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Concept development by redesigning internal collaborative processes

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Abstract

The new product development (NPD) process is critical for organizational success representing a source of competitive advantage. However, most development efforts fail at high rates.

In fact, the progress of projects being developed on the Future Concepts department of the company where this project was developed was very low. To better understand the NPD general background and the theoretical reasons leading to its unsuccess, a Literature Review was performed, resulting on the development of a conceptual framework supported by the traditional NPD Body of Knowledge (BoK).

Moreover, a research methodology was followed to collect and analyze relevant empirical data regarding the company's NPD context concerning the description of the "as-is" status. Meetings with Future Concepts developers occurred, department internal documentation was analyzed, and in-depth interviews with top managers from other crucial departments, were conducted. Lack of communication between departments and the project handover content quality were among the main reasons for unsuccess.

A structured but flexible NPD process able to involve actors from different areas, collect their knowledge and use it to support decision-making was designed, based on the developed conceptual framework and using Business Process Model Notation (BPMN) to operationalize the solution on the exploratory case study of the sponsor.

During the discussion of the project results, the knowledge diffusion BoK was identified as being a missing link in the classical NPD process. The innovative impact of the knowledge diffusion on the developed framework has showed up as a relevant recommendation for future work regarding NPD process development.

Key-words: New product development; Process design; Communication; Knowledge diffusion

JEL Classification: O32, D80

Sumário

O processo de desenvolvimento de novos produtos (*NPD)* é crítico para o sucesso das organizações, representando uma fonte de vantagem competitiva. Contudo, a grande maioria dos projetos desta natureza falha.

Identificou-se um reduzido nível de progresso nos projetos provenientes do departamento de *Future Concepts* da empresa onde este se projeto se realizou. Para melhor compreender a área de *NPD* e identificar as razões teóricas conducentes ao seu insucesso, realizou-se uma revisão da literatura, que possibilitou desenvolver um modelo conceptual suportado pelo conjunto de conhecimento (*BoK)* de *NPD* tradicional.

Por forma a recolher e analisar os dados empíricos referentes ao estado atual da área de *NPD* da empresa, seguiu-se uma metodologia de investigação. Realizaram-se reuniões com trabalhadores do departamento, analisou-se documentação interna utilizada e conduziram-se entrevistas com gestores de topo de outros departamentos, cruciais para o sucesso do *NPD*. Falta de comunicação entre departamentos e a qualidade do material transferido para futuro desenvolvimento foram os principais motivos identificados para o insucesso.

Através da utilização de *BPMN*, operacionalizou-se a solução deste caso de estudo exploratório. Assim, desenhou-se um processo de NPD estruturado e flexível, capaz de estimular o contacto entre atores provenientes de diferentes áreas, colher o seu conhecimento e utilizá-lo no suporte à tomada de decisão.

Durante a discussão de resultados, identificou-se o *BoK* relativo à dimensão da difusão de conhecimento como um elemento em falta na abordagem clássica ao NPD. O impacto inovador desta dimensão no modelo conceptual resulta numa recomendação relevante para trabalhos futuros relativos ao processo de *NPD*.

Palavras-chave: Desenvolvimento de novos produtos; Desenho de processos; Comunicação; Difusão de conhecimento

Classificação JEL: O32, D80

Acronyms and abbreviations

BoK – Body of Knowledge

BPMN – Business Process Model Notation

BPR – Business Process Reengineer

CRM – Customer Relationship Management

FC – Future Concepts

IRR – Internal Rate of Return

KBV – Knowledge Based View

NPD – New Product Development

NPV – Net Present Value

PA – Process Automation

PAT – Process Analytical Technology

R&D – Research and Development

RQ – Research Questions

R-W-W – Real Win Worth it method

T-I-OE – Throughput-Inventory-Operating Expense

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1. Introduction

1.1. Background Information

Between September of 2017 and August of 2018, the author had the incredible opportunity to live in a small city in the southwest of Germany where during this period, it was possible to develop this Business Project at an international Company founded in the mid 1920's, which is nowadays present in more than sixty countries operating mainly on the industrial automation segment. This business project focuses on the specific context of this company and uses as basis specific information collected during the internship. The Company is currently segmented into five business units: the pneumatic factory-automation unit, the electronic automation unit, the customer solutions unit, the process automation unit and a didactic subsidiary created mainly to cover training needs. This internship was performed in the Process Automation (PA) unit, more specifically, in Future Concepts department.

The aim of this department is to identify new trends in the process industry, combine them into clusters and develop new concepts that will cover future needs of the industry. The department plays, therefore, a central role in the future success of the Company, since its pursuit for radical innovation developments can allow the Company to transit from follower to leader in this specific industry.

The roadmap that defines the scope of the work developed on Future Concepts department is the radar chart presented on *Figure 1*. This chart was developed by Future Concepts department members and it is used to ensure that all new projects are aligned with the department characteristics and goals. It was built by studying a wide range of relevant sources related to the industry and then, by defining all the possible trends that could become important on its practical context, which will be used as basis for future projects development. The chart is composed by three main sectors. The Technologies sector identifies trends by focusing on the analysis of competitors technologies and processes, the Optimization with Process Analytical Technology (PAT) aggregates trends specifically related to plant efficiency and finally, the Smart Modular Systems sector is focused on more long-term oriented trends related with the standardization of components used in production. The identified trends were aggregated according to the field to which they relate, originating clusters. The same aggregation happened with the clusters which together compose segments. In other words, a cluster consists in a set

of trends and a set of clusters defines a segment. The radar chart aggregates, therefore, all the identified segments, clusters and trends of the industry that guides the entire work developed on the Future Concepts department.

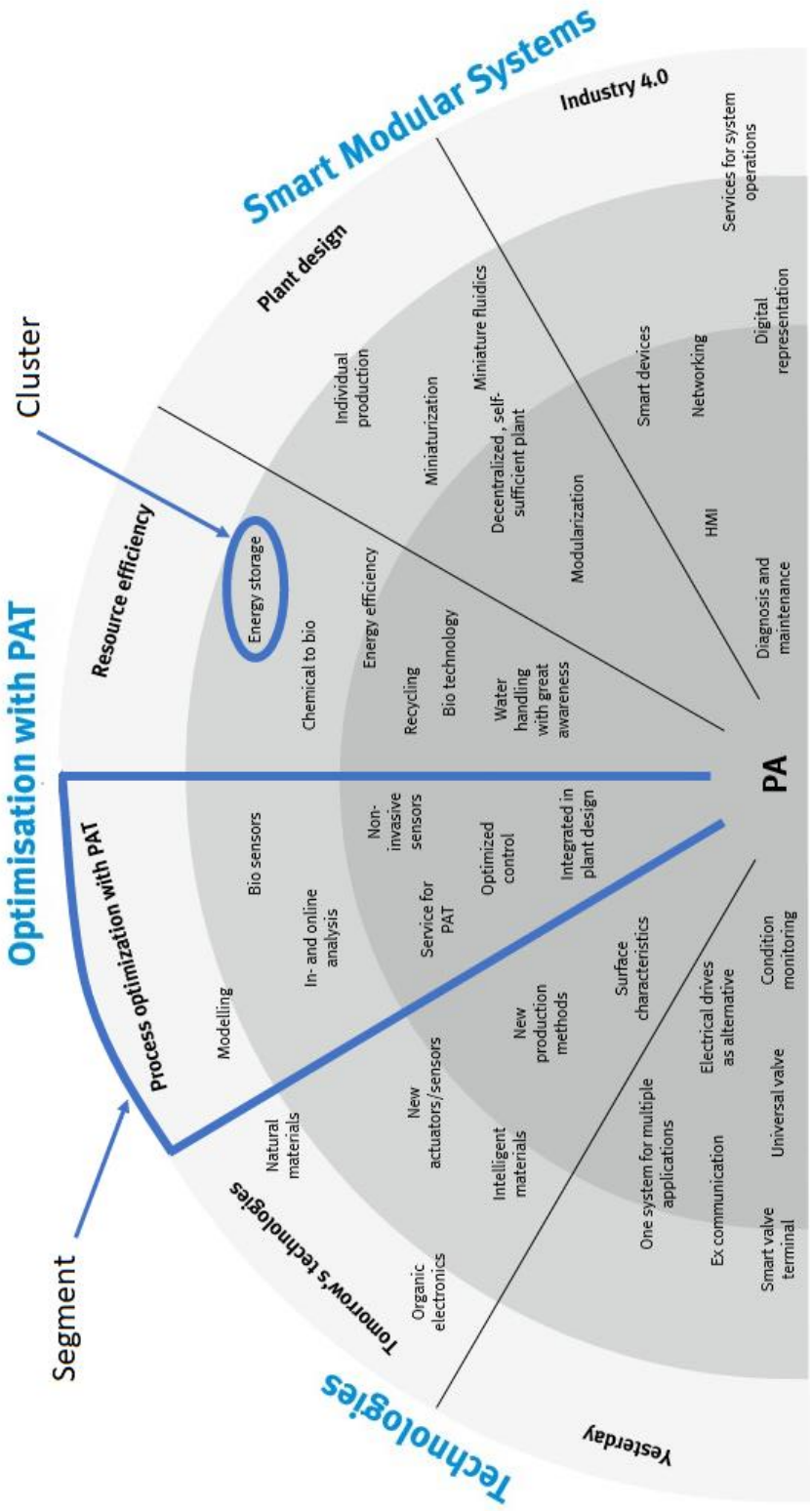

Figure 1 - Radar Chart (Source: Company)

1.2. Business Problem

Predicting the future is a "power" that every single Company in the world would like to have. If a Company knew today how tomorrow will look like, it could plan exactly what to do in order to be ahead of competition and lead the market. This is obviously impossible. It is not possible to see today precisely what customers will consider important in 10 years. However, it is possible to understand and decide the path that a Company needs to follow in order to be positioned in a certain place in the future. This path is cultural and led by making efforts towards innovation.

Before the internship started, a meeting with one of the business project tutors was scheduled. This tutor is the head of the Future Concepts department, which is focused on identifying trends that can reveal relevant in the future, and operationalize them to develop opportunities in any possible way *i.e*. new products, processes, working procedures, etc. In this meeting, the department leader presented an issue that was facing managing the work. His team was able to identify some trends and opportunities and sometimes they could even transform these opportunities into projects. However, the acceptance rate of these projects into next stages of development outside the department was very low and recurrently rejected on steering committees (meetings where new projects of the department were presented for approval to a board composed by several departments top management). As previously mentioned, and due to the nature of the projects pursued by Future Concepts, this department can play a central role in the definition of the Company path towards the future, since the work performed here is focused on the identification of possible ways to innovate and differentiate from competition. In the long term, this work could have the power to transform a current follower company into a leading one.

This business project has born due to the urgent need to change this scenario in order to enable Future Concepts to succeed on the development of their projects. For this, the *status quo* must be questioned, being the main goal of the project to develop effective and assertive measures and working procedures that can have real impact on the way the department is working and ultimately, on its performance level.

The challenge is, in a broad way, to identify the reasons that were leading the projects developed on the department to have such a low rate of acceptance by the next responsible departments regarding development, and to present working procedures to improve the current scenario.

1.3. Context

NPD is a critical activity since the launch of new products is in fact the nexus of competition for many firms (Clark and Fujimoto, 1991). On the one hand, Companies able to quickly develop exciting products that people become anxious to buy, are likely to win. On the other hand, Companies that take too long to introduce new products or do not follow the correct processes to develop them, are likely to lose. It is then possible to state that product development is a potential source of competitive advantage for many firms (Brown and Eisenhardt, 1995). NPD is among the essential processes for success, survival, and renewal of organizations, particularly for firms in either fast-paced or very competitive markets (Brown and Eisenhardt, 1995).

In earlier eras, expertise could be centralized in a single person who knew (or developed) the product technology, production process, and means to market goods to others (Griffin and Hauser, 1996). Nowadays, however, the communication and exchange of information between a big set of areas of expertise within the firm become a major requirement for the success of the NPD process, since the process uses as inputs several outputs linked to a very wide range of knowledge fields, becoming a transversal process. To achieve this, many firms adopted flatter management structures, cross-functional teams, and cross-discipline management processes to start working collaboratively regarding NPD. These are the companies succeeding nowadays (Griffin and Hauser, 1996).

To be a truly world-class organization, the company needs, therefore, to work as a team and all the functional areas of the business need to be properly integrated, with each understanding the importance of cross functional processes. As the basis of competition changes from cost and quality to flexibility and responsiveness, the value of process management is now being recognized. The role that process management can play in creating sustainable competitive advantage was termed Business Process Reengineering. The aim of reengineering in this environment is to facilitate the match between market opportunities and corporate capabilities by processes redesign, and so, ensure corporate growth (O'Neil and Sohal, 1999).

Successful innovation requires an integrated design process, *i.e*. integration in the design of the enterprise, the design of the product, as well as the design and implementation of new technologies. Such an integrated design effort requires good collaboration and management of the designs and should be supported by efficient knowledge management techniques and tools (Du Preez and Louw, 2008).

The evaluation of investments in Research and Development R&D projects is a crucial topic in R&D management. High uncertainty and the enormous pressure to innovate in R&D intensive industries force the use of sophisticated instruments which help to evaluate chances and risks of R&D projects as well as to choose the 'right ones' (Perlitz et al., 1999). Methods for economic analysis are currently the most diffused methods for evaluation of innovation projects (Ryan and Ryan, 2002). Although the existing methods largely differ in their implementation, they all share a common principle, that is, the capital budgeting approach for calculating the economic return of a project as a sequence of discounted cash flows (Chiesa and Frattini, 2009).

These factors are not being completely fulfilled with the current process in place, which is leading to the main issues that generated the need to develop this project, *i.e.* to increase the success rate of new projects. Lack of assertive communication between the departments involved in the process, *i.e.* Development department, Sales department and Product Management department, lack of potential economic justification associated to the projects in order for decision makers to understand the real benefits of the projects and An unstructured and clear way to present the projects and transfer them for further stages of development, appear to be on the basis for this low success rate.

These issues will be explored along the project and procedures to overcome them will be presented.

1.4. Goals and purpose

As previously mentioned, the main goal of this business project is to develop measures at the structural basis of the business processes that will allow *to increase the success rate of projects that are born in the Future Concepts department, regarding further development efforts in the next stages of the product development process.*

The purpose of this business project is to achieve a reengineered process that selects the best innovation opportunities based on the analysis of several internal and external factors, *e.g.* market analysis, customer perception, time to market requirements, internal capabilities and capacity, etc., that demands interactions with other departments playing key roles on the process to take decisions, *e.g.* Development, Product Management and Sales departments, and that provides the tools to perform several analysis to justify why should the projects be pursued, *e.g.* NPV, Risk, and sensitivity analysis.

Based on the context explicit on section 1.3, and to understand the common problems regarding this scenario, a literature review focusing on five main areas, strongly connected on the context of this project, was developed following the guidance provided by the research questions expressed in the following section. Firstly, *NPD process* best practices were studied to understand how they can be incorporated in the department case. Secondly, the characteristics and tools associated with *business process reengineering* (BPR), to assess in which dimensions can the process be improved were analyzed. Thirdly, the *NPD performance evaluation* field was explored to understand which methods should be used to evaluate projects regarding their potential benefits and, in this sense, justify their needs of investment. Moreover, information regarding a *business case structure* was gathered to understand how a project should be properly documented and presented. This resulting structured document can allow the actors in the next stage of the development process and the decision makers to clearly see what the projects are about and what are the benefits attached to their development in a standardized way. And finally, the relevance and benefits of *collaborative working procedures* were studied in order to be able to show to the real actors of the process the importance of their individual activities in the *big picture* scenario.

The goals of this business project are then to:

G1) Identify the main issues that are leading to the very low success rate of Future Concepts projects.

G2) Incorporate the best-practices on the Future Concepts NPD process design and apply the best tools to map it.

G3) Guarantee that the process ensures the development of a financial analysis.

G4) Develop and implement a tool that is capable to aggregate and standardize all the information collected along the process.

G5) Guarantee that external relevant actors interact with the process and feed it with crucial information.

1.5. Research Questions

Setting out the Research Questions (RQ) based on a preliminary literature review is a very important step in the research process, because they narrow the research purpose to specific questions that researchers attempt to address in their studies (Johnson & Christensen, 2004).

In this context, and in order to achieve the established goals for this business project, five Research Questions were defined as follows:

RQ1) Why is the success rate of Future Concepts projects so low?

RQ2) What are the benefits of having a formal structured NPD process?

RQ3) Which tools can be used to design the process for this specific case?

RQ4) How can the most relevant information collected along the development process be aggregated and stored on a standardized and structured way?

RQ5) How can knowledge from other relevant departments for the process be incorporated on the Future Concepts NPD process?

1.6. Methodology

To achieve the previously established goals (*vide section 1.4*), a path was defined to follow and structure the business problem solving process. This path and the methods used along the entire development of this business project to achieve the established objectives and to answer the defined research questions, are highlighted on this chapter.

In the first place, it is important to understand the perspective of the real actors that are involved in the process in a practical way, since they can provide valuable inputs regarding the problematic under study. For this, in-depth interviews with different actors from different departments will occur to identify potential improvement areas and understand their singular perspective regarding why projects from the Future Concepts are not being successful. These interviews can potentially provide very useful guidance to understand the direction that the solution for this business project can take and in which specific areas should it focus. Eight interviews will take place with different actors from different areas.

The current process procedures together with all the documentation used along to support the development will be analyzed, since it is crucial to understand which processes are in place and which support tools and documents are used by the team for the development of new projects.

Regular fixed weekly meetings with one of the project tutors will occur to guarantee the alignment with the company and department needs.

The collected data will be analyzed according to the method presented by Miles and Huberman (1994) which consists on data reduction, data display and conclusions verification.

1.7. Business Project structure

The developed business project is divided into seven main sequential chapters.

On the first chapter, which is the ***Introduction***, general information that frames the entire project is presented. The chapter starts by introducing information about the company and the department where the project was developed, then the business problem is identified together with its specific context, and finally the goals and RQs are revealed.

The second chapter contains the ***Literature Review*** that was conducted to enable the acquisition of theoretical knowledge guided by the research questions content. The NPD activity is analyzed in detail by stressing some of the best practices on the market and its economic success, the process reengineering methods and tools are identified and studied, factors affecting NPD performance are discussed, the business case models are analyzed, and content related to resources relationship management is presented.

The third chapter consists on the ***Conceptual Framework***. On this chapter a Literature review synthesis that summarizes relevant collected knowledge from the literature is presented, and what is going to be done to achieve the previously set goals is exposed.

The fourth chapter details the ***Methodology*** used on this business project. The different sources for data collection and the method that will be used for data analysis are explained.

The fifth chapter presents and details the ***Case Study: Results analysis and developed solution***. The chapter starts by exposing the results from the data analysis performed to the collected data and by presenting a preliminary discussion regarding the identified root causes of the problem that will further be used as the foundations for the developed solution. Not only the activities and subprocesses from the designed NPD process developed using BPMN are sequentially introduced and explained, but also all the required interactions between different actors involved on the process are stressed, and the developed documentation and tools to be used during the development are presented.

During the business project development, the knowledge diffusion dimension revealed crucial to be considered on this specific case. In this context, chapter 6 was developed and it consists on the ***Discussion of the Impact of the Knowledge Diffusion Dimension on the Project.***

The business project ends with the ***Conclusions*** chapter, where the most relevant conclusions of the business project are presented and the RQ's are formally answered. Suggestions for future work and the contributions brought by the present business project are highlighted.

2. Literature Review

A review of prior, relevant literature is an essential feature of any academic project since it creates a firm foundation for advancing knowledge (Webster and Watson, 2002).

Bell (2014) states that the literature review should be focused on the research questions and objectives previously determined, trying to offer relevant information to answer the questions and guidelines to achieve the objectives.

In order to answer the previously defined research questions and fulfil the established goals, this literature review is divided into five main related areas. It starts with the analysis of the characteristics and importance of the NPD process for the organizations, highlighting at the same time its best practices. Secondly, the BPR concept is analyzed and its benefits are exposed, also in this stage the main tools to perform it are studied and analyzed. Thirdly, the NPD performance measurement field is explored highlighting the most relevant factors leading development efforts to unsuccess. Fourthly, a business case structure is presented and is showed how this tool can be used to aggregate the most relevant information regarding new projects in a standardized manner. At the end of this literature review, the importance of the collaboration working procedures between the key actors involved in a process is explored and its benefits highlighted.

2.1. Economic Success in NPD

Companies strive to develop and produce exactly what customers want, when they want it and to accomplish all of that with no risk of overstocks. But such a manufacturing nirvana has become increasingly difficult to attain, given customers' quickly changing preferences, the heterogeneity of their demands and the resulting micro-segmentation of many product categories. Today, many consumer goods companies have been forced to accommodate smaller markets, as these niches often provide the only path to growth and escape from heavy price competition (Ogawa and Piller, 2006).

In the '80s, Goldratt et al. (1986), were already affirming that in that time people were living in a period where, if a company was late to the marketplace with a new product by six or nine months, it has the risk of losing the entire market.

In this context, for an organization to grow and prosper is crucial to have the ability to generate new ideas and solutions and exploit them effectively for the long-term benefit of the organization (Flynn, M., et al., 2003).

In a commercial company, the success of product development results in products that can be produced and sold profitably. However, profitability is difficult to assess quickly and directly but should be considered when the process is designed. Ulrich and Eppinger (2015), suggested five dimensions ultimately related to profit that could be used to assess the performance of a product development effort.

The first dimension is product quality. How good is the product resulting from the development effort? Does it satisfy customer needs? This dimension is ultimately reflected in market share and the price that customers are willing to pay. The second dimension is the product cost. What is the manufacturing cost of the product? Product cost determines how much profit accrues to the firm for a particular sales volume and a specific sales price. The third dimension is the development time. How quickly did the team complete the product development effort? The development time determines how responsive the firm can be to competitive forces and technological developments. The fourth dimension is the development cost. How much did the firm have to spend to develop the product? Development cost is usually a significant fraction of the investment required to achieve the profits. The fifth and last dimension is development capability. Is the team and the firm able to develop future products better, as a result of their experiences with a product development project? Development capability is an asset that the company can use to develop products more effectively and economically in the future (Ulrich and Eppinger, 2015).

Goldratt et al. (1986), suggest a different approach regarding the possible profitability achievement. According to this author, the cost blocks should be replaced by three operational measures that ultimately will define profitability. These are *throughput*, *inventory* and *operating expense*. *Throughput* is defined as the rate at which an organization generates money through sales. Notice, through sales, not through production. If something has been produced but not sold, it's not throughput. *Inventory* represents all the money that the system invests in purchasing things that it intends to sell. The author states that this definition of inventory deviates from traditional definitions since it excludes the added value of labor and overhead. This definition was chosen to mitigate the distortions and counter-productive decisions caused by accounting generated inventory profits and inventory losses. And finally, *operating* expense is all the money the system spends to turn inventory into throughput.

If actions that increase these three measures at the same time are taking simultaneously the projects are certainly moving in the right direction.

The intuitively felt connection between throughput-inventory-operating expense (T- I-OE) and the bottom line measures are sharpened with these definitions. It is possible to see that when throughput is increased without adversely affecting inventory and operating expense, then net profit, return on investment and cash flow are simultaneously increased. The same result can be achieved when operating expense is decreased without an adverse effect on throughput or inventory. When analyzing the impact of reducing inventory the result is not the same. Decreasing inventory directly increases only return on investment and cash flow and it does not have any direct impact on net profit. Should inventory be considered as less important than throughput and operating expense? This is the way that most managers have historically viewed T-l-OE. Net sales (throughput) and total operating expense have always been seen to be important and inventory has frequently taken a less relevant role. When looking more closely, it is possible to conclude that inventory does impact net profit and has an additional effect on the other two bottom-line measurements. However, these impacts are indirect - through the carrying charge channel (Goldratt et al., 1986).

2.2. NPD Process Best Practices

The emphasis on NPD has spurred researchers from strategic management, engineering, marketing, and other disciplines to study the NPD process. However, despite all efforts, new product failure rates are still very high. Many projects never turn to a commercial product, and between 33-60% of all new products that reach the marketplace fail to generate an economic return (Schilling and Hill, 1998). The ability to get better at the innovation process to drive new products (NPD process) from idea to market faster and with fewer mistakes is the key to win this war (Cooper, 1990).

The NPD process is the sequence of steps or activities that an enterprise employs to conceive, design, and commercialize a product.

In the next sections, two different approaches to manage innovation in the product development context are presented. Firstly, the dimensions of the generic product development process suggested by Ulrich and Eppinger (2015) are analyzed, and after the Fugle innovation process model developed by Du Prez and Louw (2002) is detailed.

2.2.1. Planning

This is the most relevant phase regarding this business project context since it considers the entire set of required activities that will generate opportunities and transform them into projects. The planning stage is often referred as “phase zero” because it precedes the project approval and launch of the actual product development phase. This phase begins with opportunity identification guided by corporate strategy and includes assessment of technology developments and market objectives. The output of the planning phase is the project mission statement, which specifies the target market for the product, business goals, key assumptions, and constraints (Ulrich and Eppinger, 2015).

Over the past years, much attention has been focusing on managing the process of exploiting identified opportunities and progressing them into innovative projects. However, the process by which organizations generate these ideas and solutions has remained relatively unexplored. Since the idea creation phase of the innovation process is relatively less costly in comparison to the later development stages of the process (Rochford, 1991), it is logical to maximize the output of the idea creation phase. In doing this, a larger number of higher quality opportunities will be available for exploitation. Thus, through this greater choice of potential innovations as input for the innovation process, it is probable that the eventual outputs will be more effective and profitable since increased competition between ideas will ultimately improve the quality of potential innovations being presented to the process (Flynn, M., et al., 2003).

2.2.2. Concept Development

In the concept development phase, the needs of the target market are identified, alternative product concepts are generated and evaluated, and one or more concepts are selected for further development and testing. A concept is a description of the form, function, and features of a product and is usually accompanied by a set of specifications, and analysis of competitive products, and an economic justification of the project (Ulrich and Eppinger, 2015).

2.2.3. System-Level Design

The system-level design phase includes the definition of product architecture, decomposition of the product into subsystems and components, preliminary design of key components, and allocation of detailed design responsibility to both internal and external resources. Initial plans

for the production system and final assembly are usually defined during this phase as well (Ulrich and Eppinger, 2015).

2.2.4. Detail Design

The detail design phase includes the complete specification of the geometry, materials, and tolerances of all the unique parts in the product and the identification of all the standard parts to be purchased from suppliers. A process plan is established, and tooling is designed for each part to be fabricated within the production system (Ulrich and Eppinger, 2015).

