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Development and Implementation of an Economic and Financial Evaluation Model of R&D Projects:

A case study in the mobility sector

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This is the end of a challenging chapter, but the beginning of a greater one.

STATEMENT OF INTEGRITY

I hereby declare having conducted this academic work with integrity. I confirm that I have not used plagiarism or any form of undue use of information or falsification of results along the process leading to its elaboration.

I further declare that I have fully acknowledged the Code of Ethical Conduct of the University of Minho.

Development and Implementation of an Economic and Financial Evaluation Model of R&D Projects: A case study in the mobility sector

RESUMO

Os projetos de Investigação e Desenvolvimento (I&D) possuem orçamento limitado, e estão dependentes das capacidades de investimento e de financiamento à disposição da empresa. Deste modo, a dimensão financeira deve estar presente na gestão de I&D para que possam ser identificados possíveis riscos e para que seja possível avaliar o retorno do investimento (ROI) o mais precocemente possível. Este projeto de investigação teve como objetivo o desenvolvimento de uma metodologia para avaliar projetos de I&D. O modelo de avaliação económico-financeira desenvolvido (modelo FINECON) é uma ferramenta para a tomada de decisão e avaliação de projetos de I&D e respetivos cenários financeiros, que se destina a empreendedores, empresas com projetos de I&D, ou, em último caso, investidores permitindo analisar as condições de viabilidade económico-financeira de novos produtos, negócios e startups de base tecnológica.

A metodologia proposta foi aplicada no MobiBUS, um projeto de mobilidade inteligente de I&D desenvolvido na Bosch Car Multimedia, em colaboração com a Universidade do Minho. A aplicação do modelo ao projeto MobiBUS suportou a sua total avaliação, a formulação hipotética de cenários otimistas e pessimistas, e o fornecimento de informações à equipa e potenciais investidores.Em suma, o projeto MobiBUS avaliou-se viável, tendo em conta os recursos, produto e tecnologia utilizada, e ainda suficientemente sustentável para que se crie uma start-up. O modelo desenvolvido pode ser aplicado noutros casos no contexto particular da mobilidade e noutros projetos de I&D de base tecnológica.

Palavras-Chave

Inovação, Projetos I&D, Empreendedorismo, Análise Económico-Financeira, Avaliação de Investimento

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ABSTRACT

Research and Development (R&D) projects have limited budgets, depending on the company's investment and funding capacities available to the company. That being said, the financial dimension should be included in R&D management at every stage to identify possible risks and evaluate the return on investment (ROI), as soon as possible.

This research aims to develop a framework to evaluate R&D projects. The developed economic and financial model (FINECON Model) is a decision-making and evaluation tool for R&D projects and their financial scenarios, designed for entrepreneurs, companies with R&D teams, and, lastly, investors or business angels' usage, allowing the economic and financial viability study of new products, businesses, and technological startups.

The proposed methodology was applied to MobiBUS, an intelligent mobility R&D project developed in Bosch Car Multimedia, in collaboration with the University of Minho.

The application of the developed model to the case study MobiBUS supported the whole evaluation, the formulation of good and bad hypothetical scenarios, and the delivery of information to the team and potential investors.

In conclusion, the MobiBUS project was evaluated as viable, taking into consideration its resources, product, and used technology, as well as sustainable enough to create a start-up. The developed model can be applied to other case studies in mobility contexts or other technological R&D projects.

