investigation extends Petit's study (2010, and 2012) by applying the DC framework of Teece et al. (1997) in investigations of IPPM processes. By doing that, it enriches the scarce literature of IPPM and DC framework, and gives additional subsidies to future studies on that field.

In terms of practical contributions, this research helps Project Management Offices (PMOs), innovation managers, project managers, decision-makers, portfolio managers, CEOs, and shareholders. PMOs and innovation managers can benefit from understanding the dynamics of a decision-making process and how its quality can influence portfolio agility. By doing that, they are able to design robust practices and governance rules to accelerate portfolio decisions and prevent projects and decision-makers from overlooking formalities and decreasing the quality of process.

Project managers can benefit from a quality decision-making process by having clarity on how to manage their projects, what are the conditions and pathways to progress with their projects throughout its project life cycle, and what are the expected conditions and information to accelerate buy-ins from stakeholders.

By understanding the importance and the effect that a robust decision-making process can have on portfolio agility, decision-makers and portfolio managers will be willing to stick to processes, have clarity about their roles, and help PMOs and innovation managers on maintaining a healthy decision-making process because it tends to benefit them in different horizons of time.

As the last beneficiaries of having a quality decision-making process that influences the portfolio agility, CEOs and shareholders will benefit from a higher IPPM performance that can be achieved by better processes, which in turn increases the overall firm performance that is pursued by any top manager.

Finally, mastering on managing an innovation portfolio can help firms to choose the best set of projects that will (1) maximize the firm's financial results, (2) balance the portfolio

between high and low risky projects, and short-, mid, and long-term launches, and (3) ensure the strategic fit of the projects with the firm's strategy, which are the main objectives of a portfolio manager according to Cooper et al. (1997).

7 CONCLUSION

The main objective of this research is to analyze the influence of the quality of the decision-making process on innovation portfolio agility. This is a case study research in a unique organization where triangulation was adopted in order to cross validate the data collected from different sources: document analyses, twelve interviews with decision-makers in three different regions, and seven direct observation in innovation committees.

The discussions around the data collected leads to the conclusion that the quality of the decision-making process is not always translated into portfolio agility once better founded decisions require a reliable and complete set of information that are not readily available in most of the cases due to specific and uniqueness conditions of each project. On the other hand, organizations are able to structure themselves in order to facilitate and accelerate information availability, therefore, this is not just a matter of establishing a robust and clear decision-making process but also designing their organizational structure to better support development teams.

Turbulent and uncertain environments can affect the quality of the decision-making process and the portfolio agility, but organizations can design their IPPM processes to better deal with changing conditions and to mitigate unfounded decisions. Well-designed IPPM processes reduce opinion-based decisions in turbulent environments by providing a complete set of auxiliary information and paths that can be adopted by decision-makers, allowing them to follow the procedures as much as possible and avoiding shortcut formal decision-making processes.

Personal evidence-based style can or cannot affect the portfolio agility when there is lack of data; it depends on how urgent and important a decision is. Decisions that have to be made in a certain point of time will be made regardless of data availability; on the other hand, non-urgent decisions tend to be adjourned due to lack of data, negatively affecting portfolio agility. Personal opinion- and power-based styles also can or cannot affect portfolio agility but depending on the quality of the decision-making process. High quality decision-making processes prevent decision-makers from making unfounded decisions because the process establishes clear governance rules and practices that have to be obeyed.

There was not analyzed any correlation between portfolio agility and shorter project development times in firm Alpha. However, there was found some indications during the interviews that faster decisions may have a very limited influence on the whole project development time because most of the project lifecycle is consumed by development activities

and not waiting for decisions. Of course, this can be a characteristic of firm Alpha and may not be extended to other companies.

7.1 LIMITATIONS AND FUTURE WORK

This study has clear limitations and some of them can be translated into opportunities for future researches. The most prominent limitation leads to the few number of interviews that were conducted. Twelve decision-makers of a single organization were interviewed to analyze and end up in a conclusion about how the quality of a decision-making process can influence innovation portfolio agility. Since this subject is not fully understood yet, I suggest a large qualitative research to interview hundreds of decision-makers in multiple organization in different regions. This multiplicity of case studies would allow to explore how organizations behave under different environmental turbulences and determine in large scale the effect of it on the quality of a decision-making process.

Another limitation of this study is that it was not possible to find decision-makers declaring themselves as assuming a power-based style in innovation portfolio decisions. A multiplicity of case studies could also detect power-based decision-makers in a way that it would investigate the effect of this personal style on the quality of a decision-making process and portfolio agility. Moreover, defining a framework or scale to determine the personal styles of the decision makers would bring objectivity to future studies.