2.2.5. Testing and Refinement

The testing and refinement phase involve the construction and evaluation of multiple preproduction versions of the product. Early prototypes are usually built with production-intent parts – parts with the same geometry and material properties as intended for the production version of the product but not necessarily fabricated with the actual process to be used in production (Ulrich and Eppinger, 2015).

2.2.6. Production Ramp-Up

In the production ramp-up phase, the product is made using the intended production system. The purpose of ramp-up is to train the workforce and to work out any remaining problems in the production processes. Products produced during production ramp-up are sometimes supplied to preferred customers and are carefully evaluated to identify any remaining flaws. The transition from production ramp-up to ongoing production is usually gradual (Ulrich and Eppinger, 2015).

2.2.7. The Fugle Innovation Process Model

General innovation models usually neglect or totally exclude the exploitation part of an innovation, *i.e.* to successfully exploit the innovation in different markets and application areas (including exploitation of different business models for the enterprise). This is important since an innovation should at the end generate more value to the company than the cost that it is associated with (Du Prez and Louw, 2008). In this context, Du Prez and Louw (2008) developed an innovation model that has the aim to help businesses to identify, evaluate, develop, implement and exploit new products and services more efficiently and effectively.

The model is centered on a generic innovation process that combines the convergent innovation front-end with the divergent deployment and exploitation of the identified opportunity. The innovation process operates internally in the firm, but all the stages of the process are linked to the external environment. This emphasizes the innovation network factor, as well as the open innovation concept – all the stages could have external influence, or even be outsourced externally. The complete innovation process is guided and supported at the top by the firm's strategies, its human resources and culture, organizational structure and processes, as well as information and knowledge. Although the model has distinguishable stages with gates and filters, the activities within the stages can overlap. Iterative loops are possible between the concept definition and concept feasibility stages, as well as between the deployment and refinement stages. Iterative loops are also possible within the stages, and gates and filters are used as decision points between certain activities and stages. During the idea generation and concept definition and evaluation stages these decision points are called filters. This illustrates the fact that less harsh go/ no go decisions are required during these beginning uncertain stages. Filters are used to evaluate the attractive and less attractive ideas and concepts. The less attractive ideas and concepts should however still be documented and stored for future revisit and evaluation since circumstance may for example be more favorable for these ideas in the future (Du Prez and Louw, 2008). The fugle model can be analyzed in detail on *Figure 2*.

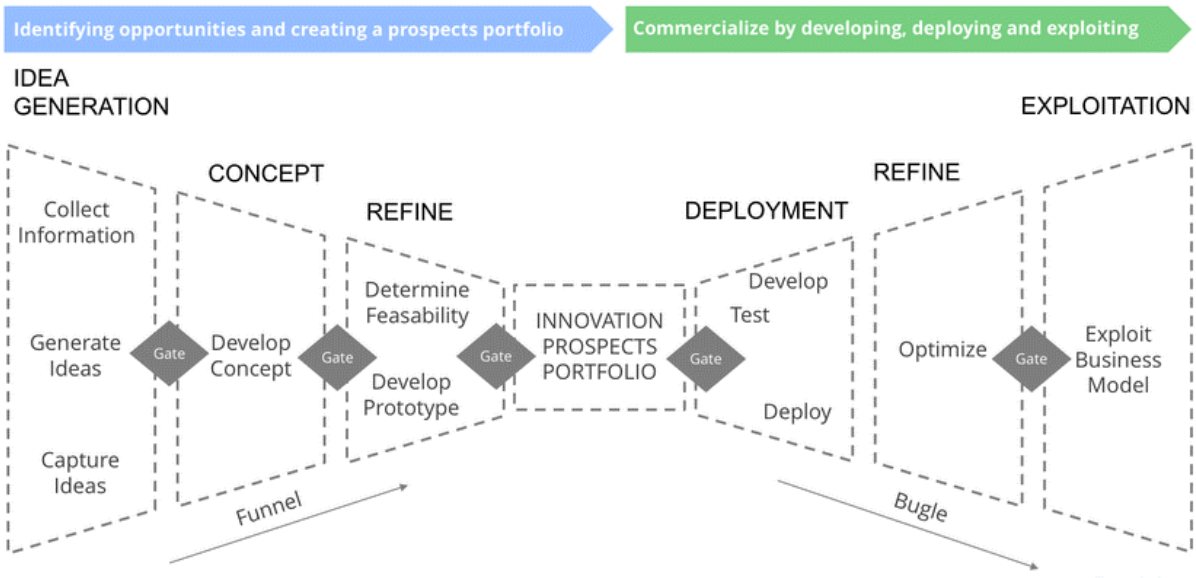

Figure 2 - The fugle innovation process model (Source: Du Prez and Louw, 2008)

The authors clearly define seven stages of the process. Firstly, on the *idea generation and identification stage* new opportunities are identified from several different sources and they are filtered in order to select the most promising ones. Secondly, the ideas are transformed into workable concepts with specific characteristics on the *concept definition stage*. Thirdly, the concepts should be further analyzed, tested and prototyped to study its feasibility level on the *concept feasibility and refinement stage*. Fourthly, the projects are prioritized, and the resources are allocated and assigned with responsibilities on the *Portfolio stage*. After this, the *deployment stage* happens and involves the design, implementation, and testing of the innovation solutions as identified, conceptualized and decided upon the previous stages. The sixth step is the *refinement and formalization stage*, and it is about monitoring, measuring, evaluating and refining the solution until it functions satisfactorily according to specifications. And the last step is the *exploitation stage*. This stage does not occur to all solutions, just for the ones that pass the filter that analyzes which should be further exploited. This stage consists in exploit the solution through new business models and markets with the aim of generate more value from the solution (Du Prez and Louw, 2008).

In *section 2.1* two different perspectives to measure the economic success in the NPD process were summarized and in *section 2.2*, two different approaches to manage innovation by developing new products through processes were presented.

Even though that the two presented approaches regarding the NPD process are different solutions, they have a lot in common and share a significant amount of procedures and knowledge to achieve the same goal. They both suggest that the opportunity identification and concept development should be managed through a process capable to ensure that the most promise opportunities are captured, screened and evaluated to allow, afterwards, the selection of the best projects, aligned with the company strategy.

Also, the way to measure and ensure economic success on the NPD process can follow different perspectives. One presented approach focuses on the product quality and production cost to evaluate if there is an available market willing to pay enough for a certain product with certain features and evaluate several company characteristics to analyze its development capacity, like development time, cost and capability. The other one defends that if the company can reduce inventory level and operational expense, and increase throughput in the process, it ensures its profitability. During this business project, knowledge from the different approaches will complement each other, which will allow to achieve a more sophisticated and complete solution.

2.3. The Business Process Reengineering in NPD Process

To be a truly world-class organization, a company needs to work as a team and all the functional areas of the business need to be properly integrated, with each understanding the importance of cross-functional processes. As the basis of competition changes from cost and quality to flexibility and responsiveness, the value of process management is now being recognized. The role that process management can play in creating sustainable competitive advantage is termed Business Process Reengineering. The aim of reengineering is, therefore, to facilitate the match between market opportunities and corporate capabilities, and in doing so, ensure corporate grow (O'Neill and Sohal, 1999).

The literature related to BPR definition is not unanimous and several authors focus on different approaches. For example, Davenport and Short (1990) describe BPR as the analysis and design of workflows and processes within and between organizations. Hammer and Champy (1993) have promoted the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed. On the other hand, Lowenthal (1994) describes the fundamental rethinking and redesign of operating processes and organizational structure as the focus on the organization's core competencies, to achieve dramatic improvements in organizational performance.

Having these definitions in mind BPR might be understood as the rethinking and redesign of the company processes, in order to improve their performance level and, thus, to achieve previously established goals.

The Japanese competitors and young entrepreneurial ventures proved that drastically better levels of process performance were possible. According to Hammer (2000), in the beginning of the century, the Japanese companies were developing products twice as fast, utilizing assets eight times more productively and responding to customers ten times faster than the American companies. This can be justified since, in the specific context of product development, the Japanese developed outstanding internal communication channels in order to develop products effectively and efficiently, made great use of the suppliers in the development, and developed products taking in special consideration the design for manufacture characteristic (Cusumano and Nobeoka, 1992).

The Japanese success was, therefore, based in BPR, by rethinking and redesigning the traditional NPD process procedures, it was possible to improve its performance levels.

BRP is key in the current ultra-competitive business world. To adapt and find more effective ways to perform is extremely important to keep or increase the competitive level of the companies.

2.4. Business Process Reengineering Tools

As seen before, BPR focus on the radical improvement of processes performance. After reaching this conclusion, it is then important to understand what are the tools and techniques that can be used to achieve the BPR philosophy goals. In the available literature regarding this topic, the most used tools used by researchers and consultants are, as aggregated by O'Neill and Sohal (1999):

Process visualization: Authors like Barret (1994), suggests that the goal should not focus on the development of the "end state" for process intended to be developed. According to the author, the key to success lies in the development of a vision of the process. Process mapping consists of constructing a model that shows the relationships between the activities, people, data and objects involved in the production of a specified output. One reason why process mapping method is so widespread today is that it has been widely recognized that such models can offer useful, and relatively inexpensive, descriptions which can help towards improving and re-designing business processes (Biazzo, 2002).

Benchmarking: According to O'Neill and Sohal (1999), benchmarking forms an integral part of reengineering, since it allows the visualization and development of processes which are known to be in operation in other organizations. Benchmarking can reveal itself very useful in the reengineering context, since it can bring to one company reality, processes that succeed in other companies operating in the same industry segment with similar value propositions. It is, however, important to say that the benchmarking of processes can be a very difficult task since many companies have very rigid measures to protect their processes from their competitors.

Process and customer focus: According to some authors like Chang (1994) or Vantrappen (1992), the primary goal of BPR is to redesign processes regarding the improvement of performance from the customers perspective. The same authors suggest that the focus of BPR should be on the processes that are significantly linked with customers interaction with the company.

It appears that a balanced tool is the combination of the different techniques and tools suggested in the literature, varying the focus according to the specific situation targeted by reengineering.

The process should, therefore, be visualized in order to understand the current scenario. To achieve this, the process flow should be mapped, and responsibilities assigned to the different actors of the process. O'Neill and Sohal (1999) alert to the fact that it should be noted that few authors refer to any single technique when discussing BPR. Most incorporate a mixture of tools, although the nature of the mix depends on the application. While the exact methodologies to be used are the source of some discussion, it can be seen that BPR, as a strategic, cross-functional activity, must be integrated with other aspects of management if it is to succeed.

2.5. NPD Performance Measurement

According to Tatikonda (2007), performance measurement can have three meanings. First, it can imply a specific performance measure (*i.e.*, an actual, definable metric). Second, it can mean the process of measurement (*i.e.*, the systems and organizational processes for going about measuring performance). Third, it can indicate an essential aspect of a comprehensive strategic planning process (*i.e.*, the management process of setting appropriate performance targets and evaluating their achievement to validate or revise the organization's strategy). The author also states that the richest consideration of performance measurement must include all three of these definitions.

Cooper and Kleinschmidt (2007) performed an analysis to 161 businesses spread across the world to identify the main factors leading new products towards good performance values. The authors measured performance considering different variables like profitability, success rates and percentage of sales of new products.

Firstly, it was identified that the strongest driver for good performance is the existence of a high-quality, rigorous NPD process that emphasizes up-front homework, tough Go/No go decision points regarding several dimensions of the project, sharp early product definition, and flexibility. Secondly, the role of NPD strategy in the business unit, whether or not there is one, what it contains and whether it is clearly communicated has a pronounced effect on performance. And thirdly, resources availability both people and money are strongly tied to NPD performance.

Since the NPD process is identified as the strongest driver for good performance of new products, it is crucial to study what are the main factors driving new products success at the project level, since then, it could be possible for companies to incorporate them when designing

their own NPD processes. These factors are identified by Montoya and Calantone (1994) and are summarized on *Figure 3*.

Factors Found to Drive New Product Success at the Project Level

Strategic Factors:
- Product advantage
- Technological synergy
- Marketing synergy
- Company resources
- Strategy of product

Development Process Factors:
- Proficiency of technical activities
- Proficiency of marketing activities
- Proficiency of up-front (homework) activities
- Protocol (product definition)
- Top management support
- Speed to market
- Financial/business analysis

Market Environment Factors:
- Market potential/size
- Market competitiveness
- External environment

Organizational Factors:
- Internal/external relations
- Organizational factors

Figure 3 - Factors leading new products success at the project level (Source: Montoya and Calantone, 1994)

The presented factors are closely related to the process structure and content, for example, factors such as product advantage, project synergy and familiarity, market analysis as several vital process-related activities including sharp project screening, undertaking market studies and so on Cooper and Kleischmidt (1995).

The factors presented on *Figure 3* are directly correlated with the success level of new products at the project level and reveal an opportunity to include them on the NPD process structure to increase the success rate of projects generated by it. In the context of this business project, these factors will be considered on the NPD process design to guide the work of the actors involved.

2.6. Business Case

A business case is a decision support and planning tool that projects the potential financial results and other business consequences of taking a certain action (Schmidt, 2005).

When the goal is to create a new product or service, the development of a business case enables to demonstrate the profits that the development of this new product or service would add to the bottom line, supported by the one or more capital appraisal methods. The business case will provide decision makers with information to weigh sales estimates against the costs of development, manufacturing, delivery and so on (Sheen & Gallo, 2015).

According to Schmidt (2005), the business case must consider five major components: Introduction and Overview, Assumptions and Methods, Business Impacts, Sensitivity, Risks and Contingencies and Conclusions and Recommendations.

The previous list represents a very natural order for presenting the elements of the reasoning, evidence, and analysis regarding the business case (Schmidt, 2005).

The success of a business case does not necessarily mean getting approval for the intended action. It means enabling the decision makers to make a wise investment decision. A business case answers to the question: "What happens if a certain course of action is taken?", and if the answer does not demonstrate that the benefits overweight the costs it is not failure, it represents avoiding the company from making a poor investment (Sheen & Gallo, 2015).

As previously mentioned, and to develop the business case, it is very important for a company to have access to a clear picture of how its projects fall on the spectrum of risk. The innovation risk matrix and the Real-Win-Worth it tools are detailed on *section 4.3.3.4*.

Not only to assess the risk level of a certain project is very important, but also to understand what are the critical variables that can have the power to dramatically impact on the entire project at different levels.

The sensitivity analysis allows to assess the impact that changes in a certain parameter will have on the model's conclusions and, therefore, which parameters are the key drivers of a model's result. There are of two main kinds of sensitivity analysis: The simplest form of sensitivity analysis is to simply vary one value in the model by a given amount and examine the impact that the change has on the model's results. This is known as one-way sensitivity analysis, since only one parameter is changed at one time. This analysis can be undertaken using various approaches, each of which is useful for different purposes. While one-way sensitivity analysis

is useful in demonstrating the impact of one parameter varying in the model, it may be necessary to examine the relationship of two or more different parameters changing simultaneously. The multiway sensitivity analysis approach involves the changing of two or more key parameters, showing the results for each potential combination of values within a given range (Taylor, 2009).

A good example of a multiway sensitivity analysis is related to the study of the behavior of the NPV when the selling price and the production cost vary. This example helps to analyze the behavior of the variables and offers information regarding the limits of a certain project, regarding its profitability. An example regarding how a sensitivity analysis looks like can be found on *Figure 4*.

		70%	85%	100%	115%	130%	
	156 324,65 €	17,6 €	21,4 €	25,2 €	29,0 €	32,8 €	Production Cost
70%	26,5 €	137 035,6 €	93 714,6 €	50 393,6 €	7 072,6 €	-36 248,4 €	
85%	37,8 €	242 966,7 €	199 645,7 €	156 324,7 €	113 003,6 €	69 682,6 €	
100%	37,8 €	242 966,7 €	199 645,7 €	156 324,7 €	113 003,6 €	69 682,6 €	
115%	43,5 €	295 932,2 €	252 611,2 €	209 290,2 €	165 969,2 €	122 648,1 €	
130%	49,2 €	348 897,7 €	305 576,7 €	262 255,7 €	218 934,7 €	175 613,7 €	
	Selling Price						

Figure 4 - Sensitivity Analysis regarding NPV

2.7. Relationship Management

In nowadays context, when comes to relationship management it is automatically linked to Customer Relationship Management (CRM). There is, however, another critical type of relationship that needs to be managed properly and effectively. Cross-Functional relationship management inter and intra-departmental relationship management, or simply internal relationship management are some names possible to find in the literature that points in the same direction.

It has been suggested that success in today's competitive business environment is largely dependent on the degree to which firms are able to integrate across traditional functional boundaries to provide better customer service. With customers increasingly becoming more demanding, firms place more emphasis on customer service. To achieve better levels of customer service, working together across departments or functions is mandatory (Ellinger, 2000). Collaborative interdepartmental integration involves predominantly informal processes based on trust, mutual respect and information sharing, the joint ownership of decisions, and

collective responsibility for outcomes (Ellinger, 2000). Basically, collaborative integration is how well departments work together when it is required to.

There is evidence that collaboration increase development success. Griffin and Hauser (1996), summarized some of the scientific evidence related to this phenomenon in the specific case of marketing and R&D departments. Using the summary presented by the authors that put together a wide range of studies related to this field of knowledge, it is possible to state for example, that inter-functional harmony strongly correlates with project success. In other study analyzed, data suggested that there is sporadic communication among team members associated with failed projects and uniformly high communication across many topics among team members involved in the successful products (Griffin and Hauser, 1996).

According to Jassawala and Sashittal (1998), high levels of collaboration have a high power to impact in the most diverse dimensions, ultimately related to the success of projects. The authors state that high levels of collaboration can lead to:

- High levels of at-stakeness (involvement of team members in producing an outcome of team effort as a product that is constructed jointly), characterized by equitable input in decision making, equitable stake in NPD outcomes, and close social distances among participants.

- High levels of mindfulness that functions as a basis for all NPD related interaction. Participants understand and internalize the differences that exist among people, and always operate from that understanding.

- Constructive conflict situations that harness the creativity of participants as a result interaction between diverse voices. All voices are not only heard but all participants become voting citizens in the NPD processes.

- High levels of transparency. Participants are continually involved in making explicit all assumptions, all constraints, all objectives, and operating from a condition of high levels of knowledge about others.

To sum up, a high level of collaboration between the actors involved in the NPD process can play a central role in its success rate. In this context, it is very important that the processes when designed focus on the actor's collaboration perspective, promoting it. If this happens, work will flow smoothly, increasing the level of success of the projects. Despite this fact, it is also important to let departments keep their own identity and not becoming part of another department. Collaborative work can bring several benefits regarding the success of projects and, therefore, it is very important to focus on this dimension when processes are designed.

3. Conceptual Framework

3.1. Literature Review Summary

Product development is among the essential processes for success, survival, and renewal of organizations, particularly for firms in either fast-paced or very competitive markets. It is then fundamental to have a structured and efficient process to develop new products assertively. This can ultimately be considered a source of competitive advantage.

The different stages of the NPD and the innovation management processes should respect and follow the sequence of a predefined path. This process must be carefully designed and understood by all the actors involved on it (*vide section 2.2*).

To have updated processes that fulfills the company needs, is crucial to continuously tune and rethink them. This is what is performed with BPR (*vide section 2.3 and 2.4*), which offers the tools to design new processes or redesign existing ones. There are a wide range of different notations and possibilities to map processes. One of the simplest ways to do it is using BPMN, a very simple and clear notation that offers to all actors the possibility to generally understand the entire process and, simultaneously, to clearly see in a detailed manner their individual roles on it.

Not only to have updated and assertive processes in place is enough for a Company to remain competitive. These processes should support and facilitate the existence and development of innovative projects that would allow to keep up with competition or even lead the market. It is important to understand that such innovative projects fail at a very high rate due to the uncertainty level associated to them. This uncertainty should be mitigated as much as possible to offer to the decision makers the possibility to take better decisions supported by information as close to the reality as possible. The factors affecting the NPD performance must be controlled and overcome by developing the necessary analysis to do it (*vide section 2.5*).

A tool that aggregates not only financial analysis but also other very important information for the decision-making process regarding innovative projects, *i.e.* risk analysis or sensitivity analysis, is the Business Case document. This document offers the possibility to aggregate a wide range of information in a structured and standardized way which is very useful in the go- or no-go decision-making process for new projects (*vide section 2.6*).

Along the process of NPD, it is essential to keep all the actors involved and guarantee that all can work together effectively and efficiently. There is evidence that collaboration among actors from different departments increase the development success of a certain project. It is then crucial to manage these relationships properly and align the goals from different actors involved in the process (*vide section 2.7*).

3.2. Conceptual Framework

The solution developed for this business project is focused on Future Concepts department NPD process redesign, sustained not only by all the theoretical knowledge explored on the Literature Review, but also by all the data collected internally (*vide section 4.1*).

The redesigned process is mainly focused on the planning stage of the NPD process and is sustained by three main pillars that together allow to identify opportunities and transform them into structured and justified projects. The first pillar is called as the Macro-level (*vide Macro-Level section on Figure 5*) of the process and it consists on the establishment of the process flow and the subprocesses and activities design and characteristics based on Ulrich and Eppinger (2015) framework, which exposes the entire process generally. When the activities are analyzed in detail, it is possible to identify the second pillar that sustains the process and is called Micro-level (*vide Micro-level section on Figure 5*). This pillar represents and details all the documents produced along the process and all the developed tools used to analyze and prepare these documents. In this stage it is possible to look deeper into the process and analyze its several outputs and the tools used to achieve them. To obtain these outputs it is crucial that the actors of the process are able to introduce relevant inputs. The third pillar is called the Nano-level (*vide Nano-Level section on Figure 5*) and represents all the actions required to guarantee an assertive communication and cooperation level between all the different actors involved in the process, since it starts until it ends.

The new designed process follows the NPD process framework developed by Ulrich and Eppinger (2015) but considers also several other characteristics imposed by the department and the company specific reality. In this context, all the necessary activities are designed not only to *identify, analyze and select the best opportunities* to transform into projects, but also to *prioritize and evaluate projects*, to guarantee that the most promising and urgent projects are developed first, *allocate resources and plan timing*, to ensure that all team members know their responsibilities and roles, and to *reflect on the results of the process* to constantly refine and tune it.

To perform the designed activities of the process, several analysis and studies must occur regarding project justification and feasibility. Market research, feasibility studies, financial analysis, sensitivity analysis and risk analysis (*vide section 4.3.3*) must be performed to justify all projects and help regarding the decision-making process for its investment.

To help the project team to follow the process and to collect all the previously mentioned required information regarding project justification, an Excel tool (*vide section 5.2.1*) that integrates a big set of data will be developed. The final goal of this tool is to compute the potential financial benefit of the project intended to be developed by presenting its forecasted NPV. This tool will allow the team to simulate potential sales forecasts, based on pessimistic and optimistic scenarios, compile all the possible costs from production to development and marketing and analyze if the project has the potential to become profitable in the future or not. This tool will also help to perform sensitivity analysis and understand what are the boundaries and the most important variables that are making a certain project profitable or not.

Since the nature of these projects is focused on the future and the future is not possible to predict, a tool focused on risk analysis will also be developed. This tool has the purpose to alert the team members for potential issues regarding specific variables along the development process and help them to monitor and control it closer.

All the information collected along the process will be compiled in a Business Case document model based on Schmidt (2005) approach (*vide section 5.2.2*). This document will help the team to prepare the projects presentations for decision makers in Steering Committees by highlighting all its associated benefits and risks. This document will contain vital information regarding the entire project collected along the process that should be presented and highlighted when a go or no-go decision is taken.

The process will require, suggest and incentive several moments for communication and interaction between different stakeholders in this context. Departments like Development, Product Management, Sales and Intellectual Property can contribute with very relevant information regarding project justification, but also become active actors regarding the Future Concepts projects development.

Because of its characteristics, this process will demand through its flow several market analyses, potential benefits calculations, possible risks identification, and inputs from other important stakeholders' consideration. With this, only the best opportunities will become projects to develop on the most appropriate time with the required resources assigned.

All the information collected along the process will be stored in proper standardized and structured documents which will offer to steering committees relevant structured information for its decision-making process. The process is detailed in further sections of this business project and the conceptual framework is presented on *Figure 5*.

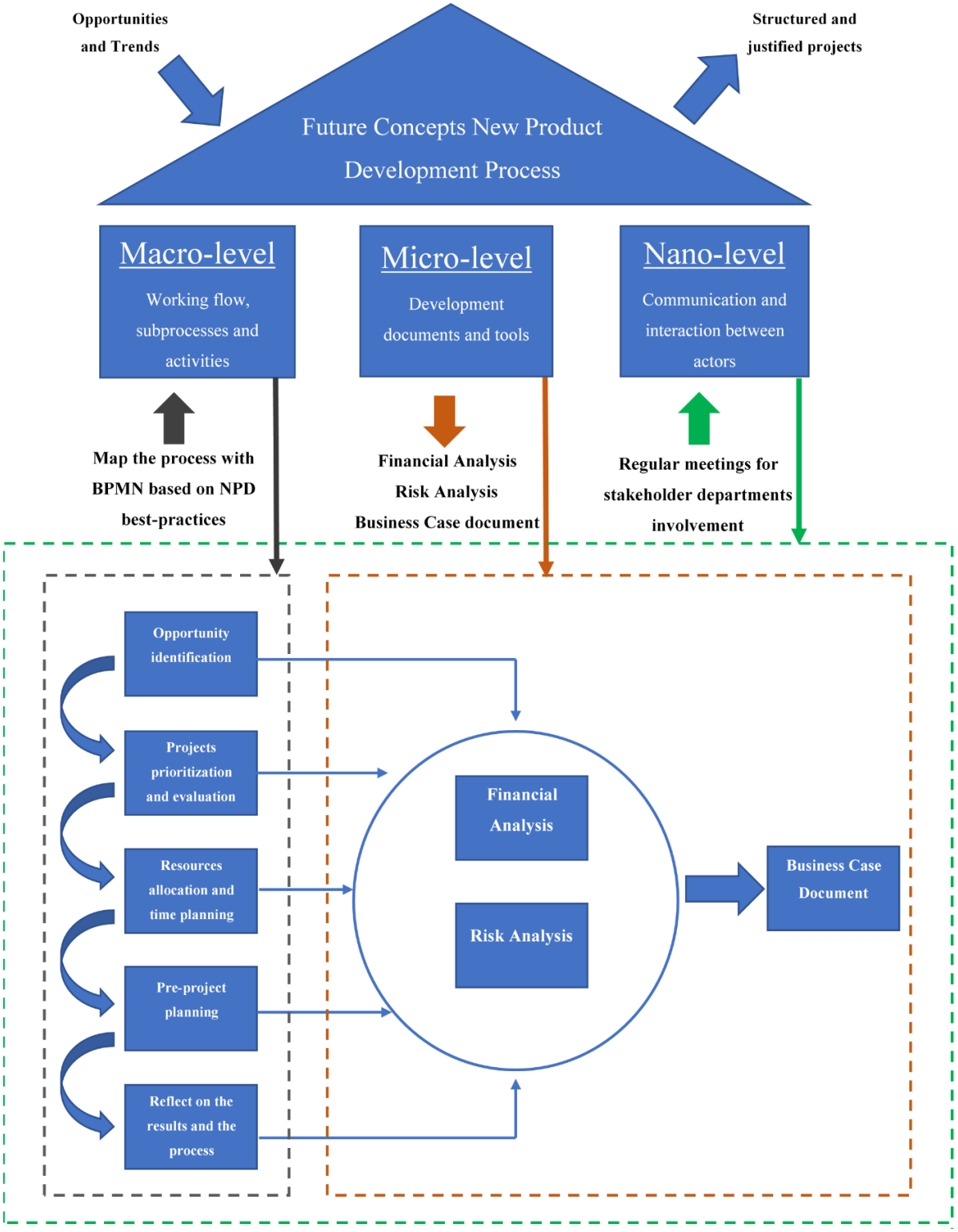

Figure 5- Conceptual framework

4. Methodology

As previously mentioned, this business project has the goal to identify procedures and offer recommendations to increase the success rate associated to Future Concepts projects. All the taken actions and used methods and strategies to assess the information that will be used to develop the solution are presented and explored in this section.