Keywords

Innovation, R&D Projects, Entrepreneurship, Financial and Economic Analysis, Investment Appraisal

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Abbreviations and Acronyms List

AHP – Analytic Hierarchy Process

BEP – Breakeven Point

BM – Business model

BOM – Bill of materials

CAPM – Cost of Capital by Capital Asset Pricing Model

CBA – Cost/Benefit Analysis

CF – Cash Flow

CMA – Cost Minimisation Analysis

DCF – Discounted Cash Flow

EBIT – Earnings before interest and tax

GDP – Gross Domestic Product

IAPMEI - Agency for Competitiveness and Innovation

ICT – Information & Communications Technologies

IRR – Internal Rate of Return

LCM – Lowest Common Multiple

MCA – Multi-Criteria Analysis

MARR – Minimum Attractive Rate of Return

MP – Raw and other direct materials

MOI – Indirect labour

MOD – Direct labour

MVP – Minimal viable product

NPV – Net Present Value

ROI – Return on Investment

RP – Retail Price

RR – Rate of Return

R&D – Research and Development

VBA – Visual Basic for Applications

WACC – Cost of Capital by Weighted-Average Cost of Capital

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1. INTRODUCTION

This chapter is concerned with replying to questions such as *what*, *why* and *how the* research project was conducted. The *what* element is answered by the contextualization and problem statement; the *why* by the motivation; and the *how* by the objectives and methodologies and methods used. In general, the importance and relevance of economic and financial evaluations in Research and Development (R&D) projects in academic research and companies is stated.

1.1 Background and Context

Businesses are evolving continuously and unexpectedly due to the introduction of new technologies, the quick changes in the markets, the concept of short life cycle products, and the increased need for innovation. Organizations should be flexible and have the ability to adapt, react, and embrace changes, fulfil market requirements, and stand out from competitors. Additionally, the gap between customer demands and the products offered by the industry must be seen as an opportunity. (Costa, 2014; Elmquist & Masson, 2009; Pereira & Amaral, 2012)

In the digital-oriented world we live in, every now and then disruptive innovation is the order winner and a competitive advantage. This concept can be defined as coming up with a new idea or method that creates value, tangible or intangible, to organisations in the market, as well as recognising the good ideas that are already present (Burkus, 2013; Damanpour & Evan, 1984; Drucker, 2002; Kline & Rosenberg, 1986; Morris, Kuratko, & Covin, 2011). Nowadays, it is considered a competitive advantage or a driver for corporate success, and it is known for its serendipity, contrasting to the production perspective where every process is meticulously planned and measured (Teresko, 2008b). So, why does not everybody innovate?

Innovative technological ideas and projects are usually developed in R&D departments, enhancing the market positioning and perhaps the organizational culture (Spinesi & Tirelli, 2018). It requires diversified talents, cooperative, agile, experienced and very creative people, and stimulating work environments (Bougrain & Haudeville, 2002; Kuusisto, 2008; Neely & Rentocchini, 2012). These departments are characterised by high uncertainty conditions and a constant industry pressure to innovate (Knudsen & Scandizzo, 2002). Hence, the factors that influence the success of a R&D Project are: the organization, specifically the planning process, the team, the monitoring and feedback process; the market; the technology; and the environment (Friar & Balachandra, 1999; Pinto & Slevin, 1989).

When framed and aligned with the organizations' strategic mission and vision, productivity can significantly increase by its existence. Strategic innovation can be defined as the reconceptualization of the applied business model and the intensification of the created value, focusing on the who (customers), what (product or service), and how (development and launching process). In general, a creator should be characterized by an absorptive capacity to persistently assimilate and transform knowledge (Anderson & Markides, 2007).

From a critical perspective, firms should detail their products or project financially, to plan and monitor investments, specifically previous and future ones (Gopalakrishnan & Damanpour, 1997). Goduscheit, Fallant, Poh, Ang & Bai (2018; 2001) stated that companies face difficulties in understanding the real value of an R&D project and its financial performance, as they are characterized by ideas and prototypes, that may be tested and in different maturity stages or technology-readiness levels (TRL). Consequently, R&D metrics should be defined, such as yearly or forecasted revenue sales and profit, number of patents and new products released, headcount, and so on (Teresko, 2008a).

On the other hand, another major problem is the validation of the investment in R&D, to prove their productivity and significance. In most cases, R&D projects have a limited budget that depends on the company's capacity to raise investment and funding from crowdfunding, business angels, venture capital, bank loans, public financing, microcredit, and so on.