The strategic innovation literature that approach decision-making process of innovation portfolios is scarce, lacking objective parameters to determine if one innovation governance process holds high, average, or low quality. The determination of the level of quality of the decision-making process of firm Alpha was conducted through a very qualitative and subjective way, because of the lack of objective parameters to measure it. One suggestion for future work in this sense would be the designing of an objective scale to measure the quality level of an innovation decision-making process similar to those tools to measure the maturity level of a project management teams or a PMO; this would help researchers on standardize these levels of quality and compare different processes in different organizations.

Based on the findings of this study, that argues that a high quality decision-making process slows down portfolio agility for the benefit of more effective and assertive decisions, it would be subject for future works an in-depth case study to analyze the effect of the decision-making quality not only on innovation portfolio agility but on innovation portfolio assertiveness. In a similar sense, a longitudinal case study research could explore the effect of different levels of process formality on portfolio agility of an organization.

Another limitation of the design of this research is that it does not investigate the effect of portfolio agility on project development lifecycle, also known as project lead time, i.e., the time to develop a project. One interviewee mentioned that decisions taking longer to be made may affect short-term projects more than long-term ones. A future work could build this correlation to analyze if portfolio agility accelerates projects or not.

The literature about decision-making quality, portfolio agility, and the use of dynamic capabilities to analyze innovation processes is very scarce to date so there is an ample avenue of research. Given that, and trying to expand the limited knowledge of this field, I call for more studies that could help researchers and practitioners of innovation subjects.

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APPENDIX A – Preliminary Interview Instrument

Metadata and guidance

Interviewee name: _____

Name of the researchers present: _____

Date: ____ / ____ / ____ **Local or Channel:** _____

Initial contact:

- Thank for the availability to receive the researcher(s).
- Briefly present the research objectives.
- Explain the information contained in the interview consent form.
- Request the signing of the interview consent form.
- Deliver a signed road for the interviewee.

Initial procedures:

- Prepare the recorder.
- Start recording.

Interview questions:

Code	Grouping	Interviewee questions	Reference
-	Interviewee data	What is your sex?	-
-	Interviewee data	What is your age?	-
-	Interviewee data	Where are you from?	-
-	Interviewee data	What is your educational level?	-
-	Interviewee data	What department do you work?	-
-	Interviewee data	What is your level of involvement in innovation portfolio decisions?	-
-	Interviewee data	What is your region of actuation in regarding with innovation portfolio decisions?	-
-	Interviewee data	What is your level of seniority?	-
Code	Grouping	Sense questions	Reference
SS01	Information sensing	How and from who do you get the information about new opportunities and threats?	Kester et al. (2011); Teece (2007).
SS02		Is the information sensing mechanism, which you are involved in, a formal process or you have to search for information by yourself?	Kester et al. (2011); Teece (2007).
SS03		Is this a satisfactory process or you have suggestions to improve the information sensing mechanism?	-
SS04	Turbulence	What kind of uncertainties do you deal with when making a portfolio decision?	Teece (2007); Kock and Gemünden (2016).
SS05		How frequent do you face changed customer needs, changed strategic goals or any other kind of changed condition?	Teece (2007); Kock and Gemünden (2016).

SS06	Strategy communication	In case of changes in the organizational or business unit strategic goals, are they effectively communicated to portfolio decision-makers?	Teece (2007); Kock and Gemünden (2016).
Code	Grouping	Seize questions	Reference
SZ01	Practices and processes	Is there a formal decision-making process in place to support project portfolio decisions?	Teece (2007).
SZ02		Describe how this formal process, if any, slows down or speeds up a project portfolio decision.	Teece (2007); Kester et al. (2011); Kock and Gemünden (2016).
SZ03		Do you tend to shortcut the formal decision-making process, if any, in face of environmental turbulence or urgent situations?	-
SZ04	Seized information	What are the variables you personally take in consideration when making portfolio decisions?	Teece (2007); Kester et al. (2011).
SZ05		Does the process provide all the information you need to make founded portfolio decisions?	Teece (2007); Kester et al. (2011).
SZ06		Do you tend to postpone a decision in case of lack of information?	Teece (2007); Kester et al. (2011); Kock and Gemünden (2016).
SZ07	(De)centralization	Are the decisions that you are involved in, or that affect you, taken collectively or enforced (top-down)?	-
SZ08	Personal style	How would you describe your personal style in portfolio decisions (evidence-, opinion-, or power-based)?	Kester et al. (2011).
Code	Grouping	Transform and reconfigure questions	Reference
TR01	Portfolio agility	How long do you take to adapt your portfolio of projects since sensing a changed customer need or competitive condition?	Teece (2007); Kock and Gemünden (2016).
TR02		How long to you take to adapt your portfolio since sensing a changed resource situations?	Teece (2007); Kock and Gemünden (2016).
TR03		How long do you take to adapt your portfolio since sensing new technologies?	Teece (2007); Kock and Gemünden (2016).
TR04		How long do you take to adapt your portfolio since sensing to changed strategic goals?	Teece (2007); Kock and Gemünden (2016).
TR05		How long do you take to adapt your portfolio of projects since seizing a changed condition?	Teece (2007); Kock and Gemünden (2016).