4.1. Methodological General Issues

This business project is focused on the design of a structured, multifaced NPD process built considering several different sources of knowledge regarding the specific case of the Future Concepts department. Robson (2011) states that a case study is a strategy for doing research involving an empirical investigation of a phenomenon within the real-life context using multiple sources of evidence. In this context, the case study research strategy will be followed. Yin (2003) distinguishes the cases according to their type, they can be single or multiple. What distinguishes both types are precisely the number of cases under analysis. In the context of this business project, only the process development for the Future Concepts department will be analyzed and, therefore, it is a single case study type. A case study can also follow three different purposes: exploratory, explanatory and descriptive. According to Robson (2011), an exploratory study is a valuable mean of finding out what is happening, to seek new insights, to ask questions and to clarify the understanding of a problem. The objective of a descriptive study is to portray an accurate profile of persons events or situations (Robson, 2011), and explanatory studies have the goal to study a situation or a problem to explain the relationship between variables (Saunders, 2011). In this context an exploratory single case study strategy will be followed, and a wide range of qualitative data will be collected and analyzed. These data are provided by different sources, *i.e.* in-depth interviews, meetings notes, observation and by analyzing internal documentation.

4.2. Data Collection

In order to receive information regarding the needs of the company that led to the current business project, as previously mentioned (*vide section 1.2*) an initial meeting with the head of the Future Concepts department took place. In this meeting, the objectives of the company were exposed and access to internal documentation was granted.

The author received access to a wide range of internal documentation related not only with the general business of the company, but mainly with the working procedures of the department, its goals and past projects.

In order to clearly identify the main issues that are affecting the success rate of the projects being developed in the department, in-depth interviews with the most important external actors of the process is going to be scheduled. For this, it is necessary to firstly define which are the more appropriate type and form of interviews for this specific context (*vide Figure 6*).

The decision is to go to a face-to-face form of interview since it is important to understand the genuine opinions of the actors of the process regarding its main characteristics. According to Saunders (2011), "when it is necessary to understand the reasons for the decisions that research participants have taken or to understand the reasons for their attitudes and opinions it is likely to be needed the conduction of qualitative interviews". It also seems that the in-depth type of interview can be the one that better suit this specific case due to the need to collect the biggest possible set of knowledge and since it can reveal easier for the interviewees to accept this kind of meeting. Saunders (2011) states that "managers are more likely to agree to be interviewed, rather than complete a questionnaire, especially when the interview topic is seen to be interesting and relevant to their current work". With this, the topic of the interview is set but the interviewees had the possibility to guide the meeting around the specific topic, providing high amounts of data and valuable insights regarding the specifications of the process.

According to Boyce & Neale (2006), the primary advantage of in-depth interviews is that they can offer much more detailed information than what is obtained through other data collection methods, such as surveys. They also may provide a more relaxed atmosphere in which to collect information, since the interviewee may feel more comfortable having a conversation with the interviewer about their thoughts and opinions compared to filling out a survey.

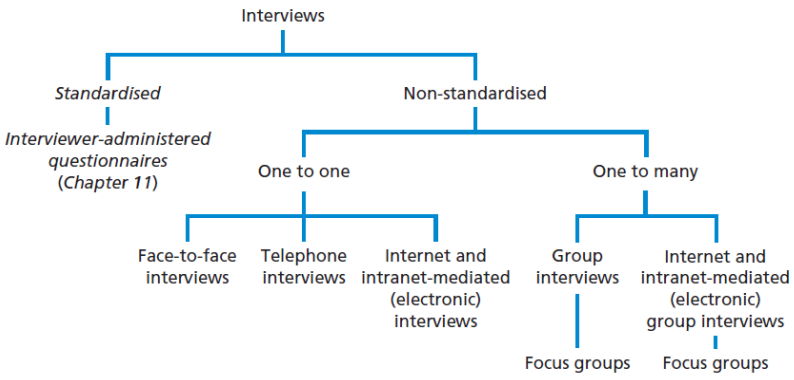

Figure 6 - Forms of interviews (Source: Saunders, 2011)

The selection of the actors invited to participate on the interviews is going to be made with the help of the project tutor. The objective is to have actors that represent the entire spectrum of the process. Eight actors representing all the departments involved in the process, with different roles and levels of responsibility, will be selected for these interviews. According to Saunders (2011), during the initial stages of the discussion, the interviewee often has some uncertainties about sharing information, and about the way these data may be used. Since the interviewer and most of the interviewees have never met before, all interviews will start with a personal presentation, a clear explanation of the goal of the interview and the business project, and a statement emphasizing complete confidentiality and anonymity.

During the development of the business project, fixed weekly meetings with the assigned project tutor will happen to update the information and ensure the alignment of the business project solution with the company reality and needs.

4.3. Data Analysis

4.3.1. Data analysis method

Miles and Huberman (1994), suggest a method for qualitative data analysis divided in three main stages: data reduction, data display and conclusions drawing/verification.

According to the authors, data reduction consists on the process of selecting, focusing and organizing all collected data. Data display is the activity of summarize and prepare all reduced data in a way that allows to easily assess the most relevant information. And the conclusions/drawing and verification corresponds to the presentation of the conclusions from the connections of the data under study in the project context.

4.3.2. Macro-level

As explained before, processes should be mapped for developers and users clearly understand their stages, activities, and tasks. One powerful and clear notation used in many different companies is BPMN. With this notation, it is possible to map and module a wide range of different processes by using the different main symbols available. These symbols can be found on *Figure 7*.

The primary goal of the BPMN effort is to provide a notation that is readily understandable by all business users, from the business analysts who create the initial drafts of the processes, to

the technical developers responsible for implementing the technology that will perform those processes, and, finally, to the business people who will manage and monitor those processes. Thus, BPMN creates a standardized bridge for the gap between the business process design and process implementation (White, 2004).

In the specific context of the macro-level, the data reduction will occur immediately after the data collection stage. It will be necessary to refine the data that will be collected from the several sources and confirm its relevance regarding the solution developed in this business project. For this, data triangulation is going to be necessary to validate which of the collected data from all the meetings, interviewees and internal documents are relevant regarding the development of the process suggested in this business project.

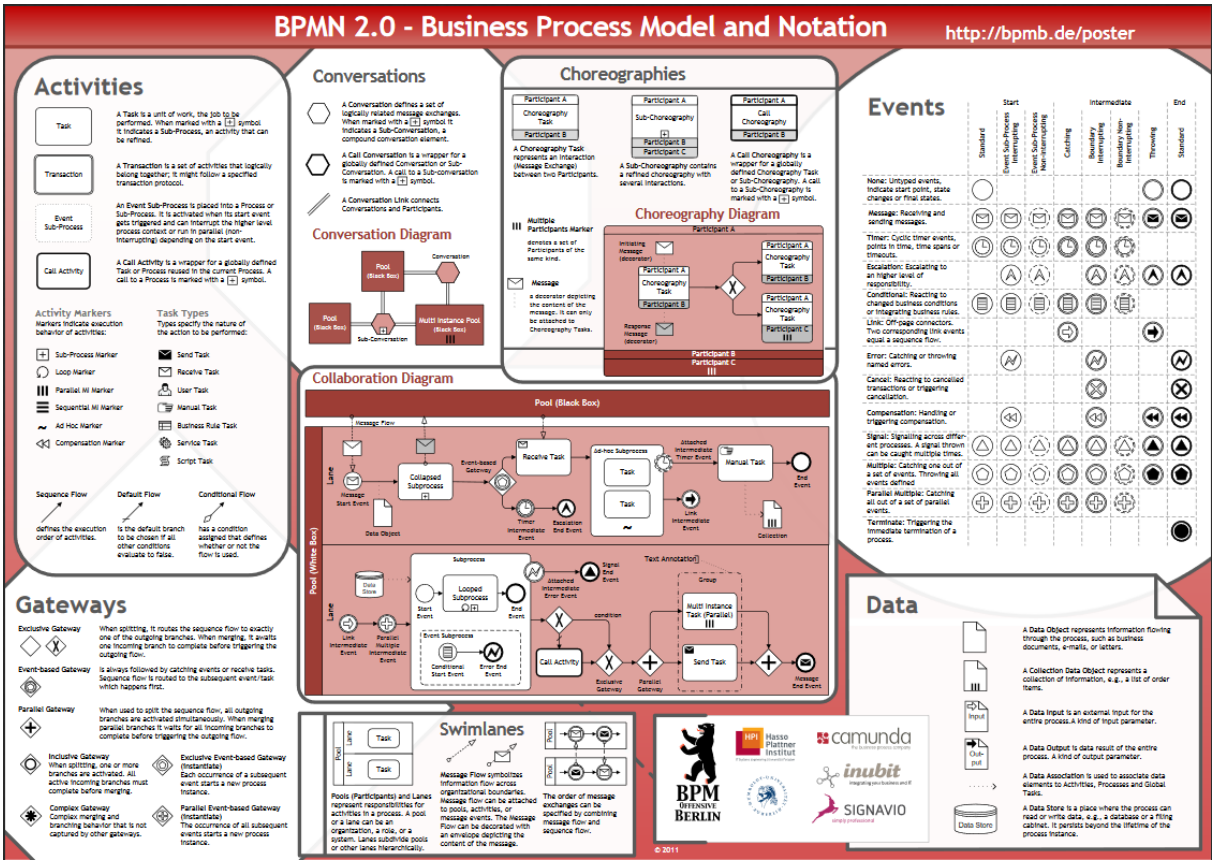

Figure 7 - Business Process Management Notation (source: BPMN poster)

For an easy and understandable data display, all the processes, subprocesses and activities will be mapped and presented graphically using BPMN. This notation will be used when comes to process design to keep the information standard and easily readable to all the actors involved.

At the end, the conclusions will be obtained by showing the connections and differences of the developed solution with the theoretical NPD process and innovation management knowledge.

4.3.3. Micro-level

It is crucial for any company to be able to constantly adapt and innovate to remain competitive in nowadays markets. The adaptation to keep up with competition, or the innovation to lead the industry both come from new projects usually developed inside the organization. These projects can have several natures, formats and budgets and go from major technology installations to post-merger integrations, new product development, or new growth strategies.

However, despite their importance, new projects fail at high rate, some of them consume tremendous amounts of resources over months or even years, frequently delivering disappointing returns (Matta and Ashkenas, 2003).

To dramatically reduce the risk associated with the development of new projects and to keep accurate information along the way, it is very important for decision makers to have access to valid information to take more sustained decisions.

Capital investment appraisal is the application of a set of methods of quantitative analysis which offers guidance to managers in the decision-making process regarding how to best invest in long-term funds (Weetman, 2006).

There are several methods used in capital investment appraisal based on different factors. Some of those, can be combined to obtain more sustained information and offer a stronger basis for the decision-making process. Some of these methods are briefly addressed in the following sections.

4.3.3.1. Payback method

The payback method of project appraisal calculates the length of time required for the stream of cash inflows from a project to equal the original cash outlay.

Under the payback method, the most desirable project is the one which pays back the cash outlay in the shortest period of time (Weetman, 2006).

Sometimes the method is used when aspects such as liquidity and project time risk are focused, but it is also commonly used in pure profit evaluations as a single criterion. The two main deficiencies of the Payback method are that it does not measure the time value of money in a correct manner and that it ignores cashflows after the payback period (Yard, 2000).

4.3.3.2. Net Present Value Method

The net present value (NPV) of a project is equal to the present value of the cash inflows minus the present value of the cash outflows, all discount the cost of capital (Weetman, 2006).

The NPV method of capital investment appraisal is based on the view that a project will be regarded as successful if the present value of all expected inward cash flows is greater than, or equal to, the capital invested at the outset. It is called net present value because, in calculation, the capital invested is deducted from the present value of the future cash flows.

If the present value of the expected cash flows is greater than the capital invested, then the NPV will be positive. If the present value of the expected cash flows is less than the capital invested, then the NPV will be negative. A positive NPV indicates that the project should be accepted, while a negative one indicates that it should be rejected (Weetman, 2006).

According to (Gable, 1992), the NPV method can be used to compare very different projects in the same financial basis. This method also offers its result in an absolute value, which is helpful in to analyze the project potential as a whole.

4.3.3.3. Internal Rate of Return

The internal rate of return (IRR) is another method in capital investment appraisal which uses the time value of money but results in an answer expressed in percentage form. It is a discount rate which leads to a NPV of zero, where the present value of the cash inflows exactly equals the cash outflows. In other words, it is the discount rate at which the present value of the cash flows generated by the project is equal to the present value of the capital invested, so that the NPV of the project is zero (Weetman, 2006).

4.3.3.4. Risk analysis

Not only to understand the potential profitability of a project is crucial for a company, but also to have access to a clear picture of how they fall on the spectrum of risk. The risk matrix employs a unique scoring system and calibration of risk to help estimate the probability of success or failure for each project based on how big a stretch it is for the firm: The less familiar the intended market (x axis) and the product or technology (y axis), the higher the risk (Day, 2007). This matrix considers a wide range of crucial variables that play central roles regarding the levels of risk of a certain project. The matrix can be analyzed with more detail on *Figure 8*.

	Intended Market					
	…be the same as in our present market		…partially overlap with our present market		…be entirely different from our present market or are unknown	
Customers' behavior and decision-making processes will…	1	2	3	4	5	
Our distribution and sales activities will…	1	2	3	4	5	
The competitive set (incumbents or potential entrants) will…	1	2	3	4	5	
	…highly relevant		…somewhat relevant		…not at all relevant	
Our brand promise is…	1	2	3	4	5	
Our current customer relationships are…	1	2	3	4	5	
Our knowledge of competitors' behavior and intentions is…	1	2	3	4	5	
					TOTAL (*x*-axis coordinate)	

	Product/Technology					
	…is fully applicable		…will require significant adaptation		…is not applicable	
Our current development capability…	1	2	3	4	5	
Our technology competency…	1	2	3	4	5	
Our intellectual property protection…	1	2	3	4	5	
Our manufacturing and service delivery system…	1	2	3	4	5	
	…are identical to those of our current offerings		…overlap somewhat with those of our current offerings		…completely differ from those of our current offerings	
The required knowledge and science bases…	1	2	3	4	5	
The necessary product and service functions…	1	2	3	4	5	
The expected quality standards…	1	2	3	4	5	
					TOTAL (*y*-axis coordinate)	

Figure 8 - The innovation risk matrix (Source: Day, 2007)

Another tool developed by 3M and widely used to easily identify and predict weaknesses on projects is the Real, Win, Worth it method (RWW). The RWW screen allows companies to evaluate the risks and potential of individual projects by answering questions in three broad topic areas: "Is it real?" explores the nature of the potential market and looks at the feasibility of building the product. "Can we win?" considers whether the innovation and the company can be competitive. "Is it worth doing?" examines the profit potential and whether developing the project makes strategic sense (Day, 2007). Despite it is a very simple tool, it can clearly help to identify blind spots on projects, generating awareness regarding certain characteristics that can avoid the failure of a project. The RWW can be found on *Figure 9*.

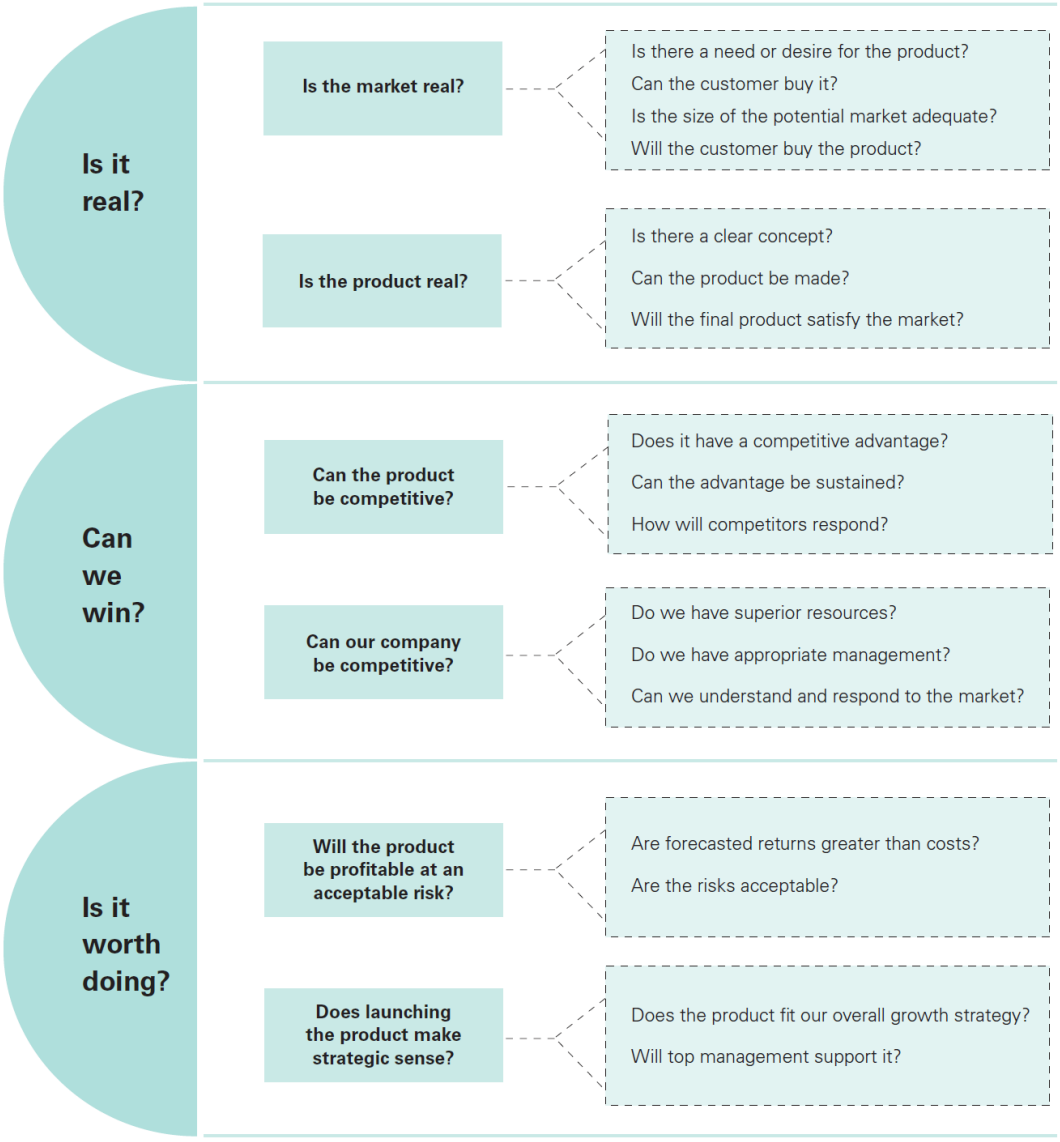

Figure 9 - The Real - Win - Worth it Method (Source: Day, 2007)

As mentioned on *section 3.2*, the Micro-Level of the developed Conceptual Framework considers all the necessary documentation and tools that will be produced and used along the process flow. After data collection, it will be necessary to reduce data and understand exactly which are the techniques that should be used on the several documents developed along the process. For this it is necessary to triangulate the data from the different sources and identify which makes sense in the context of the specific business project solution.

The financial analysis developed on the different projects from the department will be developed considering the NPV and the risk will be assessed by performing both, the Innovation Risk Matrix and RWW method. This decision was made together with the Future Concepts department leaders. An Excel tool (*vide section 5.2.1*) was developed to support the development of these analysis and its presented further.

4.3.4. Nano-level

Effective communication and interaction between different NPD stakeholders are consistently regarded as one of the most important success factors of NPD (Brown and Eisenhardt, 1995).

These interactions offer the possibility to assess a wide set of information from different areas of the organization, process it and use it to make better decisions. This factor is very important on the NPD process context due to its unique need for multidisciplinary knowledge that only together enable a robust development. As Swink et al. (2006) state, cross-functional integration is acknowledged to improve NPD performance.

Interactions between staff that relate to the NPD process can be considered as intra-functional or inter-functional. In general, intra-functional interactions happens amongst the core design team, with most interaction occurring at a technical level, to discuss engineering solutions and interfaces. Inter-functional interaction is common at a middle-management level, between project managers, development managers, marketing managers and production managers. This type of interaction is of a more tactical nature, to consider plans of an immediate nature that influence different functional domains (*e.g.*, launch planning, integration to production etc.) (Felekoglu et al., 2013).

Another important characteristic of interactions is related to the distinction that can be made between formal and informal interaction. Formal interaction is often driven by processes and procedures, whilst informal interaction is typically based around face-to-face contact either in small or large groups (Moenaert et al., 1994).

In the context of this specific business project, several different types of interactions (intra-functional and inter-functional, and formal and informal) between different actors involved in the process will be introduced to enable the projects to include, from the beginning, a broad transversal set of information to feed the process and support decision-making. The actors to interact with and the moments for these interactions to happen will be defined together with the department representatives considering the collected data. This is explored on the next chapter.

5. Case Study: Results analysis and developed solution

5.1. Results analysis and preliminary discussion

This business project started with an initial meeting with the head of the Future Concepts department. During this meeting a very big set of information was transmitted. It started with general information related to the company, the history, the sectors where the company operate, and the specific characteristics and challenges associated to each one of them, the explanation of the company strategies for the different markets, and the analysis of the company functional structure. After the general introduction about the company, the Future Concepts department characteristics and goals were exposed and detailed. Also, the main processes of the department were addressed, and the department radar chart briefly analyzed (*vide section 1.1*).

The initial introductory meeting ended with the presentation of the issue that leaded to the development of this business project. The head of Future Concepts department showed his concern about the high rate of unsuccess of projects developed internally and shared his apprehensions about the lack of structure regarding the work being performed (*vide section 1.2*). A summary of the collected information during this meeting can be found on *Appendix 1*.

To study and identify the roots of the problem, the author started by analyzing the internal documentation used on the development process of the department and to schedule a meeting with one internal developer that was assigned as one of the tutors of the project. Several relevant conclusions were taken after performing these activities. It was understood that an official and structured process for the development was not implemented. The opportunities were being identified by Future Concepts developers that based on the trends of the radar chart, were freely trying to develop concepts to cover these trends. During the project development, developers should prepare a circle of clarity document and a fact sheet (*vide Appendix 2*), where definitions, motivations, targets and deliverables of the project should be presented.

These documents were not being prepared with the level of detail and taken with the required seriousness they should, since developers, due to their nature, were only focusing on the concept development per se. These documents are, however, crucial for the department and the developed projects. In this context, the new developed process will consider their development, ensuring a convenient preparation through its flow. The main internal procedures that were being performed on the department are summarized on *Appendix 2*.

After the opportunity identification, the developers did not have an established flow to guide them regarding the work that should be performed, in which sequence and when, to identify which information would be relevant to collect for the opportunity development, and which other internal and external actors could reveal important for its successful development. It was also understood that the information aggregated on the documents presented to steering committees did not considered a wide range of very much relevant information regarding project justification, since market analysis and financial and risk assessments were not being properly performed. As mentioned on *section 4.1*, in-depth interviews were scheduled to assess the perspective of key actors from departments that can take active roles on the success of Future Concepts projects.

The in-depth interviews have the goal to collect the interviewees opinions concerning four main areas. Firstly, to *understand the interviewee opinion regarding the relevance of the Future Concepts projects*. Secondly, to *assess the interviewee perspective regarding the roles that his/her department can play to add value to Future Concepts projects*. Thirdly, *identify the interviewees opinion related to the reasons that are leading Future Concepts projects to fail*. And fourthly, *what the interviewee consider that could be done to improve the success rate of projects from Future Concepts*. The use of in-depth interviews proved to be a good decision since, due to its broader scope, it allowed to gather a big set of data regarding the process that after processed and analyzed enabled to identify the critical areas to focus on its redesign. The main data collected regarding the previously mentioned four main areas were compiled and are presented on *Figure 10*. A big set of data was collected during these interviews. Firstly, it was possible to position the opportunities pursued by the department and understand their unique characteristics, secondly it was possible to understand the roles and main responsibilities of the different actors and departments involved in the process and finally, it was possible to identify in different perspectives and interests, what were the main root causes affecting the development process and its success, which offered the needed guidance for the development of the solution for this business project. These root causes are detailed on Figure 10 - Data collected from in-depth interviews.