The common financial key performance indicators (KPI) for R&D are costs measures, revenue sales, projected value of R&D pipeline, and gross profit margin (Ojanen & Vuola, 2003). Ellis (1984) indicates that accountants see R&D mainly as an expense. However, it must be seen as an expenditure for a future return on a possibly risky or uncertain environment. Thus, the financial dimension should always be considered by the R&D management to constantly identify risks and evaluate profits and losses.

R&D management can apply various models in project evaluation by using qualitative, semi-quantitative and quantitative techniques (Newton & Pearson, 1994; Rip, 2003). They can be divided into just eight categories (Augood, 1973; Baker, 1974; Poh et al., 2001): Research with experts, Simplistic, Benefit and Effectiveness Measurement models, Multi-Criteria analysis, Comparing analysis, Systemic methods, Programming models, Real Options approaches, and Economic and Financial analysis.

The last one is used to clarify, quantify and value all inputs and outputs, considering the time value of money. The model can integrate measures like: the payback period, the rate of return on investment (ROI), the EBITDA, or the weighted average cost of capital (WACC) (Knudsen & Scandizzo, 2002; Žižlavský, 2014); and financial approaches and concepts like the valuation model, Capital Asset Pricing

Model (CAPM), discounted cash-flows methods (DCF), specifically the traditional Net Present Value (NPV) and Internal Rate of Return (IRR), arbitrage pricing theory (APT) (Cochran, Pyle, Greene, Clymer, & Bender, 1971; Perlitz, Peske, & Schrank, 2003; Pries, Åstebro, & Obeidi, 2001). Additionally, this analysis type allows the definition of relevant multiple scenarios, following a "what if" principle to decide which is the best one. Finally, a complete economic and financial study must incorporate a risk and sensitivity analysis, whereby the most common technique is the Monte Carlo Simulation. From an industrial perspective, there are some models and excel structures already in practice like the European Commission recommended approaches, the Institute for Competitiveness and Innovation (IAPMEI) model, from business and management schools, or experts in the area.

All the evaluation models vary according to the different analysis approaches and not only on the inputted financial information. Nevertheless, these models still have some problems as to their complexity and inadequacy, the lack of input data, and the absence of a standardized, complete, and customizable model with adequate KPIs (Geisler, 1994). Furthermore, a survey answered by 205 firms corroborated that 20% of them had better results when using more than one evaluation model type (Coldrick, Lawson, Ivey, & Lockwood, 2002). Also, 60% of the companies from a survey in 2014 stated that they definitely use between two or three valuation methods to evaluate investment projects, for example the discounted cash-flow, the net present value, the discount rate input, and so on (Bancel & Mittoo, 2014).

The Four-Validation Model, exposed in an article written by Afonso and Fernandes (2018), is applicable in the development and evaluation of an idea and contains four phases: the value proposition formulation, market analysis, business model development, and an economic and financial viability study. It can be strongly concluded that there is no standard way to evaluate a project accurately and adequately. However, investments can sometimes go wrong, even when products and the associated business model look feasible and is correctly evaluated.

The evaluation process, also called the investment appraisal, can deliver detailed and clear financial results that, triggered by effective market penetration, can more easily attract investors, by reaching important decisions, based on an idea the creator has to stablish a new venture, in other words creating a start-up or spin-off. In these cases, financial stability is the second most important aspect to its growth (Rodrigues Parracho, 2017).

In conclusion, success can be determined by specific criteria and evaluation models, which do not yet fulfil all companies' and entrepreneurs' needs. If the project and its products are transformed into industrialized and mass-producible ones, it is important to be aware of the financial current and future

status. According to Sievanen, Suomala & Paranko (2003), 20% of the most profitable products, that represent the majority of the business, "generate more than 150% of the profits and 50% of the net sales", which can be affected by the type of product, life cycle, after sales support, and so on.