Final considerations:

- Ask interview if there is any suggestion about what could be done to accelerate the decision-making process or the implementation of these decisions.
- Ask the interviewee if there is any additional information that I would like to add regarding the subjects covered during the interview.
- Ask if the interviewee had any questions.

Finalization and thanks:

-
- Thank the availability of the interviewee in providing the information.
 - Emphasize that the results of the research will be available to him or her and, if he/she has an interest, he/she should contact the researcher.

APPENDIX B – Interview Consent Term



Pontifícia Universidade Católica do Rio Grande do Sul
Business School
Graduate Program in Administration

INTERVIEW CONSENT TERM

Research Project: Decision-making quality as mediating factor for innovation portfolio agility: in-depth case study using Dynamic capabilities framework: Dissertation Project
Researcher: Tiago Argimon Hermann (tiagohermann@hotmail.com).
Advisor: Professor Marcirio Silveira Chaves, PhD (mschaves@gmail.com).

Dear Sir / Madam,

This document is an interview consent form. Therefore, Mr.(s). is being invited to participate as an informant of a scientific research on a voluntary basis. Any questions you have will be clarified by the researcher and you have the right to quit from participating in the interview at any time, without any charge. All information provided by the participant will be analyzed impersonally, remaining confidential.

We thank you in advance for your willingness to contribute to this study and we remain at your disposal to clarify any present or future questions. Also, if you are interested in the result of the research, please send an e-mail to the researcher mentioned above.

I, _____, declare that I have been informed of all the investigation procedures and all my doubts have been clarified. I further declare that I am aware that the data collected will be used as survey data. Therefore, I sign the present document in two ways of equal content and form, remaining a route in my possession.

I authorize recording interviews.

I do not authorize recordings of any kind.

(city), _____ of 2019.

Responsible Researcher

Research Participant



PUCRS

Av. Ipiranga, 6681 - Prédio 50 – 11º andar
CEP: 90619-900 - Porto Alegre – RS - Brasil
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APPENDIX C – Analyzed documents of firm Alpha

This appendix summarizes the list of documents that have been investigated during Document Analysis phase. There is a comprehensive PowerPoint document which centralizes most of the information about the processes in place to manage the innovation of firm Alpha. There is also a Word document that describes the same processes but in a textual format. In addition to them, there is a set of smaller documents that complement these two major documents.

Overall Innovation Governance Process V04 This PowerPoint document contains centralizes most of the information about the procedures that govern the innovation of firm Alpha. This is a working document that is constantly updated every time a change in the process takes place. This is a global document.

PR 2010-00006

This is the formal document describing in a textual format the innovation governance rules. This is a document approved by the innovation leadership and serves as an official reference for audit purposes. This is not updated every time the process change but from time-to-time. This is a Brazilian document.

Global Innovation Dashboard

This is an Excel document that contains the list of all projects under development along with a set of project and portfolio indicators to help portfolio managers manage their portfolios. This is issued every month. This is a global document.

IPAC gate meeting

This is a PDF file that describes some specific rules for the USA innovation teams in regarding the dynamics of the gate meetings and who the gatekeepers are.

Virtual Committee Process – rev06

This is a PowerPoint document that describes in detail the process of requesting gate approvals by e-mail and who the gatekeepers are to each business unit. This is updated regularly.

I&T 3rd Quarter Report 2019

This is a PDF file that is shared every quarter containing the complete set of indicators and KPIs, as well as, highlights, lowlights and product launches. This is shared with all leaders within innovation.

I&T Innovation Metrics & KPIs

This PDF file documents all the metrics and KPIs the innovation leadership establishes every new year.

Financial Worksheet V2.3

This is an Excel worksheet used by Project Managers to determine the Net Present Value of the projects, which is used as a key information to define the priority of the projects.

Microsoft Project Online

This is a software where all the innovation ideas and projects are registered and managed. Most of the governance rules and practices are automated in this system, preventing projects from moving throughout the stage-gate system without having the mandatory information complete.