Actors	A1 - Relevance of FC projects	A2 – Roles of the department	A3 – Reasons leading to failure	A4 - What can be done
Actor 1	FC projects are very important for the company growth.	Provide inputs regarding opportunities to be developed and continue the development of FC projects.	Lack of communication between departments and not enough information when the projects are presented for approval.	Regular meetings between both departments. Clearly which relevant information should be collected and presented for every project.
Actor 2	FC projects can be relevant for the company but are focused on a very distant future.	Offer valuable information regarding other connected internal products and projects. Manage the output of the FC projects if it becomes a product.	The handover should be much more detailed and coordinated. People do not understand the goal when a FC project is presented.	Define the information to be exposed when the projects are presented in order for the other actors to understand the goals of the projects.
Actor 3	FC projects can be very relevant to explore new markets and sectors.	Provide relevant information on the context of the project regarding market needs.	Not enough market research is conducted which sometimes lead to the development of non-relevant projects.	Develop market research to ensure the relevance of the FC projects and aggregate all the information on a standardized manner to be easily understandable.
Actor 4	FC projects can reveal crucial for the company to become leader in certain sectors due to their possible level of innovation.	Provide help on the assessment of potential market size and time to market requirements.	Lack of communication between departments that can provide important inputs for the development of the project.	Establish direct and regular contact between FC developers and other important actors of the development process.
Actor 5	It is difficult to focus on FC projects since they will only payoff in a very distant future.	Offer information regarding shorter horizon opportunities that are needed on the market.	The time horizon of the concepts developed on FC projects is too distant.	Review the opportunity identification process and consider innovation that can be applicable in a shorter time horizon.
Actor 6	FC projects can be the way for the company to pass from follower to leader.	Depending on the project, offer the contact of certain clients to assess their potential level of interest.	The potential financial benefits of developing FC projects are not exposed and explained.	Perform financial analysis to understand what are the potential financial benefits of the projects. Meet with selected clients under disclosure agreements to assess their level of interest.
Actor 7	FC projects can be crucial for the company differentiation.	Offer important information regarding competition for the opportunity explored in a certain project.	When the projects are presented, they do not have all the needed information, like market analysis and feasibility studies.	The projects must be better justified by developing market analysis and feasibility studies.
Actor 8	FC projects are important to force the company to focus on innovation.	Provide information regarding certain smaller opportunities that are needed to be developed to be used on other projects.	Lack of communication between departments, which make that the projects are not understood when presented.	Regular meetings with different departments that can provide relevant information on the projects development context.

Figure 10 - Data collected from in-depth interviews

5.1.1. First Root Cause – Lack of support from transversal departments

The first and more evident root cause, was the lack of support from other departments regarding the projects that were born in Future Concepts. Since the nature of these projects involves high risk and uncertain benefits in a distant time horizon, most of the people from other departments did not pay the necessary attention to them. McDermott et. al (2002) states that radical innovation is critical to the long-term success of firms, but unfortunately, it is often difficult to get support for radical projects in large firms, where internal cultures and pressures often push efforts towards more low risk, immediate reward, incremental projects.

5.1.2. Second Root Cause – Lack of communication among the critical actors

The second root cause, which was mentioned by most of the interviewees, was related to the reduced level of existing communication between the different actors involved in the process. The departments were working mainly like isolated silos, not contributing to the project's development since its beginning, which was frequently conducting to a severe level of detachment from the external actors due to the very complex nature of the projects. Brown and Eisenhardt (1995) prove that the underlying premise is that communication among project team members and with outsiders stimulates the performance of development teams. Thus, the better that members relate to each other and with key outsiders, the more successful the development process will be.

Moreover, Nonaka et al. (1996) argued that organizations cannot create knowledge without individuals, and unless individual knowledge is shared with other individuals and groups, the knowledge is likely to have limited impact on organizational effectiveness.

Baltezarevic and Baltezarevic (2014) state that a lack of personal interactions between the actors leads to lack of trust and motivation for them to share ideas. In this context, personal interactions between the actors of the process must be guaranteed, and the actors must be motivated to share. According to Lee (2010), knowledge transfer seeks to organize, create, capture or distribute knowledge and ensure its availability for future users. Knowledge transfer is very complex since knowledge resides in organizational members, tools, tasks, and their sub-networks (Argote and Ingram, 2000) and much knowledge in organizations is tacit or hard to articulate (Nonaka and Takeuchi, 1995). In fact, not only to build the necessary infrastructure that will generate interactions between the actors for knowledge transfer is important, but it is

equally crucial to ensure that the actors will effectively transfer this knowledge to apply on the specific context of the process.

The different actors involved on the NPD process detain a unique set of tacit and explicit knowledge that is required to capture, organize and combine to put on the service of the process to offer it more robustness.

Tacit knowledge can be defined as the type of knowledge that is personal, hard to formalize and so, very difficult to communicate. It can represent a source for long term competitive advantage (Nonaka, 1991). It is an experimental and subjective type of knowledge which is very difficult to express in words or numbers and is related with technical and cognitive competencies like beliefs and perspectives (Baltezarevic and Baltezarevic, 2014). On the other hand, explicit knowledge is selective and can be acquired from internal and external sources. It is rational and objective and can be much more easily expressed in words or formulas (Baltezarevic and Baltezarevic, 2014).

An actor belonging to a specific department may detain certain sets of knowledge that when applied in the specific context of the NPD process can enable to identify a certain critical risk, or allow to select a certain customer for product testing due to its specific characteristics, or even to alert for a specific feature or technology to be used on the product to be developed that can led it to a completely different level of differentiation. However, this actor can decide not to transfer the knowledge or be unable to share it effectively and put it on service of the process, maybe due to lack of trust on other actors involved or even due to insecurity regarding others reaction, which can lead the entire development effort to unsuccess. According to Burma (2014), knowledge management implies a process to produce new relevant information regarding the development of existing knowledge and organize it to be available for any user to access. This author also adds up that to ensure the transfer and sharing of information is one of the most crucial processes towards competitive advantage. The impact of knowledge diffusion dimension on the specific case of this business case will be discussed on *chapter 6*.

5.1.3. Third Rood Cause – Project handover content quality

The third root cause is related to the handover content (the set of transmitted information to the next actors of the chain responsible to keep the development) which, according to different actors, is often not clear (lack of technical and feasibility studies), not sufficiently supported (lack of market and customer research) and without clear potential explicit benefits (lack of

financial and competition analysis). This set of information must be transferred to the next development stages as clearly as possible. According to Zahay et al., (2004), the information management task ultimately reveals eight types of information that NPD managers must manage across multiple sources, forms, and functions in order to be able to develop assertive and successful products. The eight information types come from different sources and together provide the necessary guidance towards successful development. The different types are summarized below are summarized and aggregated as follows: **internally developed information**: strategic; financial; project management, **internally and externally developed information**: customer; needs; technical, and **externally available information**: competitor; regulatory

5.1.4. Final remarks concerning the identified root causes for development unsuccess

The previously identified root causes are ultimately directly connected with two main areas. The NPD process structure, which defines the activities to be performed, the time when to perform them and the content to be developed by them, and the knowledge diffusion management that is related to the knowledge sharing and transferring between the several actors of the process, ensuring that the right actor is in possession of the right information to perform proper and sustained development. To eliminate the identified root causes, this business project focuses on the development of an entire NPD process supported by several developed operational tools, guided by the analysis of internal and external information for decision making along the way and that ensures communication flows between different internal and external stakeholders. The developed process clarifies the role of each actor and enables a careful planning of all required work. It also ensures that the market and the customers are extensively analyzed in order to identify the most promising opportunities, several technical feasibility studies and interaction with the suppliers are performed to understand if the opportunities are real, and all projects are presented in a standardized way, containing risk analysis, sensitivity analysis and a financial analysis for the decision makers responsible for projects future be able to make supported and informed decisions. The people involved in the project should work as a team and be able to provide knowledge from the very beginning of the process. That is why regular interactions in different moments are considered along the process to motivate the actors to get involved and put their knowledge on the service of the project's development. The innovative process design developed in the research assignment to cope with the previously mentioned root causes is presented and detailed on *section 5.2.1*.

5.2. The developed solution

As it is possible to see on *Figure 11*, the opportunities pursued by the department, falls mainly on the category of the third horizon spectrum. The main goal is to exploit opportunities that are new to the world, embodying the highest level of uncertainty (Ulrich and Eppinger, 2015). In other words, Future Concepts is responsible for pursuing radical innovation projects.

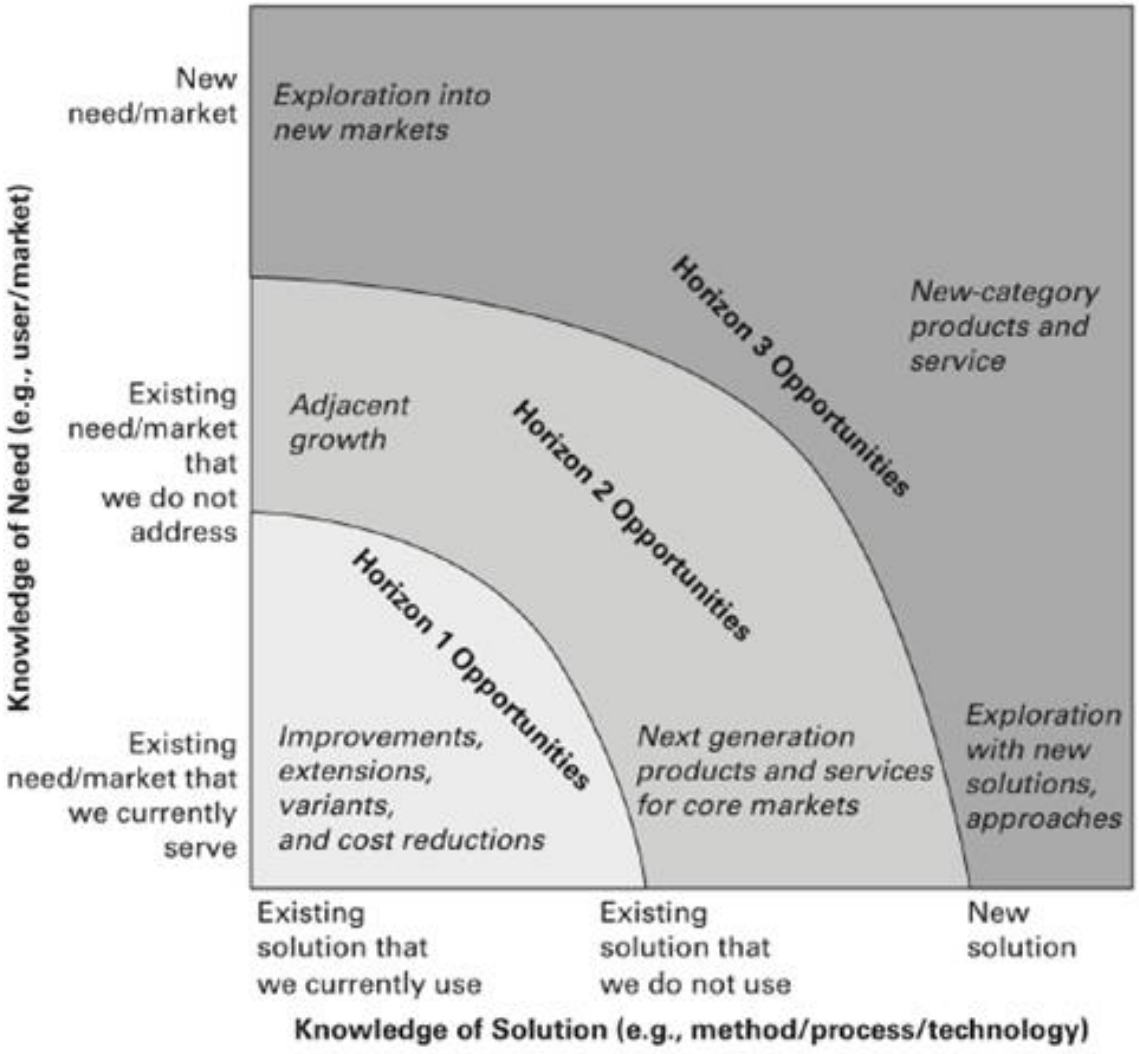

Figure 11- Types of opportunities (Source: Terwiesch, et al., 2009)

Radical innovation has the power to transform the relationships between customers and suppliers, to restructure the marketplace economies, to displace current products, and often to create entirely new product categories. Radical innovation provides a platform for the long-term growth that corporate leaders desperately seek. Unfortunately, recognizing the importance of radical innovations and successfully developing them are two very different things (Leifer et al., 2000).

On *Figure 12*, it is possible to see represented, using BPMN, the six main subprocesses of the NPD process proposed by Ulrich and Eppinger.

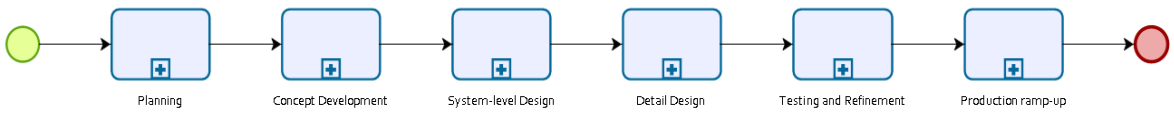

Figure 12- Main Subprocesses of the NPD process

Future Concepts department is responsible for the subprocesses of planning and concept development regarding radical innovation projects, which means to identify the opportunities, evaluate and screen them, select the best ones, transform them into projects, develop the concept by collecting all the required data and develop all the necessary studies, present them to approval and, if accepted, to transfer the project to the next department for development. The next department on the chain, which is the Development department, is responsible for the system-level design, the detail design, the testing and refinement and the production ramp-up subprocesses. Two other departments have very important roles in this process. The Product Management department will become responsible for managing all situations regarding the generated outputs of the process in the end, and Sales department will be responsible for the process outputs behavior on the market.

Brown and Eisenhardt (1995) support that the NPD should be perceived as a rational plan. This perspective emphasizes that successful product development is the result of (a) careful planning of a superior product for an attractive market and (b) the execution of that plan by a competent and well-coordinated cross-functional team that operates with (c) the blessings of senior management. Simply put, a product that is well planned, implemented, and appropriately supported has a very high probability of becoming a success (Brown and Eisenhardt, 1995).

On *Figure 13*, it is possible to see the dimensions that the authors consider crucial to ensure an effective NPD process to develop innovative products.

Cross functional communication, market analysis development and customer involvement are just some of the dimensions that are not being considered with the procedures in place for the development of Future Concepts projects. The developed solution of this business project incorporates these dimensions through the process structure and the activities content through its flow, like for example, the interaction points along the process are supported by the need of cross-functional communication for critical information collection. The process and the connections between the model on *Figure 13* will be detailed on next sections.

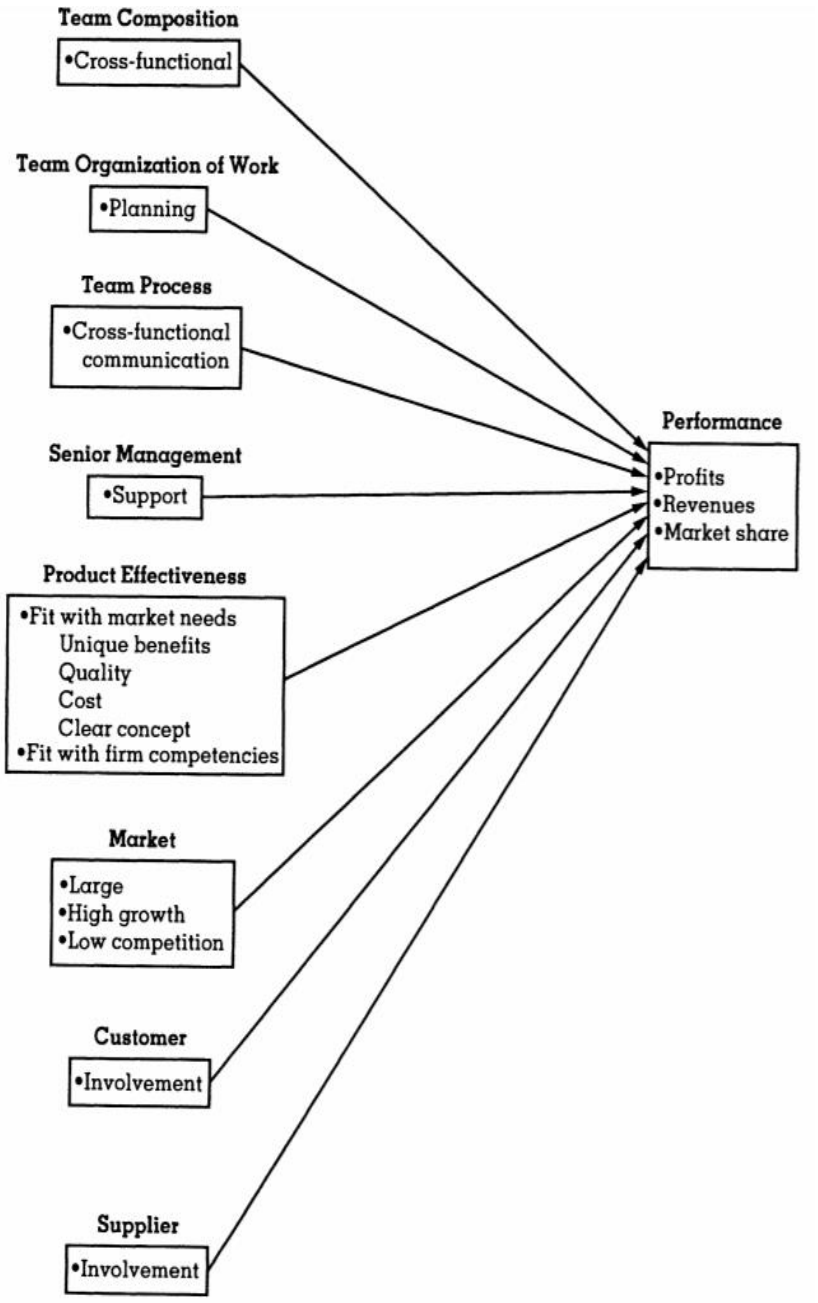

Figure 13- Rational Plan Model of NPD (Source: Brown, and Eisenhardt, 1995)

After the root causes identification, a meeting was set with department representatives in order to define the desired paths for the project. The author suggested the development of a flexible NPD process (*vide section 5.2*) that offers communication channels with potential crucial departments regarding projects success, like Development, Product Management, Sales and intellectual property departments and has specific defined tasks to fulfil the necessary requirements regarding several aspects associated to project justification *e.g.*, market research, feasibility studies, risk analysis and financial analysis. This process allows to structure the work and has the potential to cover at the same time the main constraints identified in the interviews.

The department representatives understood the logic behind the idea of the process development and considered that it could bring important benefits regarding the initial identified business problem: *to increase the acceptance rate of projects born in the department for future stages of development in the chain*. In this context, the decision at this point was to develop the process, in other words, define all the activities, tasks and different paths associated to the performance of the work that will satisfy the Macro-Level section of the Conceptual Framework presented on *Figure 5*. The development of this process is based on the process presented by Ulrich and Eppinger (2015) on the Product Design and Development book framework, with specific adaptation to the department reality, context and nature. The process considers a wide range of aspects crucial for the department projects level of success, acceptance and justification. These characteristics are explained and analyzed in the next section. As previously mentioned and how it is possible to see on *Figure 12* the NPD process contains several different subprocesses. For the projects that are born in the department, the project team is responsible for the Planning and the Concept Development stages, transferring the project after to Development department which will be responsible to continue the development. During the process reengineering, direct communication with department representatives was kept in the form of regular meetings. It was decided that the project should focus on the Planning subprocess since it is in this stage that the root causes are present.

5.2.1. The Process Design

The entire process reveals itself as very complex to explain due to its length. This happens because the majority of the subprocesses are composed by other subprocesses, that are composed by other subprocesses, which are finally composed by activities. In this section all the dimensions and characteristics that were considered in the planning subprocess design are going to be explained and detailed.

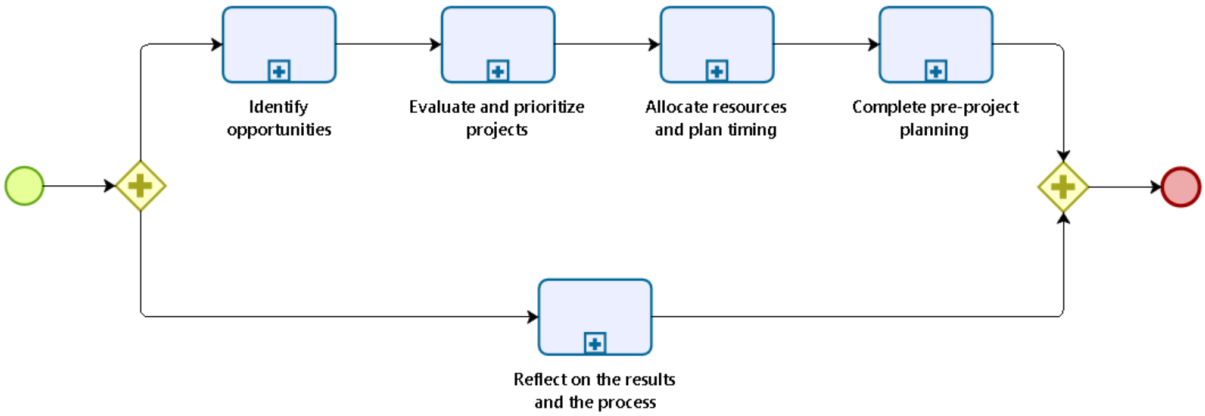

Figure 14- Planning subprocess

As it is possible to see on *Figure 14*, the planning subprocess is composed by smaller subprocesses. The different subprocesses are established as a chain with an order and the next subprocess in the chain can only start when the previous one is completed, except for the Reflect on the Results and the Process subprocess which is continuous and occurs in parallel with the remaining stages. In the specific case of the Planning subprocess, firstly the opportunities must be identified, secondly the projects must be evaluated and prioritized, thirdly the resources should be allocated, and the timings should be planned, fourthly the pre-project planning should be completed and while this four subprocesses are performed, the team should continuously monitor the results and the process.

The opportunity identification subprocess represents the start of the NPD process and it is also composed by other subprocesses as it is possible to understand on *Figure 15*. An opportunity is an idea for a new product, a newly sensed need, a newly discovered technology, or a rough match between a need and a possible solution. At the earliest stage of development, uncertainty clouds the future, so an opportunity can be thought of as a hypothesis about how value might be created in the future (Ulrich and Eppinger, 2015).

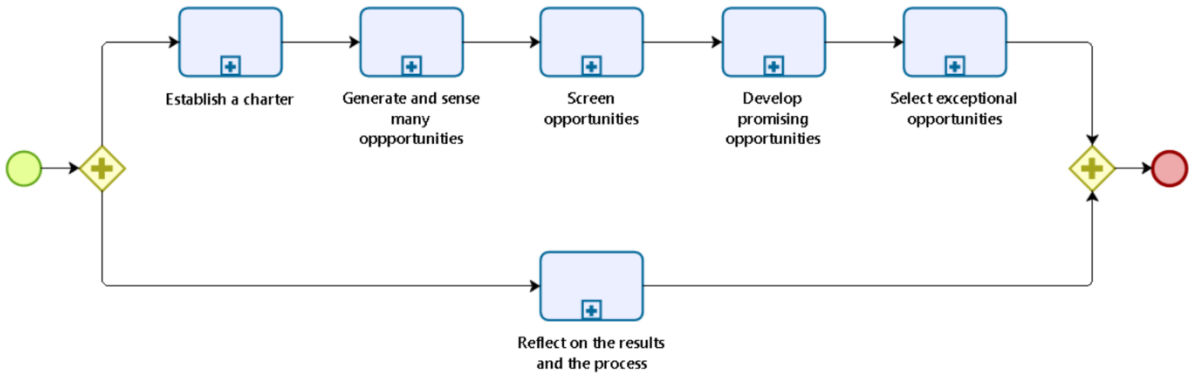

Figure 15 - Opportunity identification subprocess

Before the team start looking for random opportunities, it is very important to define and establish which are the possible areas to search for these opportunities. This will allow the team to focus from the beginning where makes more sense taking into consideration the department's activity and the company strategy. This could be achieved by the definition of a charter. Ulrich and Eppinger (2015) state that the charter must be narrow enough for the team to avoid wasting effort generating opportunities in areas that are unlikely to be pursued, but broad enough to identify innovative opportunities in these areas. The radar chart that is presented on *section 1.1*, was previously developed by the department team and is perfect to use in the context of this process, since it defines the boundaries for the department projects scope.

After defining the charter that establishes the boundaries for opportunities generation, the next step of the process is to perceive which are the different possible sources to identify these opportunities. According to Terwiesch and Ulrich (2009) about half of innovation opportunities are generated internally to an organization and about half are recognized from customers and other external sources. The department team was focusing its search only in the new trends source, which was limiting the opportunities generation process. As it is possible to see on *Figure 16*, with the new process, the team can start thinking and generating opportunities looking also to other dimensions related to customer and internal needs that adapted by new trends, can generate very interesting opportunities. The goal is to generate opportunities not only from the new trends source but from several different kinds of sources (to follow a personal passion, compile bug lists, pull opportunities from capabilities, study customers, imitate but better), and then study which new trends can be used innovatively to fit the opportunity.

According to some actors of the process a very good possible source of potential opportunities is the Development department (*vide Figure 10*) which can share possible technical problems regarding its experience on past projects and with this, offer Future Concepts department the possibility to focus on some already existing needs to fulfil in an innovative way. As previously mentioned, the interactions with other departments in different stages is one of the most important characteristics of the developed process, since they play a critical role on the knowledge diffusion dimension to ensure that the required actors are in possession of relevant information for decision making and that this information is available to be accessed and applied at the service of the process, supporting the Nano-Level section of the Conceptual Framework presented on *Figure 5*. In this context, the inputs from Development department became a source of potential opportunities for development and it is considered on the process.