1.2 Motivation and Objective

According to the R&D Funding Magazine (2019), there are considerable aspects about R&D:

- From 2015 to 2018, significant improvements were identified, and R&D is becoming even more successful and important for industries.
- In 2019, 2.3 trillion USD were spent on the global R&D gross domestic product (GDP). Additionally, the business enterprise sector represents 65% of the gross expenditure on R&D (Eurostat, 2019), and service business models achieved two-thirds of the global economy' GDP (O'Cass & Wetzels, 2018).
- The Information & Communications Technologies (ICT) sector has the highest share in R&D spending, reaching 239 billion USD. Its future technological trends involve Big Data, Cloud Computing, and Advanced Analytics, and 89% of the respondents stated that it will continue thus.
- Half of the respondents of the survey answered that they have difficulties in defining and keeping to the budget, due to market changes, insufficient investment and high costs, qualified human capital needs, and restrictive corporate policies.

Countries that continuously invest over and over, establish a good framework of science and technology, motivate people to act, and have the ability to create new innovations. Currently, the Portuguese entrepreneurial ecosystem has been growing and start-ups represent 1,1% of the national GDP[1]. Entrepreneurship is considered to be a meta-economic event, as it considerably influences and changes the economy (Drucker, 2002).

The opportunities for the acceleration, incubation, and investment in ideas or R&D projects are rising. In 2018, start-ups have created more 25,084 jobs in Portugal. Companies that challenge themselves are the most distinctive and competitive ones, as well as possible leaders in the industry (Barbosa, 2019; Castro, 2017).

Evaluating an R&D project can be challenging for firms in aspects like (Capron, 1992; Hall & Lerner, 2010; Shane, 2008; Spinesi & Tirelli, 2018):

[1] Retrieved from https://eco.sapo.pt/2019/07/26/startups-ja-representam-11-do-pib-portugues/. Accessed in 26th of July 2019.

- Input and output definition and accuracy, related to data availability and the cost-detailing process
- Hypothetically define business capacity according to the innovation process and market demand
- Budget definition
- Price formation, in particular for unformed markets
- Need to forecast and the constant unpredictability and riskiness
- Uncertain nature of innovation and the dependence on technological and economic development
- Time difference between the investment moment and the real economic impact
- Time-consuming decisions between multiple scenarios.

In spite of that, the opportunity gap is clear and the specification of a research question and its methodology is crucial in any research project (Yin, 2003). Considering the knowledge areas of economics, finance, accounting and business, the **general research question** of this research project is "*How can organizations evaluate R&D projects economically and financially and take decisions in an early phase to avoid unsuccessful investments?"*.

Regardless of what drives this research project, a *sine qua non* for the development of any R&D project is a goal-setting approach. So, this study aims to develop an economic and financial evaluation model for R&D projects, based on a current literature review, and apply it to a case study in the Engineering Department of Bosch Car Multimedia Portugal S.A.

1.3 Research Methodology

According to Saunders, Lewis & Thornhill (2009), research means that data is collected and interpreted with a clear purpose, using a number of specific methods and methodologies systematically (Ghauri & Gronhaug, 2005). The research followed a pragmatic philosophy, and a deductive approach, as the economic and financial evaluation model and respective analysis framework is developed based on relevant literature review in the afore-mentioned knowledge areas, and then it is applied to a single case-situation (Saunders et al., 2009).

The academic work is framed in a cross-sectional horizon, in the same organization with time constraints, using multi-methods with qualitative and quantitative data collection and analysis. The main data collection and analysis tool will be the Excel software, and the included VBA Macros (to create an automatic model and simplify the task of evaluating business ideas or R&D projects).

The work was developed using Scrum, an agile project framework to manage its progress considering the organization and the academic perspectives. The implementation of this framework enables tasks to be completed in a straight forward manner, to prioritize tasks, keep track of the completed work or work still

in progress, and monitor and prepare for possible risks (Rubin, 2013). Additionally, Scrum can contribute financially by reducing the possibility of risks, due to increments in productivity, product quality and customer satisfaction. In this case, it is important as the idea can result in the creation of a new venture.