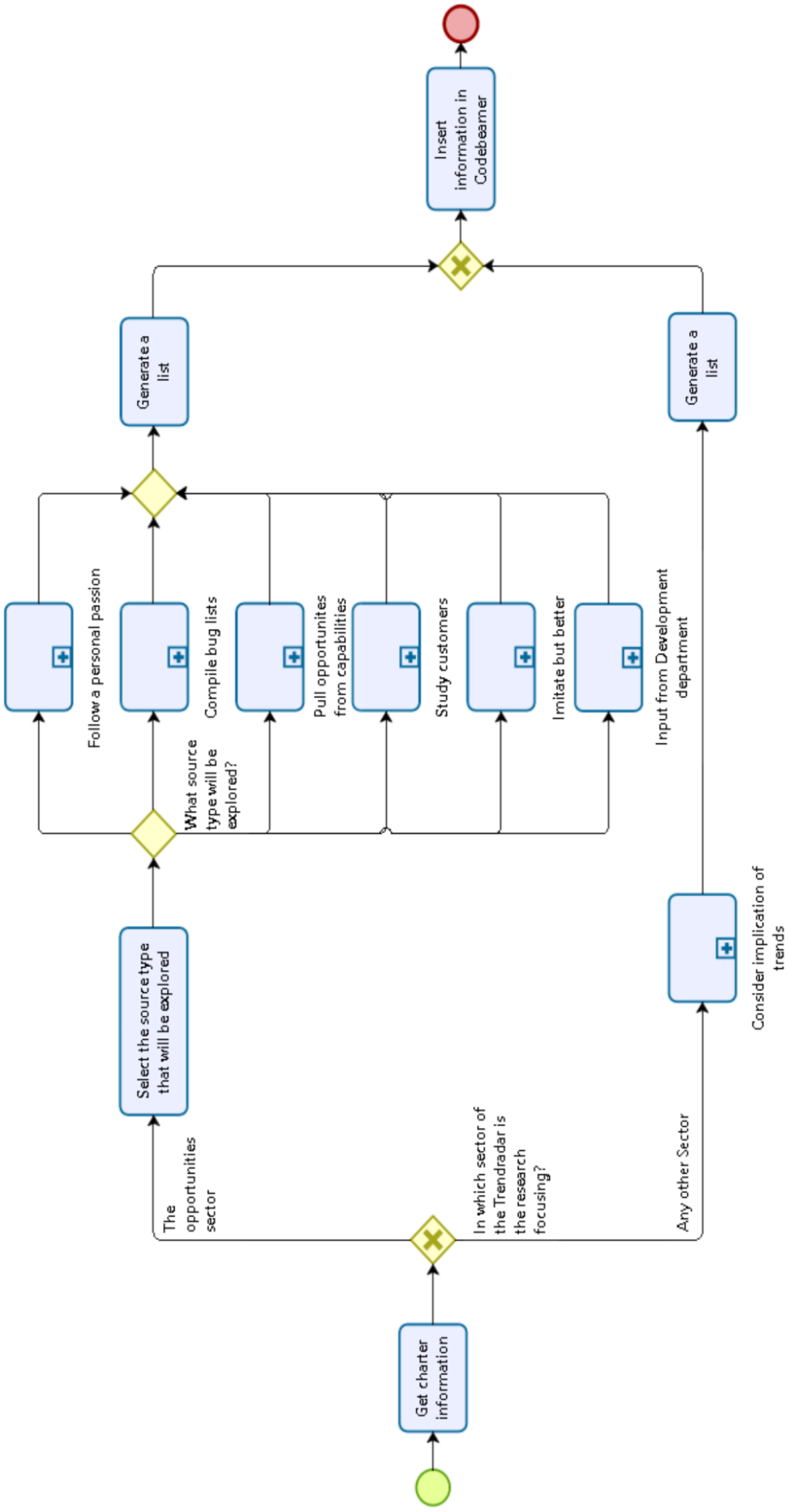

Figure 16- Generate and sense many opportunities subprocess

With the help of developers from Future Concepts department, it was possible to understand the position of the different opportunities generated from different sources regarding department radar chart and the type of opportunity.

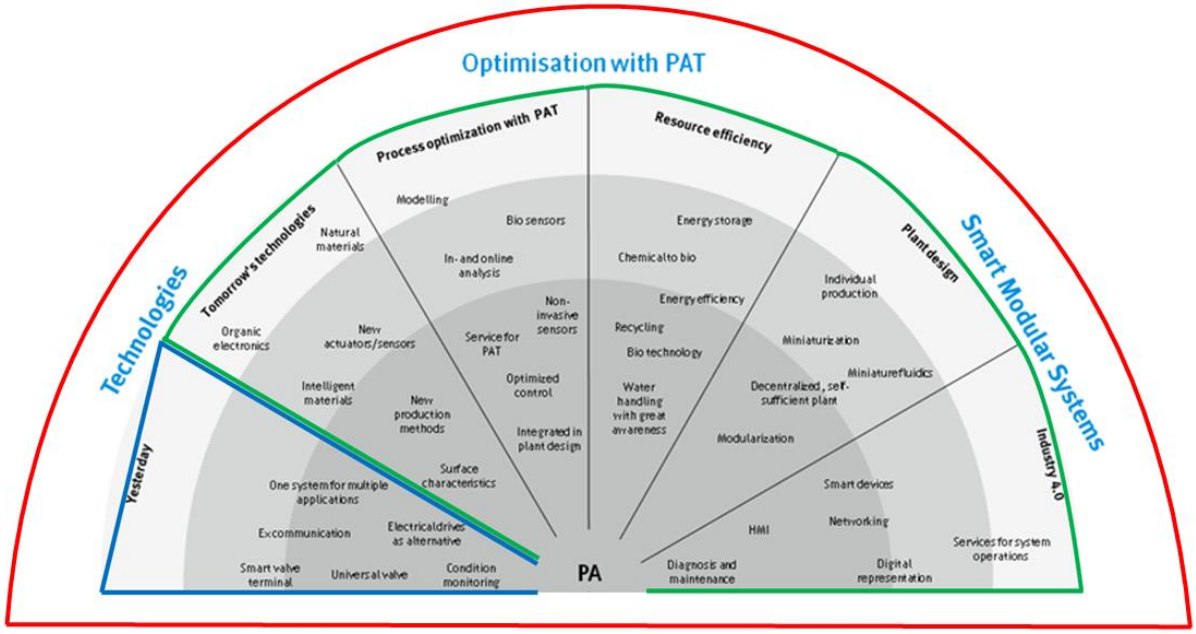

Figure 17 - Radar chart segmented by areas of activity

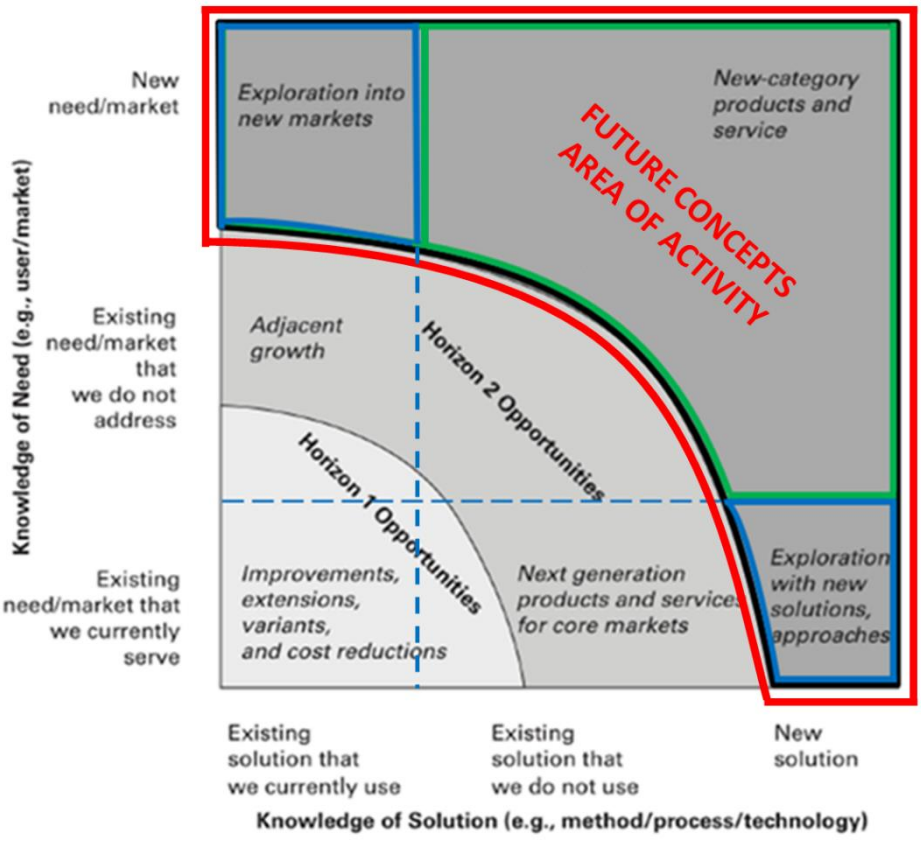

Figure 18 - Opportunity horizon positioning segmented by FC opportunity type

As previously mentioned, the projects generated by the Future Concepts department, are focused on the third horizon (marked in red on *Figure 18* as *Future Concepts area of activity*) considering the type of opportunity classification from Terwiesch and Ulrich (2009). The opportunities in the third horizon differ according to the existent knowledge of need and knowledge of solution levels. The opportunities identified by new trends search mainly cover the green area of the opportunity horizon diagram on *Figure 18* (new solutions for new markets) and represent the green area of Future Concepts radar chart in *Figure 17*. The opportunities generated by other sources presented on the process, cover the blue area of the opportunity horizon diagram on *Figure 18* (new solution for existing markets and existing solution for new markets) and are connected to the blue area of the Future Concepts radar chart on *Figure 17*.

It is important to understand the position of the different types of generated opportunities also in the radar chart and perceive their differences and characteristics. The opportunities generated by the exploration of new trends cover almost all the sectors on the radar chart, in other words, they represent the main focus of the department and are more long-term oriented. The yesterday sector of the radar chart is, however, mainly covered by the other opportunity sources (to follow a personal passion, compile bug lists, pull opportunities from capabilities, study customers, imitate but better and using inputs from the development department). The opportunities generated by these sources have already one known dimension of the horizon diagram *i.e.* market or solution. These opportunities are less long-term oriented and use innovative trends to fulfil already existing needs, or adaptation of already existing solutions to serve different new markets. The output of the generate and sense many opportunities subprocess should be a list of possible nonfiltered opportunities to pursue.

The next step of the process is therefore to understand which of the identified opportunities makes sense to develop taking into consideration different dimensions, *e.g.* technical feasibility, company strategy alignment, level of innovation associated and so on. In this stage, a big number of previously identified opportunities will be eliminated maybe because they are not possible to develop now, or maybe they are not clearly aligned with the company strategies. The goal of screening is simply to eliminate opportunities that are highly unlikely to result in the creation of value and to focus attention on the opportunities worthy of further investigation (Ulrich and Eppinger, 2015). In this subprocess, the interaction with other departments is also crucial since in this case, Product Management can offer relevant input from their expertise. This department will not take final decisions but can offer opinions and valid insights to help Future Concepts department to make more informed and supported decisions in this context.

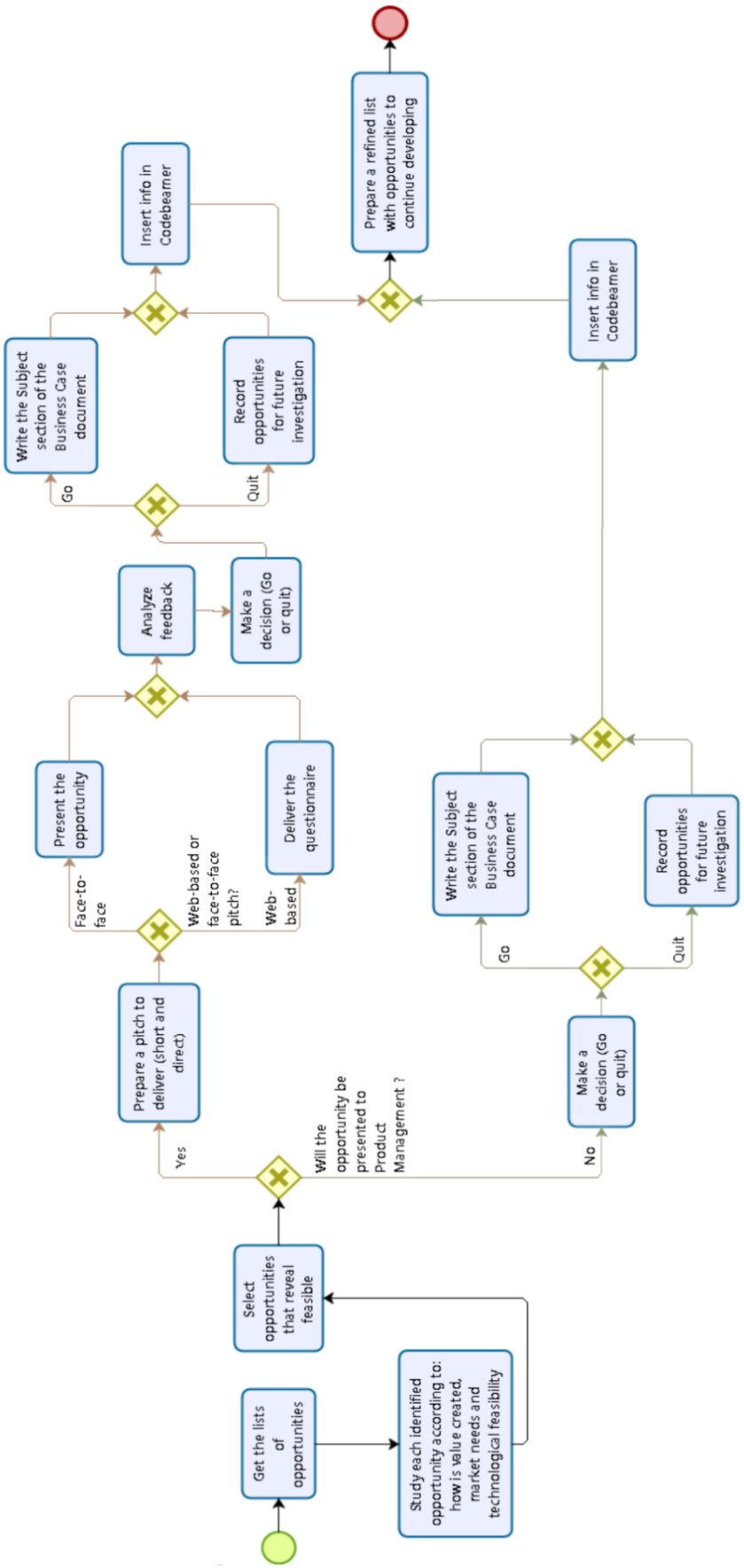

Figure 19 - Screen opportunities subprocess

On *Figure 19* it is possible to analyze in detail the Screen Opportunities subprocess, its characteristics, possible paths, and interactions.

The opportunities that were successful on the first screening progress to the next stage of the chain, which is called the development of promising opportunities subprocess. In this stage it is important to look for similar solutions on the market, perform a quick search on existing patents and study the acceptance levels from potential customers. The goal at this point is to resolve some big uncertainties related to the future potential success of the opportunity regarding market acceptance and internal competition (Ulrich and Eppinger, 2015). In this context, interactions with Product Management to assess internal possible competitor products and with the Sales department to help define which customers are more suitable to schedule meetings under disclosure agreements to assess the potential acceptance level in the market, occurs during this subprocess. These interactions will help on the one hand to eliminate unnecessary development efforts if a similar opportunity has already been developed and, on the other hand, to understand if the characteristics of the opportunity are interesting in the market perspective.

Some opportunities under analysis will not gather the requirements to continue their development process, since a similar idea is already patented, or because a project with similar goals is already being developed in the company, or even because after meeting with potential customers some issues not previously identified arose and the acceptance level of the opportunity was therefore not satisfactory. Despite some opportunities will not proceed to further stages of development, all of them must be stored, since they can become too important in the future. Du Preez and Low (2008) state that all rejected opportunities must be stored together with the reasons of rejection and analyzed again in the future. On *Figure 20* it is possible to understand the characteristics of this subprocess.

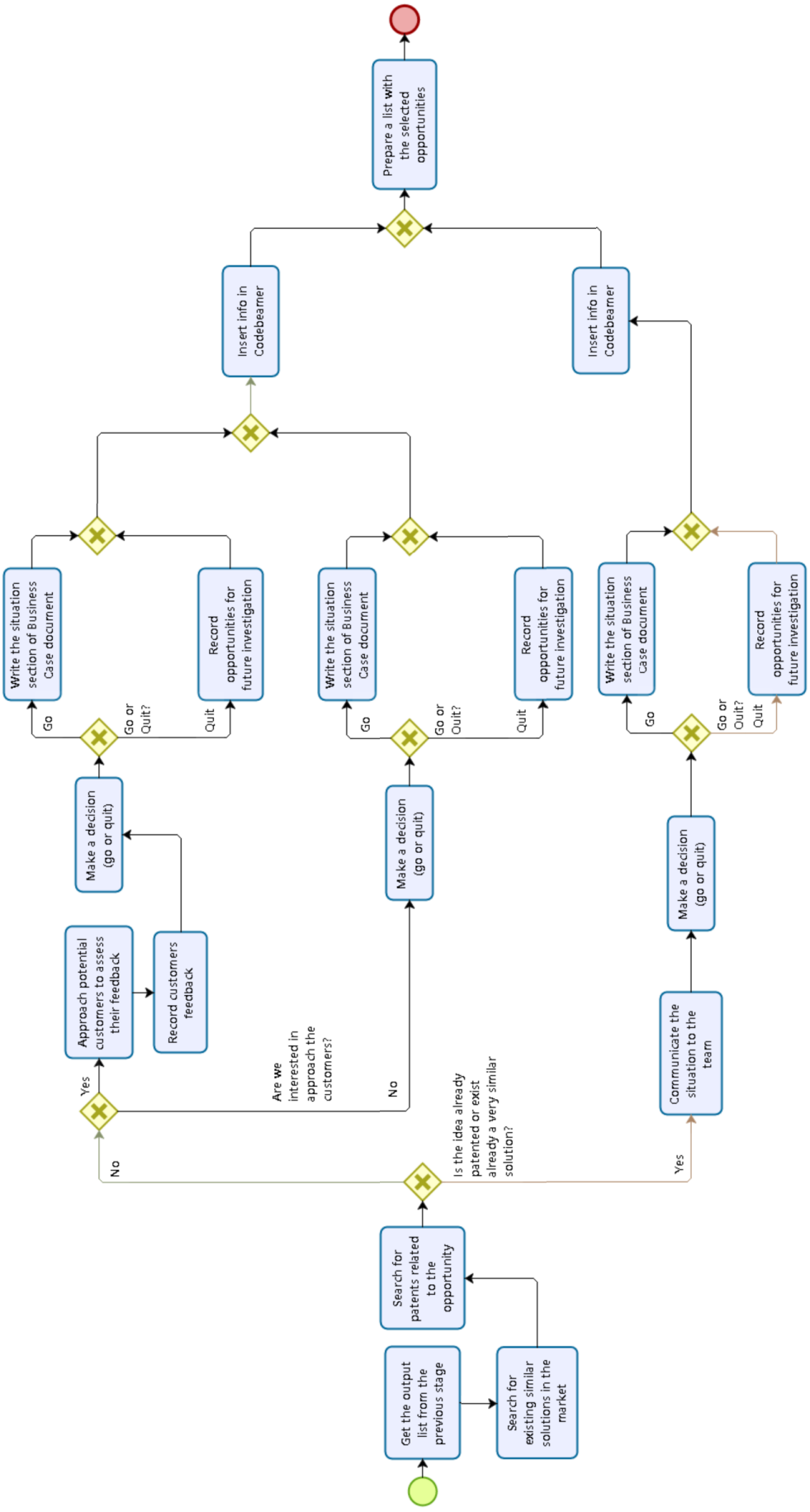

Figure 20 - Development of promising opportunities subprocess

Once a handful of opportunities have been developed with modest investment of resources, enough uncertainty should be resolved to pick the exceptional few opportunities that warrant a significant investment in product development (Ulrich and Eppinger, 2015).

Few opportunities reach this stage of the process and at this stage, the team should decide which should continue its path towards development. For this, the team should evaluate the opportunities once again by analyzing the gathered information and define what are the exceptional identified opportunities that will become formal projects. This subprocess is presented on *Figure 21*.

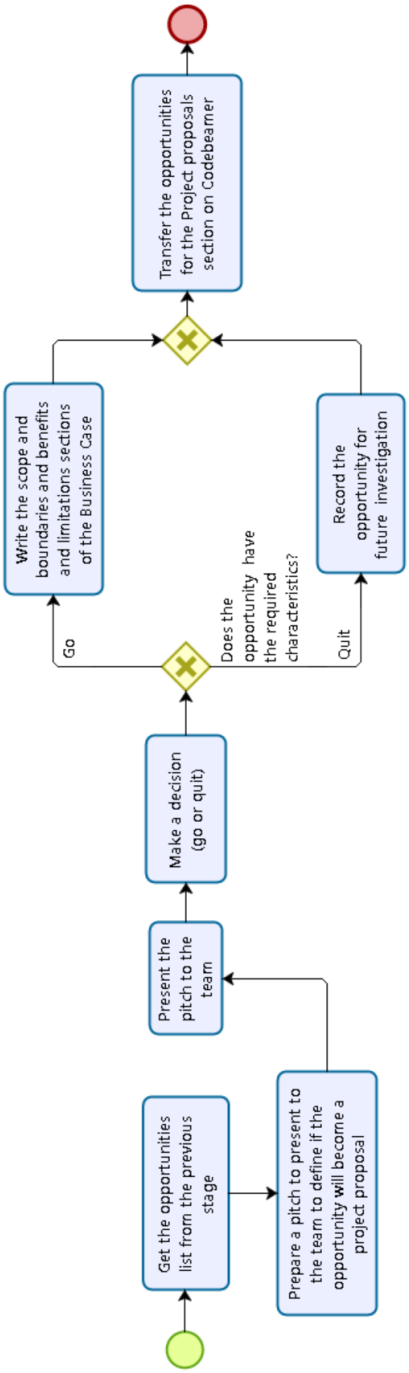

Figure 21 - Select exceptional opportunities

The opportunities identification subprocess is only concluded after performing an analysis to understand what went well and what could have been better. The reflect on the results and the process subprocess works as a control procedure to ensure that the final outputs are as expected. It is very important to control the subprocess and study if its effectiveness level is according to expectations. The product plans should be continuously analyzed to ensure alignment with the company strategies, the collaboration between different departments must be guaranteed to achieve the best possible outputs, and all the events that occur during the process must be studied and evaluated to improve the process for the future. On *Figure 22* it is possible to see the main activities of this subprocess.

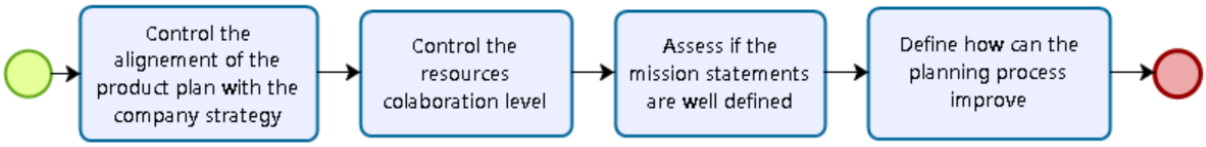

Figure 22 - Reflect on the results and the opportunities identification subprocess

The output of the opportunity identification subprocess represents the starting point for all the projects that will born in the Future Concepts department. Therefore, the performance level of this subprocess plays a very important role regarding the goal of this business project: *to increase the acceptance rate of projects born in the future concepts department for future stages of development in the chain.*

The performance of the opportunity identification subprocess depends on considering a big set of opportunities from a wide variety of sources, applying idea generation processes to identify good opportunities, and considering opportunities of varying quality. By systematically filtering and developing a large set of raw opportunities to identify an exceptional few for further development, the resources of the organization are put to their best use (Ulrich and Eppinger, 2015).

As mentioned, the opportunities identification subprocess is directly connected with the acceptance rate of Future Concepts projects, since they are born in this stage. A wide range of opportunities must be identified from several different sources and filtered using different techniques and interactions with actors from different departments involved in the NPD process. This will allow to select accurately the best opportunities that will become unique innovative projects, accepted by all entities involved in the process, aligned with the company strategies and interesting regarding the market perspective.

The opportunity identification subprocess ends transforming opportunities into possible projects. When this subprocess is concluded, the evaluation and prioritization of projects subprocess begins. At this stage, the goal is to evaluate the different possible generated projects and prioritize which ones makes sense to develop first. When managed actively, the opportunity funnel can generate hundreds of opportunities, and frequently, there are simply too many projects for the firm to pursue at once (Ulrich and Eppinger, 2015).

This subprocess is therefore composed by two different subprocesses as *Figure 23* illustrates. The first one consists in the evaluation of projects where potential profitability, risks and sensitivity analysis are studied, and the second one, consists on the prioritization of projects to establish what are the projects to focus at first by using inputs from other departments and analysis to time to market requirements.

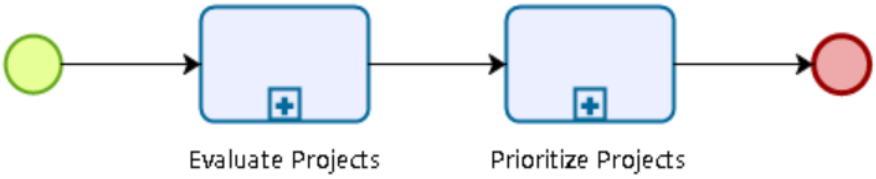

Figure 23 - Projects evaluation and prioritization subprocess

The evaluation of projects subprocess uses a Microsoft Excel tool developed internally with the help of an actor from the Future Concepts department, which supports the Micro-Level section of the Conceptual Framework presented on *Figure 5*. The basic goals of this tool are to offer the team the possibility to compute the NPV for a project, to perform sensitivity analysis regarding the different variables considered for this estimation, and to assess the risks of the project with the help of the innovation risk matrix and the RWW method. The tool is explained below and Screenshots from it can be found from Appendix 3.

This tool starts with an analysis of the market size where the output of the project will compete, and the definition of the market share goals defined by the company for this product in the time periods after its launch. Three scenarios are considered in this stage, a pessimistic perspective, a realistic perspective and an optimistic perspective and the values of the forecasts vary according to the perspective under analysis. After the definition of the potential sales volume, the potential production costs are analyzed using a formula developed by the company, which consider material costs, manufacturing costs and mold costs. Then, a potential market price for the product is determined. For this, an intended margin regarding the unit production cost is established and a benchmark to the potential competitors prices is performed to understand if the established price fits the strategic perspective.

The pre-development costs, the potential development costs and the marketing and support costs are estimated considering the costs of other similar projects developed in the company in the past.

It is possible to calculate the NPV for the project with all these inputs. To test the boundaries of this value, a sensitivity analysis model which calculates the NPV taking into consideration the different possible values for the different calculated variables was developed. In this analysis is possible to analyze how the NPV varies when the costs or the sales values changes. This analysis has the power to tell, for example, what are the limit until where costs can increase but still, keeping the project profitable.

Along with the NPV analysis, this tool considers also a risk analysis section to identify potential areas that will require extra focus, or maybe even to identify areas that will not allow the project to continue at all. In this context, the innovation risk matrix and the RWW method, are possible to apply and analyze.

It is important to state that the NPV will not be extremely precise due to the nature of the projects and the analysis performed in this context (focused on forecasts of the future), however, the goal is not that this value is extremely precise, the goal is to understand if a certain project can become profitable with realistic assumptions and show the team the required objectives to achieve in this scenario. The sensitivity analysis shows the boundaries for the values of the different variables to keep the project profitable, and the risk analysis shows the main areas to focus at to control it. The application of this tool allows therefore to evaluate the projects and understand the main variables related to them. On *Figure 24* is possible to analyze in detail the tasks associated to the subprocess of projects evaluation and how the developed tool is used along the way.

Several conclusions are possible to take after the project's evaluation subprocess is performed. Some projects can reveal that even in an optimistic perspective they are simply not possible to become profitable due to the extremely high production costs attached, other can have too many associated risks difficult to overcome and control, and other can reveal as great opportunities that need to be developed as soon as possible. This subprocess works also as a filter to understand which projects should pass to next stage and which ones should be dropped at least for the moment.