1.4 Dissertation Structure

This document is divided into three parts, and seven subsections in total. First, the introductory part, where the dissertation organization and literature is presented. Secondly, the development, where an economic evaluation model is developed and applied to a case study. Finally, the third one with the main findings and conclusions, including recommendations for future research.

This first part includes the following chapters:

- **Chapter 1** introduces the main issues of the research, states its Framework and chosen Problem, mentions the Methodologies and Methods used, and its work steps and structure.
- **Chapter 2** presents the State of the Art. In order to gain significant knowledge regarding the main topics of the research, the literature was reviewed, focusing on the main findings and research opportunity gaps. The mentioned study fields were the economic evaluation models, in particular their characteristics and limitations; the decision-making process explaining every possible option an entrepreneur has while developing a business idea; and which opportunity gaps are most present in this academic knowledge field.
- **Chapter 3** describes and explains the Research Methodologies and the Design for the chosen research process providing more reliability to the study, and the work steps.

The second part includes the following sections:

- **Chapter 4** presents the economic and financial evaluation model structure developed for R&D projects, its assumptions, and structure.
- **Chapter 5** reports the environment of the case study, specifically the company and how the case study was structured. Afterwards, it describes the business and the financial plan, where the application of the proposed economic and financial evaluation model is explained.

The third part includes the following sections:

- **Chapter 6** presents the importance of the research outcomes and findings for the academic work, the R&D project, and the organization, and its relation to the research question and goals.
- **Chapter 7** concludes the whole research project in terms of meeting its goals, advances for the literature, problems encountered, for example strengths, weaknesses and limitations, key outcomes and recommendations for future research opportunities.

2. Literature Review

The literature review is crucial to set the research in a specific context and define its importance, which will also reveal the research opportunity. The referenced topics are: the developed and commonly used evaluation models that support entrepreneurs and organizations, more specifically their characteristics, limitations and future research opportunities; and an overview of the decisions when developing a new business idea.

2.1 Investment appraisal: approaches and models

Investment appraisal is a process that may occur at an ex ante, ongoing or ex post stage. The first one allows the team to select and check what the most viable options are. The second one aims to monitor and guide a project while it is being developed and the research is being carried out. The third one analyses the results of the project according to the business and the project's strategic plan. During the three previous stages, the evaluation model can provide information regarding the forecast, the ideal path of the project and its economic impact (Capron, 1992; Fernandes, Perobelli, & Brandão, 2014).

There is no standard way to define the evaluation of a product, project or a business. Firms use several "financial analysis methods for screening and evaluation", different criteria, types of resources and budgeting programmes. Even if the company has one or more projects in hand, the evaluation models use quantitative, qualitative or both techniques, financial indices, comparison methods, and other stochastic and mathematical models (Chien, 2002).

Additionally, these decisions are taken after collecting and estimating data, formulating hypotheses and alternatives, defining limitations and criteria, applying the most adequate model, and, when required, repeating the previous steps with updated information iteratively. Consequently, there exist some problems regarding the estimations due to (Baker, 1974):

- Technical, commercial and economic accomplishment uncertainty
- Large errors in initial stages
- Completion time depending on resources availability
- Possibility to scale business
- Uncertain and frequent investment rounds
- Interactions between different variables, like costs, resources, success, and others.

The difference between all methods are the type of data, economic and social point impact, way of calculation, considered parameters, and the optimal result or financial indicator. The opportunity cost of the investment, the risk, uncertainty of future costs, the scenario's flexibility or possibility for an economy of scale, all impact the decision to invest or not (Dixit & Pindyck, 1994).

The suitable criteria for these evaluation models are multiple simultaneous scenarios with objectives and constraints; timing; resources limitations, risky and uncertain conditions, scaling opportunities, and different analysis techniques such as optimization, simulation, scheduling, and prioritisation.