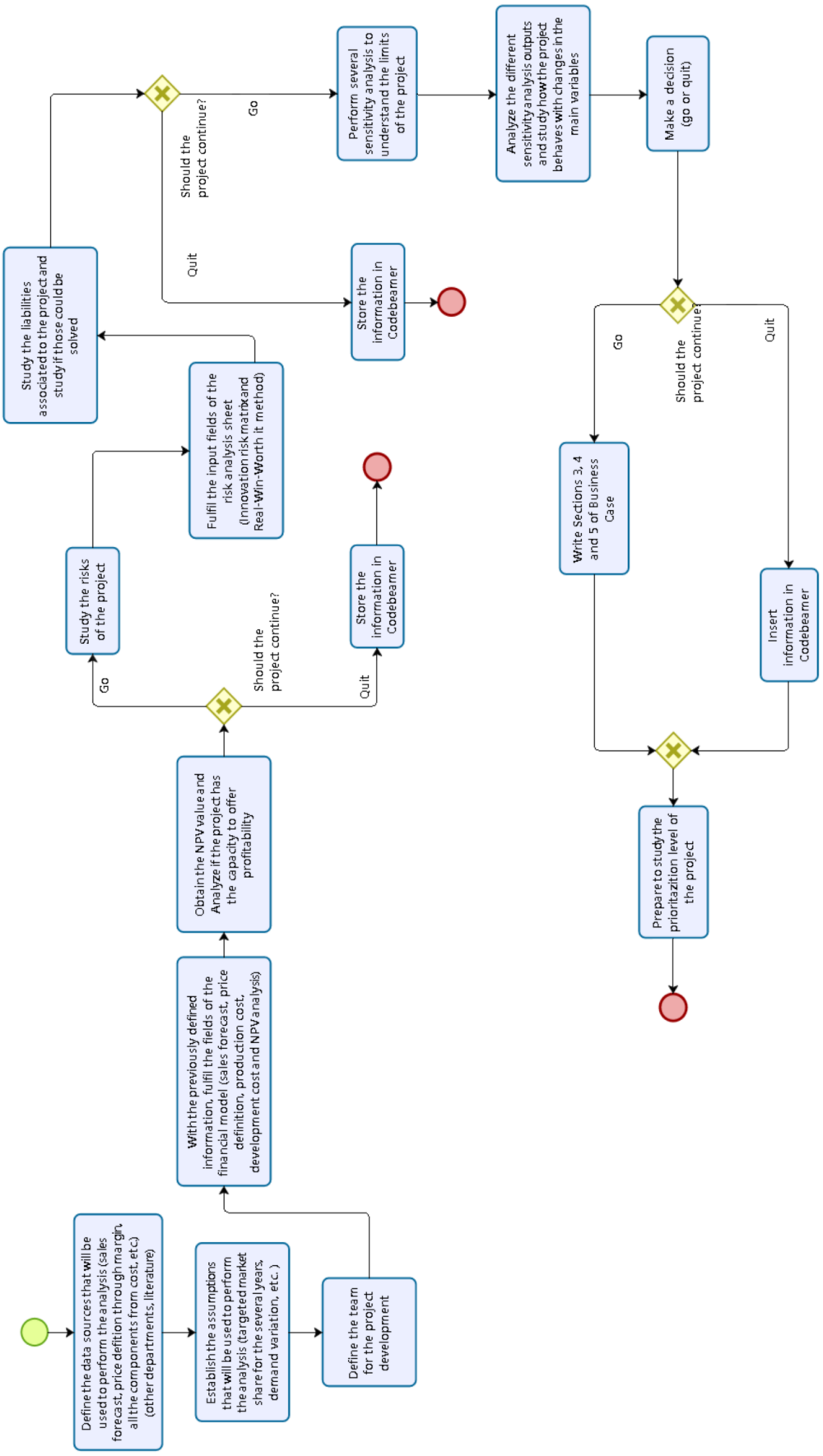

Figure 24 - Projects evaluation subprocess

The next stage of the process is the projects prioritization subprocess. This subprocess has the goal to define which of the selected projects should be developed in a shorter period basis and therefore will need resources. For this, an internal and external analysis should be performed to understand the time to market requirements from the market side and the lifecycle of the internal "competitor" products should be studied to avoid cannibalization. As it is possible to see on *Figure 25*, these analyses vary according to two perspectives: if it is a new product in existing categories both, the internal and the external analysis should be performed, if it is a fundamentally new product, only the external analysis is required to be performed due to the non-existence of internal competitor products.

To get accurate information regarding the market side, interactions with the Sales department are crucial. This is the department that interacts directly with the customers and can easily assess their interest level regarding a certain product and help performing the external analysis. Also, the Product Management department is important to approach in this subprocess, since actors from it can offer important inputs to study the existing "competitor" products lifecycle and with this, perform the internal analysis more accurately.

The output of this subprocess is a list containing the projects that will be developed by the department soon, with the prioritization of which ones should receive more attention first. This prioritization would be crucial on the resource's allocation and time planning subprocess regarding further development since the more "urgent" projects will need more work in the nearest future.

On *Figure 25* it is possible to analyze in detail the tasks associated to the project's prioritization subprocess.

As previously mentioned, the next step of the process is the resources and time allocation subprocess. It is likely that a firm cannot afford to invest in every product development project in its desired balanced portfolio. As timing and resource allocation are determined for the most promising projects, too many projects will invariably compete for too few resources. As a result, the attempt to assign resources and plan timing almost always result in a return to the prior evaluation and prioritization step to prune the set of projects to be pursuit. (Ulrich and Eppinger, 2015).

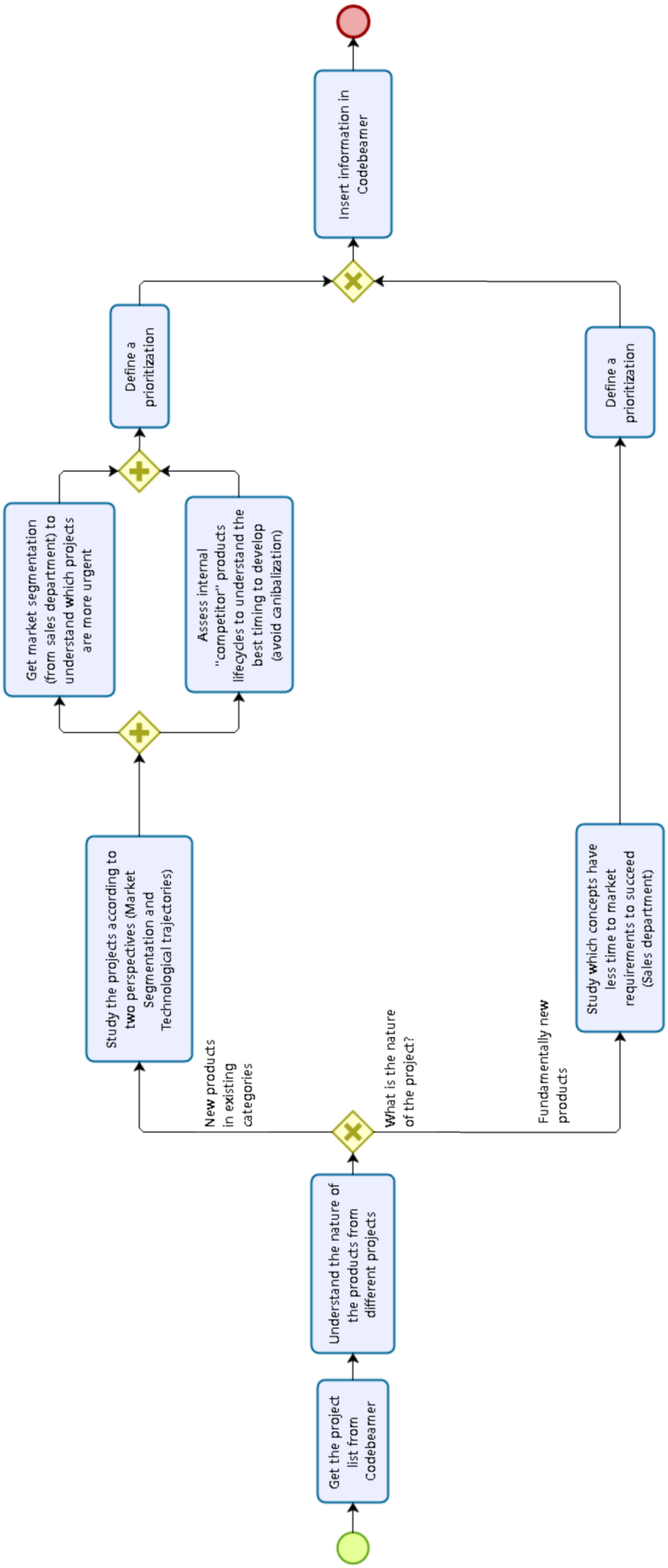

Figure 25 - Projects prioritization subprocess

In this context, this subprocess starts to define the time requirements per task for the project development and assign them to specific actors. After this, an analysis to the ongoing projects is performed to assess the actor's availability to receive the new project tasks. This will allow to define to which actor a certain task should be assigned and to manage the projects portfolio assertively, always trying to find solutions regarding the capacity for the development of different projects. This balance is very important to keep the timings under control and respect the previously established requirements, *i.e.* time to market requirements.

At the end of this subprocess a decision regarding to continue the project development in the present or to postpone it is achieved and team meetings must be scheduled to help the assignment of tasks and reorganization of work, when necessary. The Allocate Resources and Plan Timing subprocess is presented on *Figure 26*.

When the main stages of the planning are concluded, it's time to prepare the documentation that will be presented on the steering committee. The steering committee is a meeting where the projects are presented to a transversal team of the top management and where a decision regarding its development continuation is taken. As previously mentioned, the great majority of projects from the Future Concepts department is rejected at this stage due to lack of presented information in several fields, like potential financial benefits of the project, market analysis and feasibility studies.

For this, a new document was developed to aggregate all the relevant collected information along the process. This document is the business case and will be addressed further (*vide section 5.2.2*).

The main goal of this subprocess is to prepare all the documentation for the steering committee, guaranteeing that when the meeting occurs, all the relevant information is exposed.

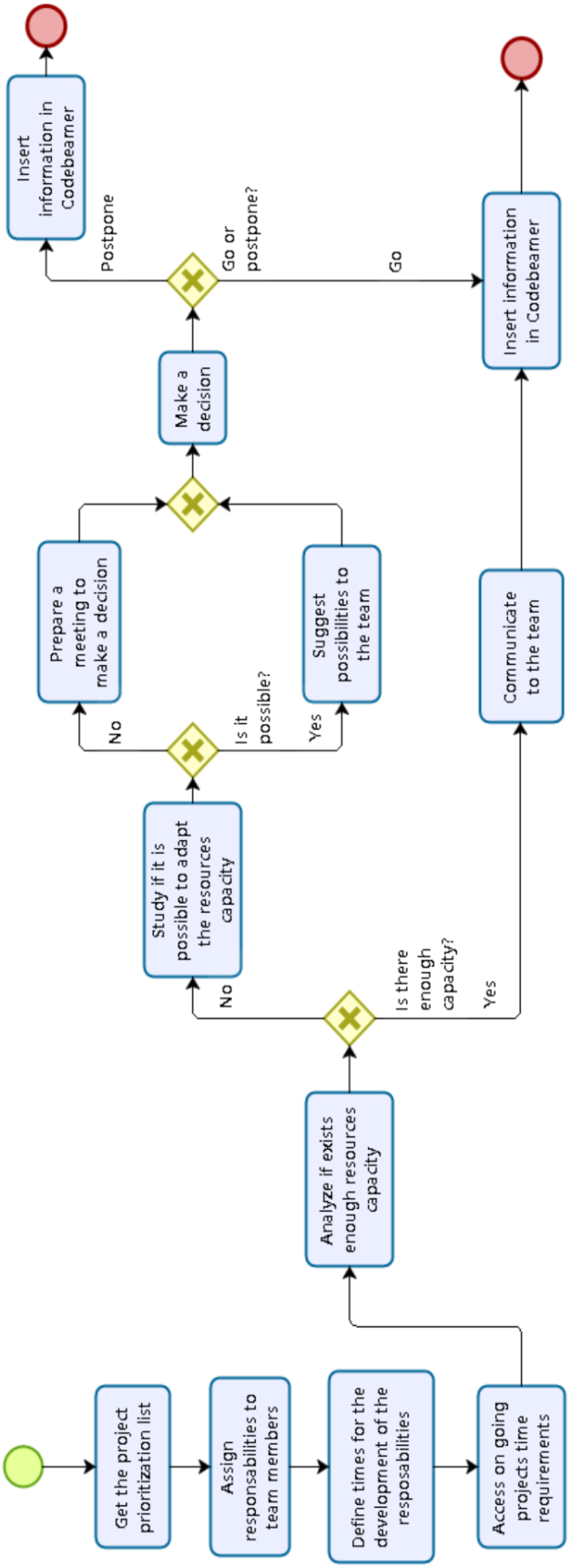

Figure 26 - Resources and time allocation subprocess

The task associated to this subprocess are presented on *Figure 27*.

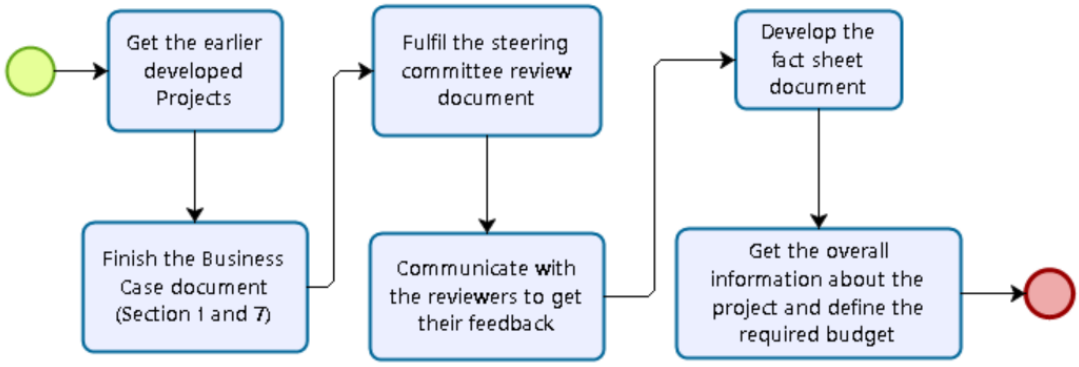

Figure 27 - Complete pre-project planning subprocess

Along the entire planning subprocess is crucial to control all the outputs along the way and collect all the information that will allow to improve it in the future. The subprocess of reflect on the results and the planning, as it is possible to see on *Figure 28*, will ensure that the entire subprocess is improved if necessary, taking into consideration the quality of the projects developed and the opportunities collected.

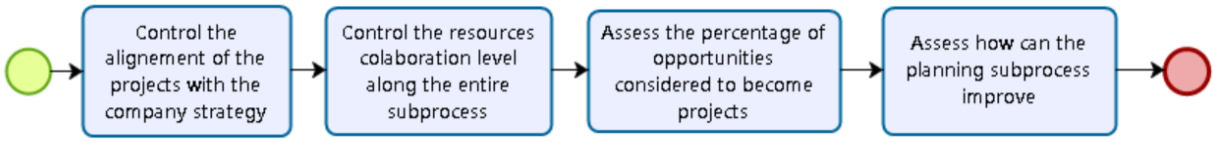

Figure 28 - Reflect on the results and the planning subprocess

The planning subprocess is crucial for the success of any NPD process. The entire business project solution is focused on this subprocess not only due to the company desire to focus in this stage, but also since it was here that the root causes leading to failure were identified. The design of the entire subprocess was regularly presented to the tutor of this business project, and along the way, several improvement opportunities were identified, explored and put into practice, bringing a final complex and robust process. This process offers structured procedures to approach the entire planning of projects developed in the Future Concepts department, taking in consideration the main issues presented by internal and external actors of the department and fixing them by considering different dimensions along its path *e.g.* constant interactions with other departments and several analyses to the external environment.

5.2.2. Business Case document

Together with the process, and as it is possible to verify on the figures that highlight the tasks of the different subprocesses presented along this business project (*vide section 5.2.1*), a business case document is being developed. The goal is to aggregate the most important set of information regarding project justification to present on Steering Committees where the future of the project is decided. Until now, projects from the Future Concepts department were presented on Steering Committees lacking important information *e.g*. financial analysis, risk analysis, etc. This document aggregates the information collected during the process flow, by the fulfilment of the several tasks and organize it into a structured document that presents the context and scope of the project, the possible financial benefits that it can bring to the company, the feasibility studies developed to the required technologies and a risk analysis showing which are the areas that will require more control and attention. This document has also the power to standardize all the information for all the projects, becoming easier to organize them in the database of the department.

The goal is to have this document prepared two day before the steering committee meeting and deliver it to the members of the board, offering them all the required information to understand exactly what is the project about, what are the possible benefits that it can bring to the Company, which resources has availability to work on it and what are the main risks that the project will face. In other words, an entire scenario based on taking a certain decision regarding a specific case is presented in advance for the board to analyze.

This document will fight the third root cause previously identified, which is based on the fact that the handover to continue the development is not clear and several vital information regularly is not presented, like market analysis and technical feasibility studies.

This tool is on the format of a dynamic document that can be updated during time and covers a wide range of relevant topics regarding the acceptance of a certain project. It has not only this capacity regarding the internal perspective, but also allows managers to have access to the most relevant information to manage projects properly. In the development of this business project, it was decided to focus on the model developed by Schmidt (2005), due to its clear structure, and because it aggregates all the required information for this specific case, *i.e*. introduction and scope definition, business impacts, risk analysis, and sensitivity analysis. The theoretical structure of the document is presented on the next chapter and the moments and required activities for its development are defined on the process flow (*vide section 5.2.1*).

5.2.2.1. Executive Summary

Although the executive summary may be the first text item in the business case report, it is recommended that it should be the last item to be written in the business case building process. It is most useful if it contains text, numbers, and one image of graphed results (Schmidt, 2005).

The executive summary deserves careful preparation and formatting since some of the audience may only read this part of the report and this may be the only chance to reach these people. Other members of the audience will read some of the report, but miss the main conclusions, misunderstand the subject and scope, or otherwise misinterpret the business case, unless these elements are detailed and specific in this section. It is then crucial to present the main conclusions regarding the specific Future Concepts project under study, like the main figures regarding potential benefits and risks provided by the developed tool to be used on the process.

5.2.2.2. Subject

Every business case needs an explicit subject statement, describing what the case is about. This statement is critically important because it helps to define or shape almost everything else in the case. The starting point for identifying the business case subject is usually a proposed or planned action, but the subject of the case should be ultimately defined in terms of objectives. The main objectives to be achieved with the specific project should be presented in this section.

5.2.2.3. Situation

The situation section presents the setting for the case and helps the reader to understand why the project is relevant. The overall picture of the business case should be presented in this section. For instance, when a team decide to develop a new product, is because an opportunity or need was previously identified, this is the situation that needs to be reported and identified in this section. In other words, it is important to look at the objective of the project and tell why this project is relevant and needed in this context. (Schmidt, 2005)

5.2.2.4. Scope and boundaries

At this point of the document, the scope and boundaries should be clearly identified, telling exactly what the project is about, and more important, defining what the project is not about and won't cover. This section will enable the reader to understand what the project covers in technical terms. In the case of product development, the product characteristics and features should be presented in this section.

5.2.2.5. Benefits and limitations

This section should be supported by the financial analysis performed with the developed excel tool (*vide section 5.2.1*) and the main results must be exposed here. The financial results (quantitative) are the most important metric for any firm which goal is to generate profit. There are however several qualitative results that the project brings which may be also presented in this section.

On the other hand, the main limitations of the project should also be exposed to the committee, for example, big investment requirements in assets to develop the project or uncertainty regarding a specific characteristic.

5.2.2.6. Project Assumptions and Data sources

One of the goals of the business case is to project the future. That means that the business case should be built from many assumptions. In this section, the assumptions used to build the business case should be summarized and explained, like the reasons for the figures used to forecast sales or the manufacturing costs. It is very important that these assumptions are as close as possible to the reality in order to better predict the possible outcomes. All the data sources used to build up the assumptions should be stored and presented since they can offer power regarding the justification of the project.

5.2.2.7. Business Impacts

The centerpiece of any business case document is the financial model and at the heart of the financial model is the cashflow statement (Schmidt, 2005).

In this section, the developed financial model should be presented and the main conclusions regarding the project financial impacts for the business summarized. It requires a big amount of work for the financial model to be accurate since, for example, cost structures and sales forecasts are very difficult to predict. That is why the previous section, regarding assumptions and data sources, is so important. Not all the impacts of a project will be translated in a financial perspective, which means, in a quantitative manner. A project can impact the business in several different qualitative ways. These impacts may include contributions to corporate image, customer satisfaction, or employee morale. These may represent major corporate objectives, which should ultimately be translated into lower costs and increased revenues. Nevertheless, it is very difficult to estimate and accept value estimates for these situations. These non-financial results will not enter the financial model, yet they still deserve consideration in the proposal

and should be presented in this section. An example of what a financial model based on cashflows should contain is expressed on *Appendix 3*. The financial and risk assessment tool developed during this project (*vide section 5.2.1*), offers a solid structure to forecast the potential benefits that a certain project can bring. All the assumptions that support the figures used in this analysis should be presented on *section 5.2.2.6*.

5.2.2.8. Risk and Sensitivity analysis

By using the methods presented on *section 4.3.3.4* like Innovation Risk Matrix and the RWW method, it is possible to assess what are the risks threatening the success of the entire project. The identification of these risks allows the team to develop procedures to control and monitor specific characteristics of the process and ultimately take actions before they occur. The identified risks and measures should be presented on this section of the business case.

If a certain variable regarding costs or sales change, the result obtained regarding the NPV of the project can change dramatically. To identify and understand how these variables can change and what are the impacts when they change, on this section of the business case the results from different sensitivity analysis should be presented.

5.2.2.9. Project Organization

This section of the business case should focus in detail which is the team responsible for the project and its main milestones. As previously stated, this is a dynamic document, that is updated during the lifecycle of the project. The main activities of the project and the team members responsible for them should be detailed, in order to keep track of the work. This is supported by the resources and time allocation subprocess (*vide Figure 26*).

5.2.2.10. Conclusions

It is rarely safe to assume that readers of the business case will automatically read the financial results and analysis, and then draw the same conclusions that the author of the business case drew regarding the implications for decisions or actions. The conclusions section is very important and should be used to state the complete situation briefly but completely, supporting the reasoning with evidence from the preceding sections.

The conclusions of the business case should be organized around the business objectives addressed by the subject section. This section should focus on the expected contribution to these objectives in terms of the analysis and results developed earlier (Schmidt, 2005).

6. Discussion of the Impact of the Knowledge Diffusion Dimension on the Project

The integration of different disciplines to develop new products has attracted much interest from scholars and has become popular among many organizations (Adler, 1995). In fact, the success of many NPD process tasks clearly depends on the interactions between the firm's different functional areas (Cooper, 1986). The integration between different actors of the process is considered a practical arrangement of task integration and communication among functions assigned to new product development. However, the success of new products is not only enhanced by employing this integration but also by how much knowledge is actually integrated and transformed to usable knowledge in this context (De Luca and Atuahene-Gima, 2007).

Due to its nature, for the NPD process to be successful, it needs to integrate tacit and explicit knowledge (Nonaka, 1991) detained by several actors belonging to different areas, cross it to identify the most relevant characteristics and use it to develop supported and structured solutions (Ulrich and Eppinger, 2015). Not only to have an infrastructure to share the knowledge is important, but it is also crucial to ensure that the all actors involved have the will to diffuse the knowledge they detain and put it on the service of the development process.

In this context, it is possible to understand that the NPD process flow is very important because it offers a clear roadmap towards an assertive development, but it is not enough. An intrinsic dimension of knowledge diffusion must be ensured to enable the transfer and consequent collection of the required knowledge along the process, which allow a more informed and supported development.

The knowledge diffusion dimension (*addressed on section 5.1.2*) can have a critical impact on the designed solution for this business project, since the different stages of the development process require knowledge inputs from actors belonging to several functional areas, *e.g.* Product Management, Development, Sales and Intellectual Property, in order to identify the best opportunities, screen them to understand which makes more sense for the company context, select the most promising ones taking into consideration their potential benefits and their feasibility level, and organize all the required work for their future development.

The intrinsic knowledge diffusion dimension should therefore be integrated on the previously presented conceptual framework (*vide Figure 5*). The updated conceptual framework considering the knowledge diffusion dimension can be observed on *Figure 29*.

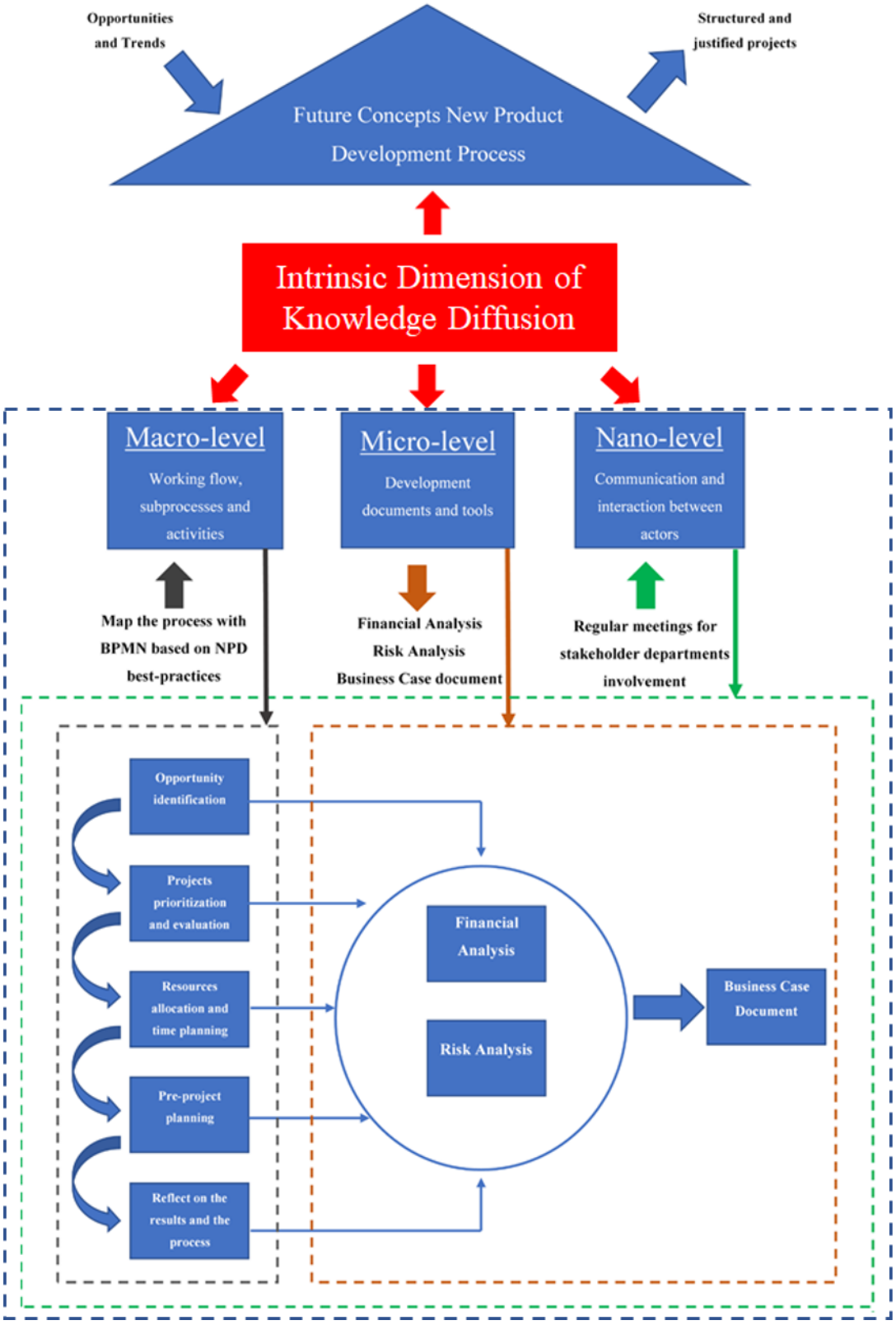

Figure 29 - Conceptual framework considering the knowledge diffusion dimension

According to the Knowledge Based View (KBV), knowledge is the primary resource underlying new value creation, heterogeneity, and competitive advantage (Barney, 1991). So, between the procedures (Macro-level), tools (Micro-level) and interactions (Nano-level), and the Future Concepts development process success, there is an intrinsic dimension of knowledge diffusion that needs to exist among the actors involved.