Furthermore, the existing models do not consider all the parameters of R&D: information can be too subjective, and the idea development and business growth is "uncertain and unpredictable". Managers tend to neglect risks and adopt an overoptimistic position when they are deeply involved. The Go/Kill moments can go wrong as teams fail to value all data and its financial results from the current models. So, R&D projects tend to grow outside the core business or even the company.

The following subsubsections from the 2.1.1 to 2.1.9 explain succinctly the main approaches on a quantitative perspective, qualitative or both, going from more simple methods like research with experts to economic evaluations and risk analyses. Afterwards, possible financial ratios, industry applied tools and sensitivity and risk analysis techniques are detailed. 2.1.12

2.1.1 Research with experts

The first step to take, in order to collect and assess raw data, is talking and research in the field. Interviewing shareholders, possible investors, network contacts, current and future clients, the team and its managers, enables decisions to be taken straightforwardly. The most adequate methodologies used in research are systematic assessments by peers, relevant and concise questionnaires, and interviews with a number of experts, written in a standardized way. Also, researchers, analysts and managers can use the Delphi method, which is a regular and interactive communication method applied to structured groups (Capron, 1992). Besides, data collection can be done using several techniques presented in Appendix I – Data collection techniques for evaluation proceedings. Finally, teams should define the most adequate data collection form, plan and analysis methods.

2.1.2 Simplistic models

Taking a simplistic and qualitative perspective (Augood, 1973), managers can use checklists, which can be simple, using a short and clear list of elements and looking for an acceptable pattern; quantified, by assigning weight to every element and evaluating success percentage from a scale of 100; or in an acceptable profile, with a common set of elements for different business' categories, comparing various

projects portfolios. However, these methods can seem difficult if engineers are required to work with such subjective data.

2.1.3 Benefit and Effectiveness Measurement models

Cost-Benefit Analysis (CBA) allows the decision whether to undertake a project. The team initially defines goals, different scenarios and its constraints. Then, they identify economic and social benefits/costs for the society from market behaviours and human capital experience, and measure or estimate statistically or by a priori judgment. Teams consider a monetary decision unit. When applying CBA, managers can define decision criteria and assign values for each option. Afterwards, they are able to analyse risk and uncertainty if necessary. Finally, they choose the best alternative by filtering the accepted ones and then choosing the best one[2]. For that reason, the ratio between benefit and cost is an indicator that should be maximized and allows the comparison of two or more alternatives (Davies, 1996; Neufville, 2008).
Secondly, cost-minimisation analysis (CMA) is used for businesses where the impact is the same and the only dependent variables are costs.

2.1.4 Multi-criteria analysis

The multi-criteria analysis (MCA) assigns weight to the project's criteria, both qualitative and quantitative, transforms their utilities into measurable values, scores their performance in different parameters, ranks options by their final value and chooses the best one. These types of methods can be integrated into computing programs for graphic creation and better decision support (Shvetsova, Rodionova, & Epstein, 2018). For projects evaluated between 5 and 20 million euros, the most adequate is the MCA, and for valuations higher than 20 million euros or innovative projects with future great operational costs, managers should apply CBA techniques, previously explained.
Finally, the analytic hierarchy process (AHP) assigns a specific weight for different options, according to its importance and priority in a matrix. Afterwards, the best alternatives are ranked in each criterion and teams take a decision for what is best for the project (Saaty, 1980).

2.1.5 Comparing analysis

A project can be evaluated for different alternatives related to costs such as: location, suppliers, raw materials, technology, design, project planning, investment requirements, timing, working capital, and so

[2] Retrieved from https://www.tcd.ie/Economics/assets/pdf/MScEPS/Economic%20Evaluation/evaluationLecture3MC.pdf. Accessed in 24th of June 2019.

on. On the other hand, the other factors can be the level of output, quality, prices, time to market and its scope. These allow that, in an initial stage, analysts can test the options at hand and see what the best preliminary results for the project are. While estimating all these scenarios regarding costs and benefits, the team can forecast qualitatively and quantitatively, and compare each option. Also, these analyses enable the filtering of what the most favourable path should be.

The solely comparative methods are the decision tree analysis allowing managers to choose an optimal solution between different quantifiable scenarios, like the development of interdependence matrices with identified interactions between the weighted attributes of each project's phase, resulting in a final desirability index (Mohantyy, Agarwalz, Choudhuryz, & Tiwari, 2005).

Additionally, the scoring model includes matrix approaches, such as analysis matrices for the economic impact, and decision-making matrices, when sorting alternatives by criteria, and evaluating the correlation between the results and data from experts (Baker, 1974).

2.1.6 Systemic models

In general, these kinds of methods systemically analyse the available options, evaluate selected ones, determine control points, and dynamically model all the variables and their values, considering economic terms and components from their environment.

A commonly-used systemic model is the continuous-time stochastic, which combines dynamics with uncertainty and determines the probability distribution of future stages and not the value (Rafiee & Kianfar, 2011). As an extension, there exists the theory of investment-Brownian motion, which can analyse the random behaviour of financial markets over time, and the Poisson-process to detect the variation pattern for a number of alternatives, for example headcount or sales increase and associated variables (Dixit & Pindyck, 1994).

2.1.7 Programming models

These programming models are function and probabilities-based algorithms, which vary from having one main goal if using mathematical programming techniques, or simultaneously many for multi-objective programming. The first ones relate to evaluations with reliable and sufficient data. The second ones may include stochastic criteria to view several solutions, considering uncertainty, as well as specific resources, criteria, and budget. When applied, the team seeks the maximization of the expected return or the efficient assignment of resources (Graves & Ringuest, 2003). There exist several programming techniques for project' selection (Chien, 2002; Levine, 2005):

- Linear or non-linear - used for optimal resource allocation and project selection, considering constraints and limitations of the project. The final result is obtained by summing up all contributions to the projects.
- Integer – is a subdivision of linear/non-linear programming, although variables should only be integers. The zero-one model is a deviation of the integer programming where variables can only have values between 0 and 1
- Dynamic – refers to the technique of dividing a problem into smaller ones, and taking a decision at a time
- Goal – is a multi-objective optimization, guided according to the analyst's main goals.

2.1.8 Real Options Approaches

Managers tend to find problems in the information regarding budgets, operational efficiency, and financial payoffs, and in deciding whether to buy or sell an asset, hypothetically.

The real-options model allows the investment's evaluation and application in several stages and the determination of the best improvements for the project, like abandoning, expanding, contracting, for example. This model involves dynamic programming with probability and final payoff for every option, considering different stages and variabilities in a business. This evaluation process is more adequate for the ones with risky, uncertain and flexible conditions, such as development costs and time, performance level, market requirements and payoff. However it cannot evaluate projects simultaneously (Fernandes et al., 2014; Huchzermeier & Loch, 2001).

Using a real-option approach, Silva and Santiago (2009) developed a model where the project's duration is uncertain. The model uses Markov stochastic principles for time, considers risks and evaluates the business performance for every stage. The team can decide if they want to continue, improve with more resources, abandon the project, or accelerate with more resources but completing the plan earlier, in every finished phase and not just periodically.

The option-pricing theory, similar to the real-options approach, calculates the fair value of the option using stock price, adequate price of option, end date of the solution, expected dividends, risk free interest rate, and volatility. The fair value depends on a professional's perspective and assumptions whereas the market price is mainly dictated by supply and demand, as well as other pricing factors (Mondher, 2002; Newton & Pearson, 1994).