The knowledge diffusion dimension is therefore critical and there are several dimensions that can affect its success. According to Szulanski (1999), there are four main dimensions based on the knowledge source and recipient characteristics that clearly affects the success of the knowledge transfer process.

Firstly, the effectiveness of knowledge transfer depends on the ease of communication and on the "intimacy" of the overall relationship between source and recipient. A distant relationship might increase the effort needed to solve transfer related problems. Secondly, the motivation of the source may vary with the incentive to compete or collaborate with the recipient and with the effort required to support the transfer. Furthermore, the source may be not perceived as reliable. A capable and trustworthy source is more likely to influence the behavior of the recipient. Thirdly, the recipient can be more or less motivated to accept knowledge from the outside. Lack of motivation may result in passivity, hidden sabotage or fake acceptance in the implementation and use of new knowledge. Recipients may also vary in their absorptive capacity (Cohen and Levinthal, 1990), *i.e.*, their ability to exploit outside sources of knowledge. Finally, the organizational context where the transfer is embedded may affect the eventfulness of the transfer. Ultimately, the organizational context affects the willingness and ability of organizational units to complete transfer related tasks.

For the development process presented as the solution of this business project to work effectively and achieve its ultimate goal – *i.e. to increase the success rate of projects born on the Future Concepts department*, the dimension of knowledge diffusion must be ensured. It is then crucial to understand the characteristics related to the relationships between sources and recipients of knowledge during the process, observe these interactions, and identify corrective measures, if necessary, to guarantee a smooth flow between knowledge across the different actors involved on the process. This dimension is very complex to measure and analyze but plays a central role on the entire success of the NPD process being, therefore crucial to take into consideration along the process implementation. Further research should focus on expanding this topic, which is believed to be a core issue regarding the NPD process, and has not been sufficiently addressed.

7. Conclusions

On this chapter the final conclusions of the project are presented. So, the chapter will start by reviewing the initial statement of the project. Then, the development of the proposed approach will be shortly addressed. Next, it will be argued for the achievement of the goals by following the guidance provided by the research questions (*vide sections 1.4 and 1.5*). In this way, the report is providing evidence to satisfy the initial curiosities motivating this investigation, *i.e.* the research questions. Finally, the limitations of the project and the recommendations for future work and the project contributions for different fields are presented *(section 7.2).*

7.1. Final Conclusions

This business project was born due to urgent need of the Future Concepts department to identify and implement measures to overcome the verified very low acceptance rate of the internally developed projects through further stages of development. It was found that the root causes leading to this situation were:

1- *lack of support from other departments regarding the projects that were born in this department*

2- *a reduced level of existing communication between the different actors involved in the process*

3- *the handover content was not clear and did not have the required information*

To overcome this situation, an entire NPD process was developed (*vide section 5.2.1*) supported by several developed operational tools (*vide Appendix 3*), guided by the analysis of internal and external information collected along the way for decision making, and that offers communication channels for internal and external stakeholders to interact. The process is supported by the business case document (*vide section 5.2.2)* and ensures that the market and the customers are extensively analyzed in order to identify the most promising opportunities, several technical feasibility studies and interaction with the suppliers are performed to understand if the opportunities are real, and all projects are presented in a standardized way, containing risk analysis, sensitivity analysis and a financial analysis for the decision makers responsible for the future of the project be able to make supported and informed decisions (*vide section 5.2.1*).

This project brought several benefits for the company in general and for Future Concepts in particular, since it was possible to clearly understand the perspectives and opinions from other departments that perform complementary work regarding product development and take actions to improve some identified aspects based on them. The process development represents the most relevant action in this regarding since it incorporates measures to overcome several identified intradepartmental and interdepartmental issues, like lack of communication channels and lack of development regarding crucial information for the product development activity.

The goals of this business project are then to:

G1) *Identify the main issues that are leading to the very low success rate of Future Concepts projects.*

G2) *Incorporate the best-practices on the Future Concepts NPD process design and apply the best tools to map it.*

G3) *Guarantee that the process ensures the development of a financial analysis.*

G4) *Develop and implement a tool that is capable to aggregate and standardize all the information collected along the process.*

G5) *Guarantee that external relevant actors interact with the process and feed it with crucial information.*

In this context, and in order to achieve the established goals for this business project, five Research Questions were defined as follows:

RQ1) *Why is the success rate of Future Concepts projects so low?*

RQ2) *What are the benefits of having a formal structured NPD process?*

RQ3) *Which tools can be used to design the process for this specific case?*

RQ4) *How can the most relevant information collected along the development process be aggregated and stored on a standardized and structured way?*

RQ5) *How can knowledge from other relevant departments for the process be incorporated on the Future Concepts NPD process?*

As mentioned, it was necessary to understand exactly why the success rate of the projects from Future Concepts was so low (*RQ1 and G1, vide section 5.1*). By analyzing all the collected data and after observing how projects were being developed, it was understood that an NPD process was not clearly implemented. The work was performed individually and there were no specific

mandatory activities to accomplish. This scenario was leading to unstructured, unjustified and weakly supported projects mainly rejected on Steering Committees.

The solution of the business project is then focused on the development of a formal and structured process (*RQ2 and G2, vide section 5.2*) focused on best practices presented on the literature, *i.e*. the NPD process presented by Ulrich and Eppinger and the innovation Fugle developed by Du Prez, that can offer the possibility on the one hand, to connect the projects developed in Future Concepts department with the relevant external actors on the process chain, and, on the other hand, to organize and perform the required activities of the process according to the project's needs, *i.e.* performing market analysis, feasibility studies, economic analysis and so on. This scenario allows all actors to work collaboratively, clearly understand the benefits of the projects, select the ones with higher potential and prevent efforts in the development of projects that are not aligned with the company business strategy. This also allows the department to focus on the most urgent projects and helps the development of a relationship of trust and partnership between all the actors involved in the process. Moreover, the process design was achieved by mapping all the activities with the help of BPMN (*vide section 5.2.1*) as required by *RQ3 and G2*. This mapping utilizes a very easily understandable notation to all the actors involved, from the developers of the process to the ones that will follow its expressed activities and the ones that will have the responsibility to monitor and control it.

One of the main concerns associated to the implementation of the process was related to the way that information would be collected and stored along the way (*RQ4 and G4*). One of the identified issues was that the presented information to Steering Committees was often not the most relevant and it was not presented on a structured way. To address this issue, a business case document model was developed, which aggregates the information collected during the process flow when the fulfilment of the several tasks occur and organize it into a structured document that presents the context and scope of the project, the possible financial benefits that it can bring to the company, the feasibility studies developed to the required technologies and a risk analysis showing which are the areas that will require more control and attention (*vide section 5.2.2*). This document has also the power to standardize all the information for all the projects, becoming easier to organize them in the database of the department, in this way.

To support the process and provide input for the business case document, a tool for financial analysis performance and risk assessment was developed (*vide section 5.2.1*). This tool considers the collection of data for different variables like potential sales volume and price definition, production, predevelopment, development and, marketing and support costs; with

this data, the NPV for the project (*G3*) might be computed. It is also possible to analyze how the NPV of the project changes according to changes on specific variables with the help of a sensitivity analysis model and identify the main risks of the project with the help of the risk assessment section. The quality of the information collected and developed along the process was another crucial characteristic that needed to be addressed. The knowledge from the actors belonging to other departments that had relevant roles needed to be collected and used along the process (*RQ5 and G5, vide section 5.1*). To address this issue, the process was designed considering formal interactions with external but important actors, for them to offer their opinion and knowledge, which will ultimately support the decision-making processes of the project's teams.

Therefore, the developed process offers structured procedures to approach the entire planning stage of projects developed in the Future Concepts department, taking into consideration the main issues presented by internal and external actors of the department and fixing them by considering different dimensions along its path, *i.e.* constant interactions with other departments and several analyses to the external environment.

7.2. Project Limitations and Future Work Recommendations

These sections are written together since in the case of this business project the most evident limitation is the one that will guide future work recommendations.

The presented NPD process that considers a broad set of interactions among several different actors and collects a wide range of information to support decision making along the way (*vide section 5.2*), offers in fact a strong and flexible infrastructure for knowledge transfer and sharing, through specific established moments of interaction between actors from different areas (*vide chapter 6*). However, if the actors involved do not want to transfer their knowledge along the process, it might not work properly. On *chapter 6* the topic of knowledge diffusion was discussed in the context of NPD process and more precisely on the specific case of this business project. All actors involved on the process should, therefore, have the will to transfer its individual knowledge (tacit knowledge), be able to receive the knowledge from other actors, and put it on the service of the process and ultimately the organization (explicit knowledge). This dimension appears to be crucial for the NPD development process to aggregate all the required established inputs that will support the development of projects from Future Concepts and it might ensure its transfer for further stages. What started as a business project completely focused on the NPD process, which is still absolutely crucial in this context, led to a concern

with the knowledge diffusion dimension that when does not occur might have the power to block all the efforts towards innovation. The fact that the process success is dependent on the will of its actors to share their knowledge is the main limitation that was found out on the course of this business project. As a future work suggestion and to complement and extend the present business project, it is important to understand how the characteristics of sources and recipients on the knowledge diffusion process (*vide chapter 6*) affect the specific case of the NPD process, and identify which actions could be taken to overcome these issues occurring during the knowledge diffusion process.

7.3. Contributions to Theory, Investigation and Practice

In this section, it is going to be argued that the development of this business project offered different contributions for several fields.

For the theory field, it offers a conceptual framework, resulting from the literature review, focused on the development of a solution to increase the success rate of projects with radical innovation characteristics, based on i) the definition of a specific NPD process structure, ii) the development of tools to evaluate the projects and aggregate the most relevant information, and iii) the establishment of interaction moments with several actors relevant for the process success (*vide section 3.2*). In the beginning, the project was focused mainly on processual characteristics, but after analyzing the results from data analysis, it was possible to identify high relevance of the knowledge diffusion field on the specific case of the NPD process (*vide section 5.1*). These conclusions led to a further proposal, studying the impact of this dimension on the conceptual framework and on the developed solution, as well as, to its introduction in the framework by adjusting it. Thus, the main characteristics that might affect the framework success were revisited and reviewed (*vide chapter 6*), suggesting a final innovative updated path for future work. In addition, for research, a formal, organized and systematic NPD process was developed based on the investigation of the area best practices and adapted to the specific context of the company's department where it was applied (*vide section 5.2.1*). Also, a business case document that aggregates the vital information generated along the flow was developed using the same basis as the process (*vide section 5.2.2*)For the practitioner, it was offered a new and improved but supported solution for the development of new products and a different perspective to manage the resulting projects, which is expected to have the potential to improve the success rate of projects started and proposed by the Future Concepts department through further stages of development.

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9. Appendices

Appendix 1. Data collected on introductory meeting

Data collected on the introductory meeting with the head of Future Concepts (FC) held on the 18th of September of 2017, concerning the Company context and FC goals, the FC process in place and the issues identified that generated the business project (*vide Figure 30*).

Company context and FC goals and tasks	The FC development process	Identified issue and challenge
The company have been creating value for the factory and process automation fields for many years. It is concerned with mechatronics the latest simulation technologies, microsystem technology as well as intelligent components for industry 4.0. The innovation management creates the necessary framework conditions to turn good ideas, knowledge and technology into successful products on the market. The FC department is focused on identifying trends for the future and work them to develop opportunities in any possible way i.e. new products, processes, working procedures, etc. The department can play a crucial role in the definition of the Company path towards the future, since the work performed internally is focused on the identification of possible ways to innovate and differentiate from competition. In the long term, this work can have the power to transform a current follower company into a leader one.	The developers from the department identify opportunities based on the trends exposed on the radar chart. After this, the developers can freely develop the opportunity in the way they consider more convenient. During the project development, developers should prepare a circle of clarity document and a fact sheet where definitions, motivations, targets and deliverables of the project should be presented. These documents are not being prepared with the required level of accuracy and detail as they should, since developers, due to their nature, are only focusing on the concept development per se. When possible, prototypes are developed and prepared, but financial justification that consider market analysis and risk assessment are not properly performed. In the end the projects are presented on steering committees to decide if more effort should be put on them or not.	The acceptance rate of FC projects into next stages of development outside the department is very low and recurrently rejected on steering committees (meetings where new projects of the department are presented for approval to a board composed by several departments top management). The projects are developed on a non-standardized way and decision makers complaint that they don't receive all the relevant information to the support their decisions. The challenge is, in a broad way, to identify the reasons that are leading the projects developed inside the department to have such a low rate of acceptance by the next responsible departments regarding development, and to present working procedures to improve the current scenario.

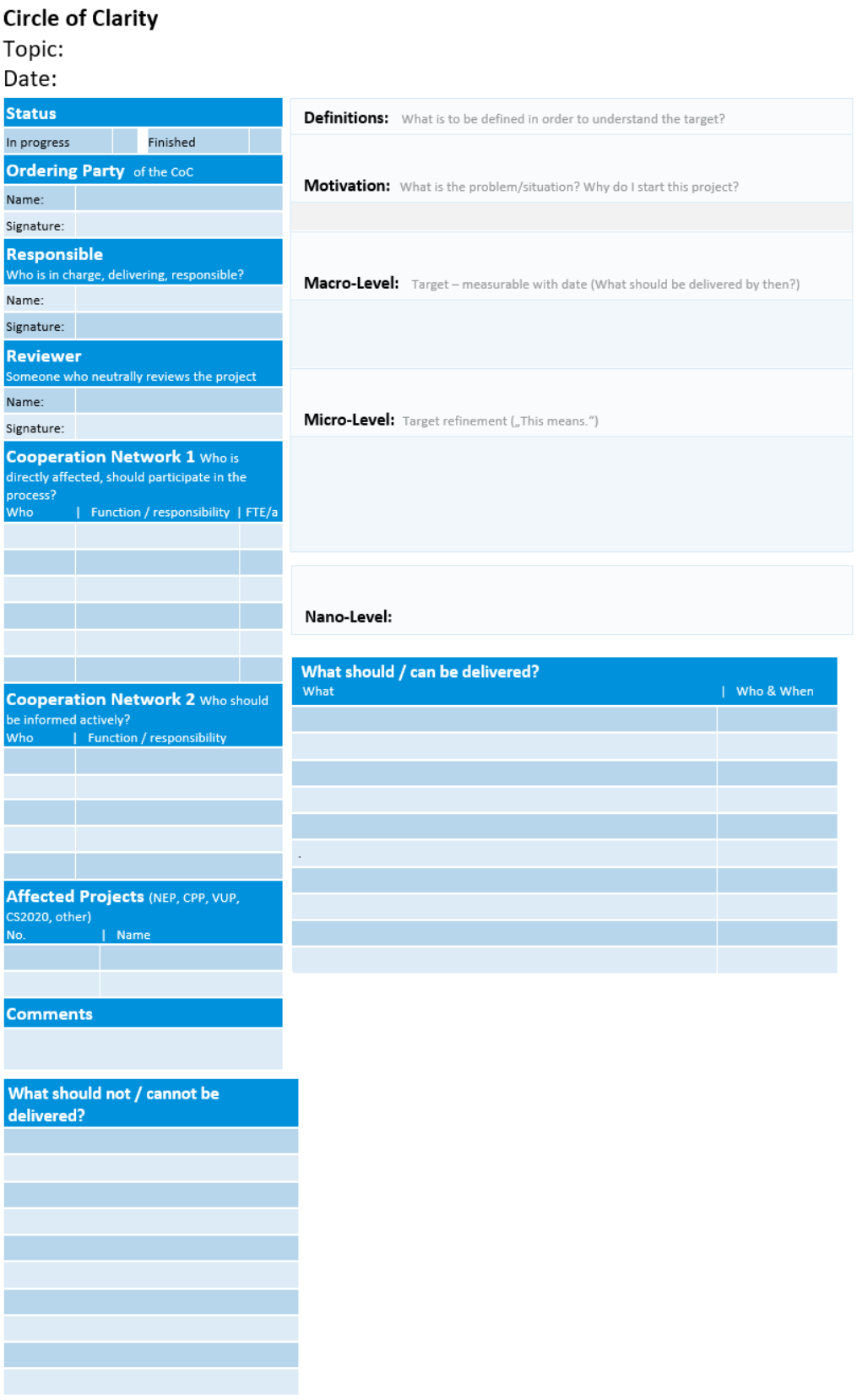
Figure 30 - Data from introductory meeting

Appendix 2. Documentation used on the current process and its main activities

The circle of clarity aggregated crucial information of the project like main definitions used, the motivation for the development, the target of the project and the deliverables. It also provided a place to insert information regarding project organization like the project responsible and reviewer and other projects affected by the present one, its template can be found on *Figure 31*.

The fact sheet document, presented on *Figure 32*, is no more than template that considered the information to be presented on Steering Committees. It reserves space to explain the project objectives and targets the main costs and benefits identified, the timeline for its development and some identified risks.

The main activities required by the process that was in place in Future Concepts department (*vide Figure 33*) considered the selection of a trend from the Radar chart, search for applications for this trend and develop a concept based on it. Then the required documentation was prepared, and the project was presented on Steering Committees for decision.



Circle of Clarity

Topic:

Date:

Status

In progress | Finished

Ordering Party of the CoC

Name:

Signature:

Responsible

Who is in charge, delivering, responsible?

Name:

Signature:

Reviewer

Someone who neutrally reviews the project

Name:

Signature:

Cooperation Network 1 Who is directly affected, should participate in the process?

Who | Function / responsibility | FTE/a

Cooperation Network 2 Who should be informed actively?

Who | Function / responsibility

Affected Projects (NEP, CPP, VUP, CS2020, other)

No. | Name

Comments

What should not / cannot be delivered?

Definitions: What is to be defined in order to understand the target?

Motivation: What is the problem/situation? Why do I start this project?

Macro-Level: Target – measurable with date (What should be delivered by then?)

Micro-Level: Target refinement („This means.")

Nano-Level:

What should / can be delivered?

What | Who & When

Figure 31 - Circle of clarity document

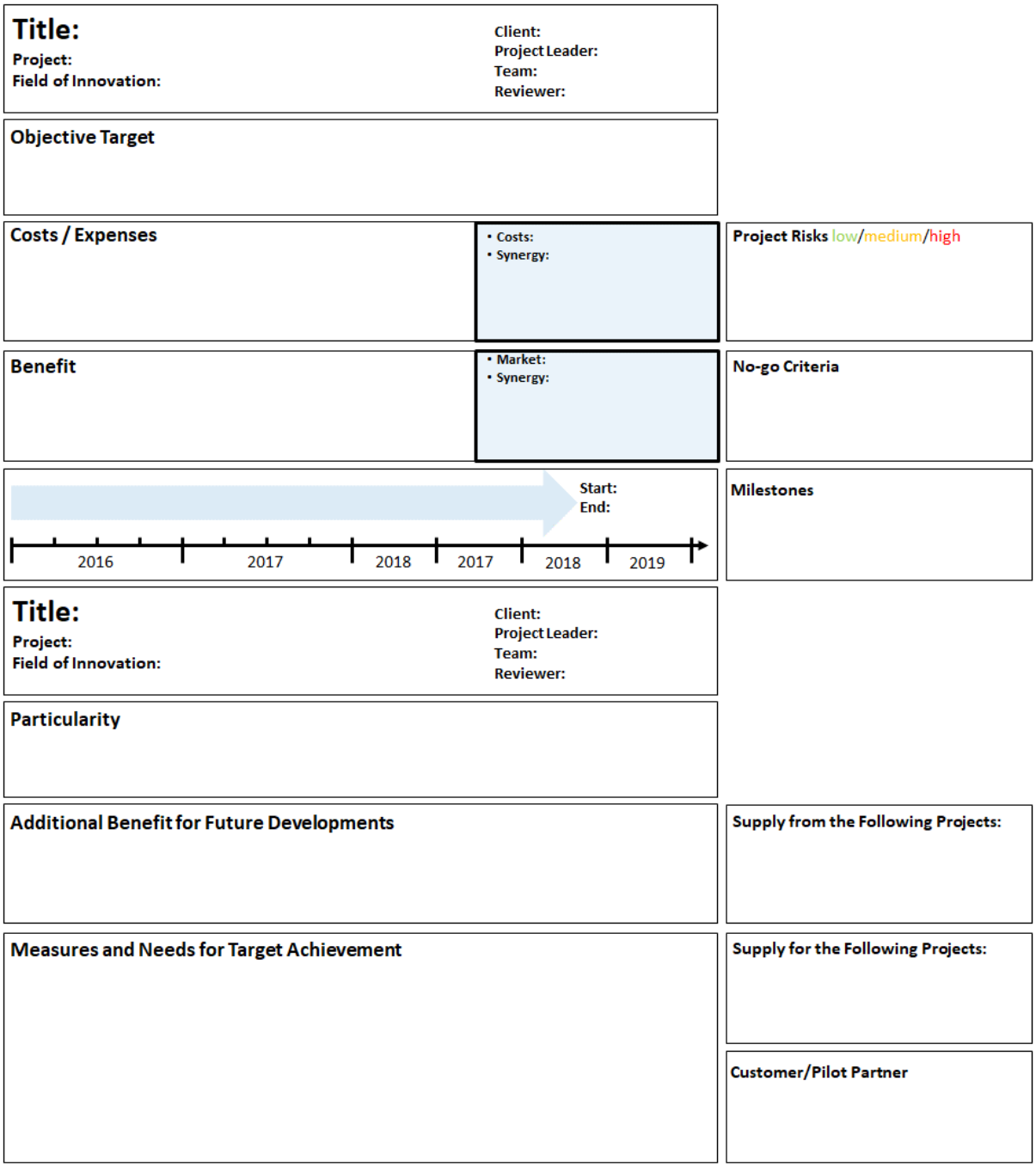


Figure 32 - Fact Sheet document

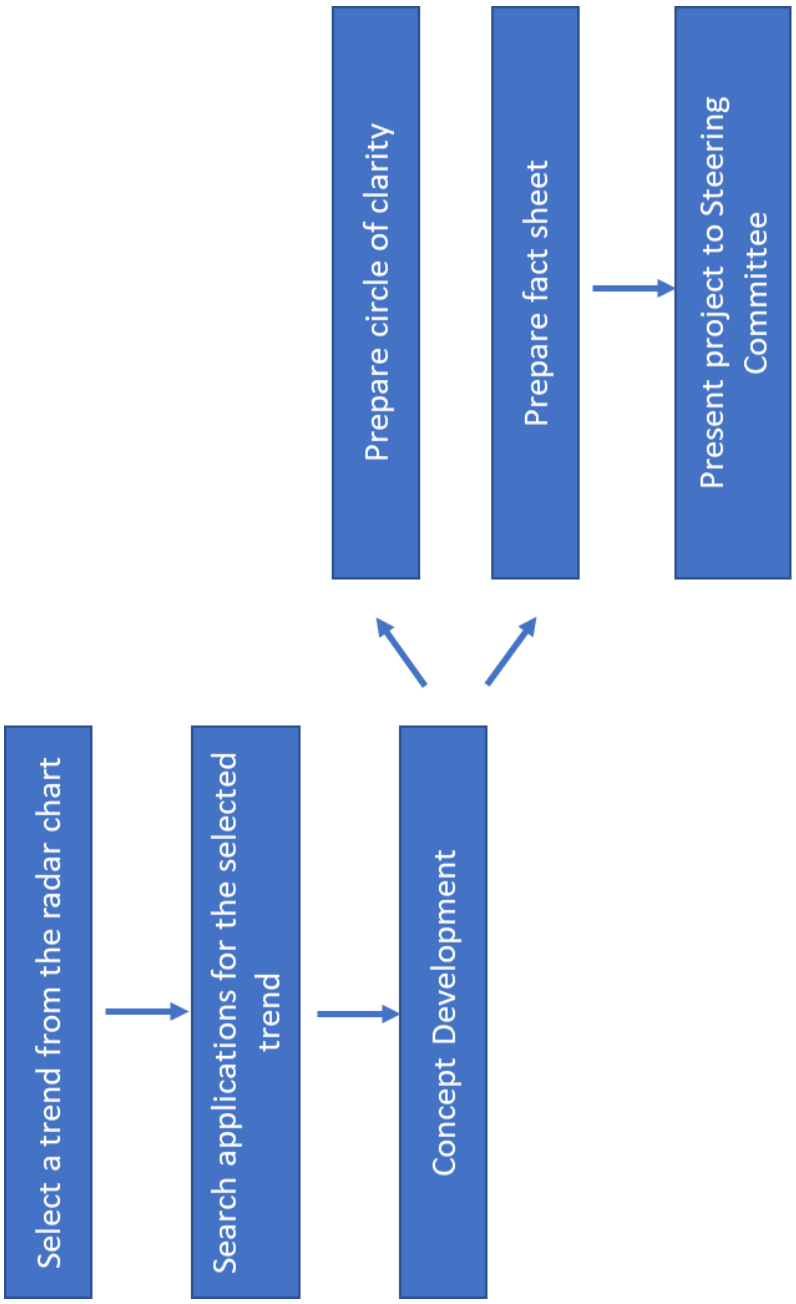


Figure 33 - Main activities of the AS-IS FC Development Process

Appendix 3. Financial and risk analysis tool

For projects evaluation a Microsoft Excel tool was developed. This tool offers the possibility to compute the NPV for a project, and to assess the main risks associated to its development.

The tool starts with an analysis of the market size where the output of the project will compete, and the definition of the market share goals defined by the company for this product in the time periods after its launch (*vide Figure 34*). Three different scenarios considering, a pessimistic perspective, a realistic perspective and an optimistic perspective are developed, varying the values of the forecasts according to the perspective under analysis. After the definition of the potential sales volume, the potential production costs are analyzed using an the company internal formula to perform this calculation, which considers material costs, manufacturing costs and mold costs (*vide Figure 35 and Figure 36*). Then, a potential market price for the product is determined. For this, an intended margin regarding the unit production cost is established and a benchmark to the potential competitors prices is performed to understand if the established price fits the strategic perspective (*vide Figure 37*).

The pre-development costs, the potential development costs and the marketing and support costs are estimated considering the costs of other similar projects developed in the company in the past (*vide Figure 38, Figure 39 and Figure 40*).

With all the collected inputs, it is then possible to calculate the NPV for the project (*vide Figure 41*).

Together with the NPV analysis, the tool considers also a risk analysis section to identify potential areas that will require extra focus, or maybe even to identify areas that will not allow the project to continue at all. In this context, the innovation risk matrix (*vide Figure 42 and Figure 43)* study two dimensions related to the market and the available technology and compute a potential probability of failure for the project *(vide Figure 44*). The RWW method, complements the risk analysis by asking key questions, and through the answers, highlight if the opportunity is real, if it is possible to win with it and if it is worth to pursue (*vide Figure 45*).

Sales Forecast	Market Potential (1) Revenue	375 126,13 €			Market Potential (2)	482 974,90 €
Realistic Perspective						
Quantities purchased of competitor products (year 0)	Market Share (year 1)	Forecasted Sales (year 1)	Targeted Market Share (year 2)	Demand variation	Market Growth Expectation	Forecasted Sales (year 2)
120000	8,00%	9600	10,00%	2,00%	3,00%	12360
Optimistic Perspective (+25%)	25%					
Quantities purchased of competitor products (year 0)	Market Share (year 1)	Forecasted Sales (year 1)	Targeted Market Share (year 2)	Demand variation		Forecasted Sales (year 2)
120000	10,00%	12000	12,50%	2,50%	3,00%	15450
Pessimistic Perspective (-25%)	-25%					
Quantities purchased of competitor products (year 0)	Market Share (year 1)	Forecasted Sales (year 1)	Targeted Market Share (year 2)	Demand variation		Forecasted Sales (year 2)
120000	6,00%	7200	7,50%	1,50%	3,00%	9270

Figure 34 - Sales Forecast example

Material Costs	Direct Material	Material Quantity x Material Price
	Material Overhead Costs	Direct Material x Material Overhead Costs (%)
Manufacturing Costs	-	Hourly rate x Number of hours required to produce 1 unit
Mould Costs	-	Mould Costs / 5 year produced quantity

Material Costs (Direct Material Costs and Material Overhead Costs)

Component	Name	Required Units	Direct Material Unit Cost	Direct Material total Cost	Characteristics	Characteristics scale	Classification	Total Points	Percentage	Material Overhead Costs	Material Cost
1		3	0,3	0,9	Source	**Catalog** 3 points	3	6	4,0%	0,04 €	0,94 €
						Not shape bound drawing part 5 points					
						Shape bound technologies 10 points					
					Origin	**Mainly UE** 0 points	1				
						Third Countries 1 Point					
					Storage	**ICH/Kanban** 0 points	1				
						Not in ICH/Kanban 1 point					
					Quality critical?	**No/Inspection skip** 0 points	1				
						Yes 1 Point					

Figure 35 - Material Costs Calculations example

Manufacturing Costs			
Operations required for production	Time required to perform the operation (sec)	Average Hourly Rate (€)	Cost of operation
Operation A	65	80,00 €	1,44 €
Operation B	44	80,00 €	0,98 €
Operation C	150	80,00 €	3,33 €
Operation D	60	80,00 €	1,33 €
Operation E	90	80,00 €	2,00 €
Operation F	45	80,00 €	1,00 €
Operation G	68	80,00 €	1,51 €
Operation H	54	80,00 €	1,20 €
Operation I	75	80,00 €	1,67 €
		TOTAL Unit Manufacturing Cost	14,47 €

Figure 36 - Manufacturing costs calculations example

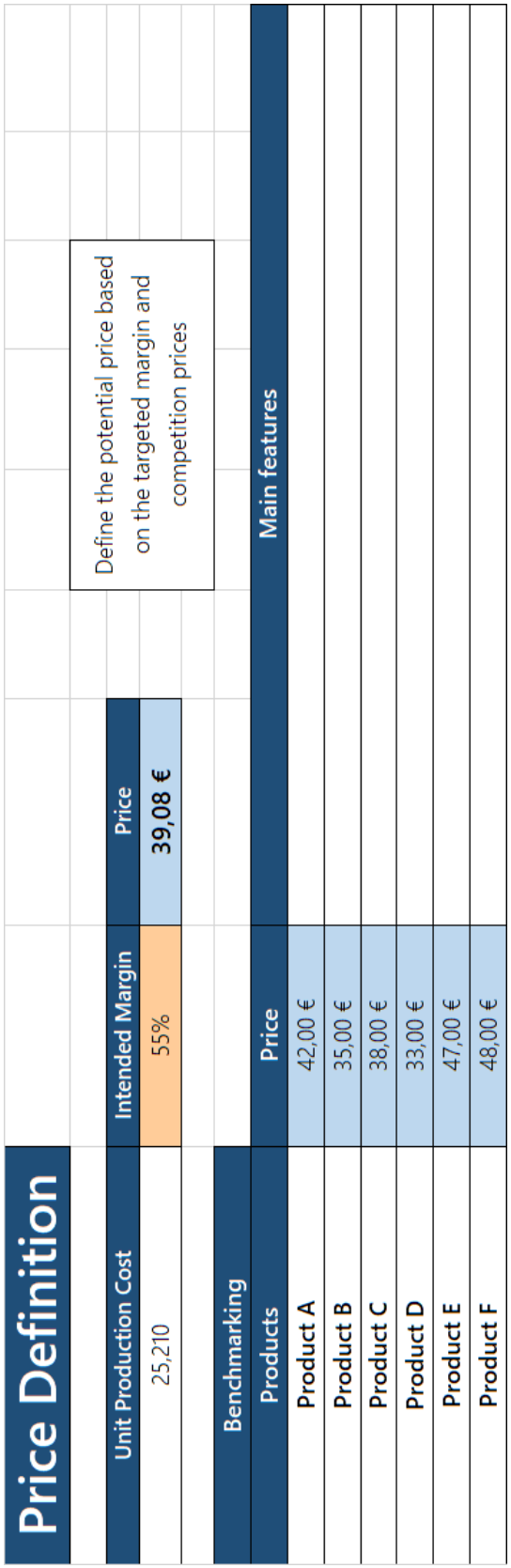


Figure 37 - Price definition example

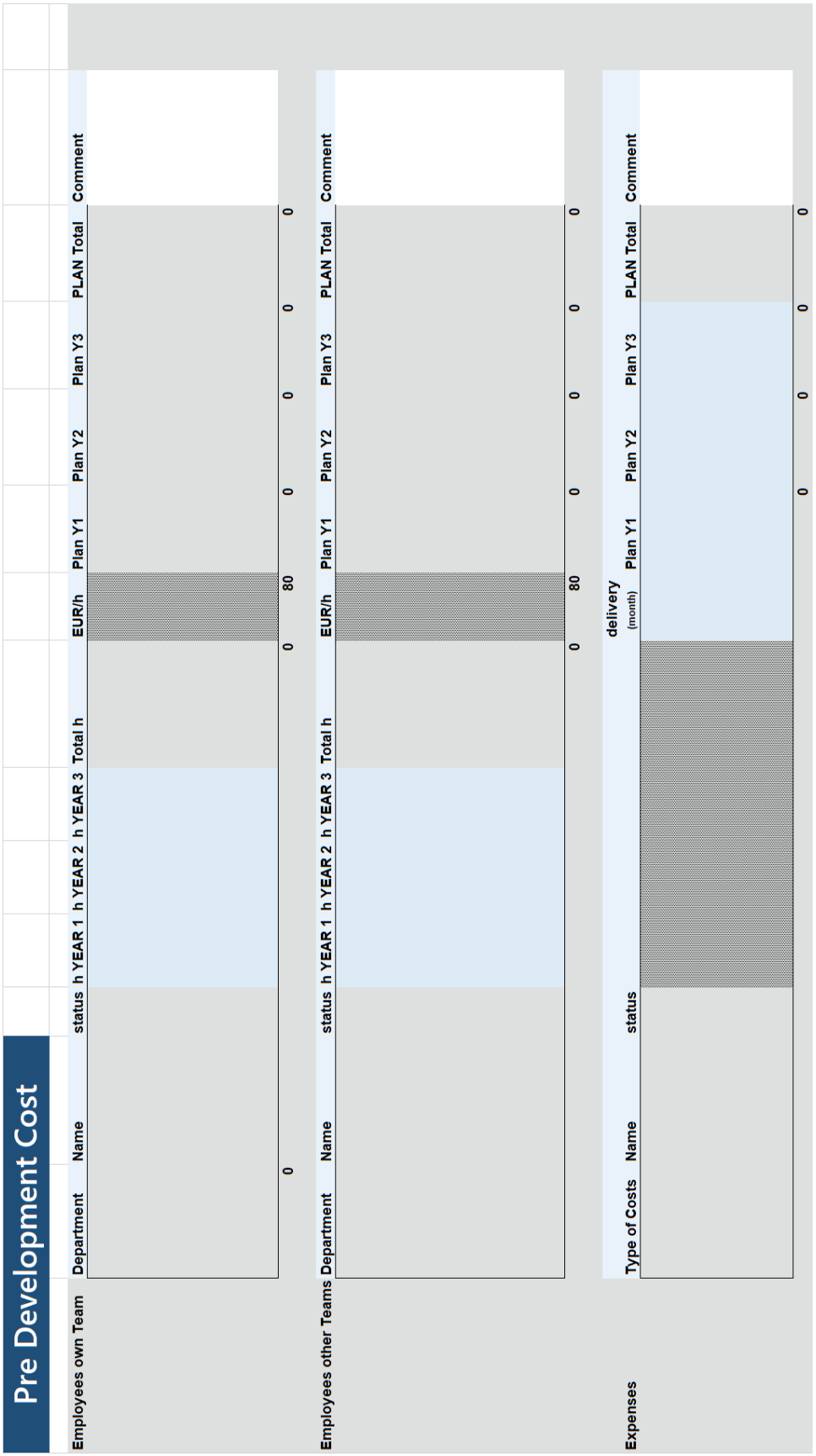


Figure 38 - Pre-Development Cost calculation example

Potential Development Cost						
Periods	Year 0	Year 1	Year 2	Year 3	Year 4	Total
Development Cost	50 000,00 €	70 000,00 €	45 000,00 €			165 000,00 €

Information estimated based on other projects information

Figure 40 - Potential Development Cost calculation example

Marketing and Support Costs								
Periods	Year 0	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7
Marketing and Support Costs			50 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €

Information estimated based on other projects information

Figure 39 - Marketing and Support Cost calculation example

Realistic Perspective									
Periods	0	1	2	3	4	5	6	7	8
Sales volume				9 600,00 €	12 360,00 €	15 912,00 €	20 160,00 €	25 704,00 €	25 872,00 €
Unit price				39,08 €	39,08 €	39,08 €	39,08 €	39,08 €	39,08 €
Total revenue	0,00 €	0,00 €	0,00 €	375 126,13 €	482 974,90 €	621 771,57 €	787 764,88 €	1 004 400,22 €	1 010 964,93 €
Pre Development Costs	74 104,00 €	377 080,00 €	27 656,00 €						
Potential Development Costs	50 000,00 €	70 000,00 €	45 000,00 €	0,00 €	0,00 €				
Unit Production Cost (Direct Material; Manufacture; Mould)	0,00 €	0,00 €	0,00 €	25,21 €	25,21 €	25,21 €	25,21 €	25,21 €	25,21 €
Production Volume	0,00 €	0,00 €	0,00 €	9 600,00 €	12 360,00 €	15 912,00 €	20 160,00 €	25 704,00 €	25 872,00 €
Total Production Costs	0,00 €	0,00 €	0,00 €	242 016,86 €	311 596,71 €	401 142,95 €	508 235,41 €	648 000,14 €	652 235,44 €
Marketing and Support Costs	0,00 €	0,00 €	50 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €	30 000,00 €
Total Costs	124 104,00 €	447 080,00 €	122 656,00 €	272 016,86 €	341 596,71 €	431 142,95 €	538 235,41 €	678 000,14 €	682 235,44 €
Total Profit	-124 104,00 €	-447 080,00 €	-122 656,00 €	103 109,27 €	141 378,19 €	190 628,62 €	249 529,47 €	326 400,08 €	328 729,49 €
Period Cash Flow	-124 104,00 €	-447 080,00 €	-122 656,00 €	103 109,27 €	141 378,19 €	190 628,62 €	249 529,47 €	326 400,08 €	328 729,49 €
Period Present Value	-124 104,00 €	-417 831,78 €	-107 132,50 €	84 167,88 €	107 856,74 €	135 915,57 €	166 272,02 €	203 265,56 €	191 323,56 €
	-124 104,00 €	-541 935,78 €	-649 068,28 €	-564 900,40 €	-457 043,65 €	-321 128,08 €	-154 856,06 €	48 409,51 €	239 733,07 €
Net Present Value (NPV)	239 733,07 €								

Figure 41 - NPV Calculation example

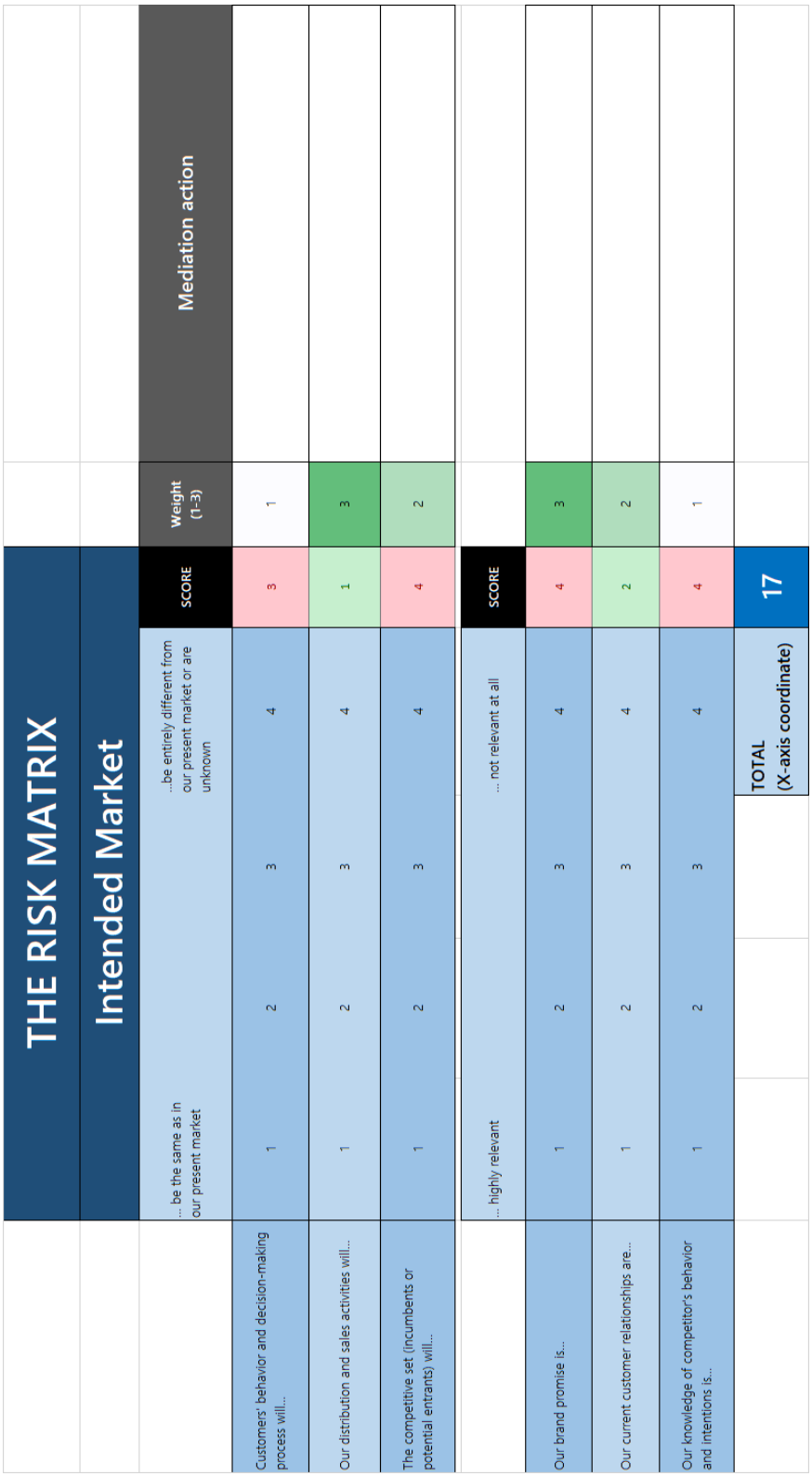


Figure 42 - Risk Matrix part 1 example

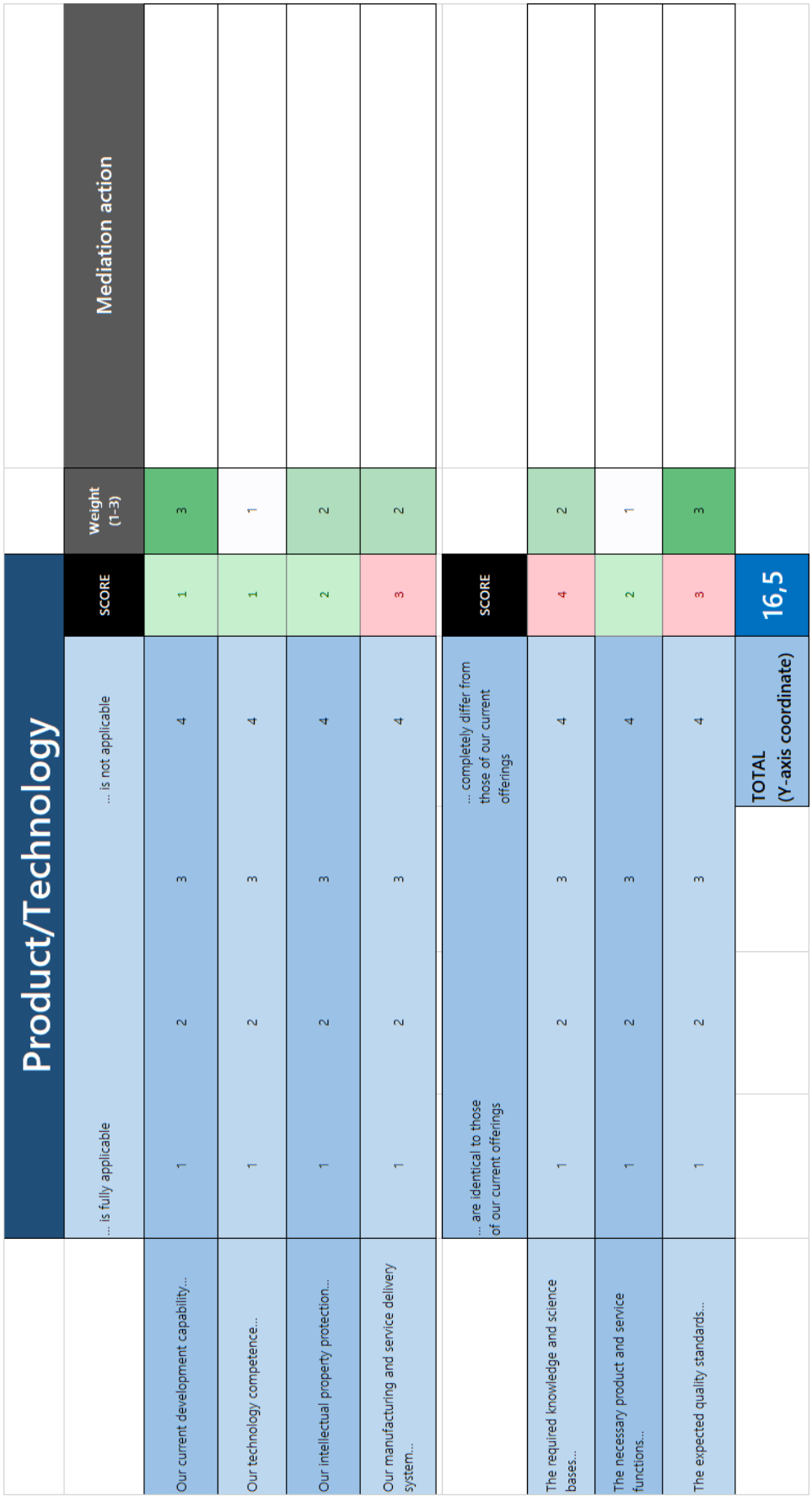


Figure 43 - Risk Matrix part 2 example

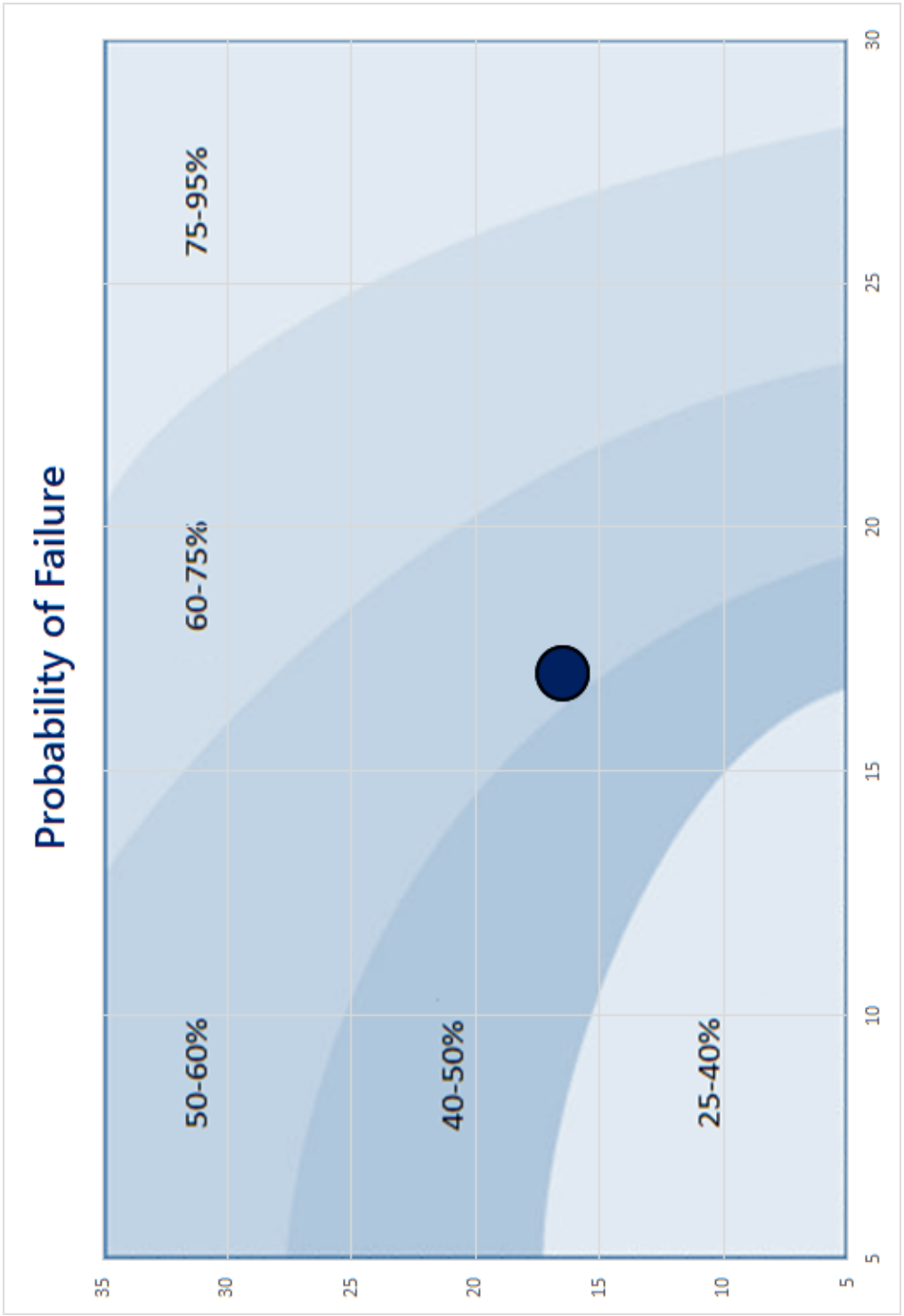


Figure 44 - Probability of failure generated by risk matrix example

Real-Win-Worth it Method			Select Yes/No		Mediation action
Is it Real?	Is the market real?	Is there a need or desire for the product?	Yes	Market analysis and customer feedback	
		Can the customer buy it?	No	Price definition	
		Is the size of the potential market adequate?	Yes	Sales forecast	
		Will the customer buy the product?	No	Customer feedback	
	Is the product real?	Is there a clear concept?	Yes	Business Case	
		Can the product be made?	Yes	Production Operations	
		Will the final product satisfy the market?	Yes	Customer feedback	
Can we win?	Can the product be competitive?	Does it have a competitive advantage?	Yes	Benchmarking	
		Can the advantage be sustained?	Yes	Internal analysis	
		How will customers respond?	Yes	Customer feedback	
	Can our Company be competitive?	Do we have superior resources?	No	Internal analysis	
		Do we have appropriate management?	Yes	Internal analysis	
		Can we understand and respond to the market?	Yes	Internal analysis	
Is it worth doing?	Will the product be profitable at an acceptable risk?	Are forecasted return greater than costs?	No	NPV analysis	
		Are the risks acceptable?	Yes	Risk analysis	
	Does launching the product make strategic sense?	Does the product fit overall growth strategy?	Yes	Company Business Strategy	
		Will top management support it?	Yes	Steering Committee Feedback	

Figure 45 - RWW Method example