Finally, there are other pricing models such as the binomial option pricing model, which is a tree of priced alternatives with individual probabilities and using a risk-free rate during a specific time period (Neves,

2014; Perlitz et al., 2003), and the Black-Scholes-Merton pricing model, which allows the valuation of an asset and its price variation, considering a constant volatility and risk-free rate as well as the non-payment of dividends (Black & Scholes, 1973).

2.1.9 Economic and Financial Analysis

In order to identify the real value of the project, and choose the most beneficial or less costly project, one or more projects in hand can be economically and financially evaluated. An economic and financial evaluation uses CF concepts and an/the NPV model with a decision-tree. These evaluations can be done at a micro, using internal data; meso, that is industry and market data; and macro level, specifically the economic situation and its variables as well as the state of R&D, depending on the required level of detail and interdependence (Capron, 1992).

On one hand, an economic evaluation analyses the project in a broader perspective, regionally or nationally, and considers the impact that it might have on society, referring to the effects on the economy. This type of evaluation considers the economic and shadow prices without transfer payments (taxes, profits, subsidies, and others), to view the adaptability of the project in a national environment[3]. Moreover, an economic price is the price customers can afford and a shadow price is the actual market or intrinsic value of a product/service that is not normally priced or sold in the market.

A project economic analysis contemplates the following steps[4]: validation of the economic context and principles, particularly the macro context, sector analysis, rationale for Public Sector Involvement, and choice of modality; and the project's viability, specifically the demand and alternative analysis, valuation of benefits and costs, institutional sustainability, distribution and sensitivity analysis, and monitoring and evaluation.

On the other hand, a financial evaluation is a fund-based method which compares the sustainability and balance of an investment, using market prices. This method is concerned with the profitability for stakeholders (Davies, 1996; Ferreira, 2016; Hayes, 2019).

To conclude, the difference is that costs and outputs are valued financially and then adapted for the economic perspective, considering government intervention, the market structure and opportunity costs of resource usage. Although a project might not be financially sustainable, it can be economically viable due to the way government funds are allocated.

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[3] Retrieved from https://www.adb.org/sites/default/files/page/149401/financial-analysis-economic-analysis-2006.pdf. Accessed in 14th of May 2019.

[4] Retrieved from https://www.adb.org/sites/default/files/page/149401/economic-analysis-projects-principles-concepts-2006.pdf. Accessed in 14th of May 2019.

For a more clearer financial demonstration, engineers develop an investment, exploration, and financing plan (Ferreira, 2016). The first one describes the value and time of the received investments. The second one, also an income statement, presents the expected revenues and costs. The last one describes how the project will be financed in the short or long-term.

2.1.10 Economic evaluation tools and models applied in the industry

There are numerous economic and financial evaluation models as well as files in Excel to support these processes. The manager should decide whether he might create his own or not. However, the following models are common in the industry:

a) Investment' Projects Evaluation Tool by IAPMEI

IAPMEI is an institution that supports micro, small, and medium firms and promotes Portuguese entrepreneurial competitiveness and growth[5]. They have developed a complete tool, in Excel, to evaluate investments in a 5- or 10-year perspective, using the Portuguese accounting regulations as well as the most common financial indicators, such as IRR, NPV[6].

b) Manual from the European Commission for financial and economic analysis of development projects

This manual, developed by the Commission of the European Communities, delivers profound knowledge regarding the financial and accounting concepts and its application on these evaluations, the applied calculations, how the correlation between the national or international scale affects each project, techniques for financial and economical evaluation of a project, whether integrated in the firm or not, with tangible or intangible products, how to include risk and uncertainty in the evaluation process, how to assess an investment' decision, and evaluate a project's relevance. Last, this manual tells teams to consider: the payback period, NPV, IRR, the benefit-cost ratio, and the ROI, as well as sensitivity analysis for the evaluation of R&D projects. To sum up, this manual explains a methodology that should be followed when evaluating projects of any kind (Fabre & Jones, 1997).

Additionally, the European Commission provides the requirements, financial indicators, for example if it is financially autonomous or profitable, and the best practices to assess the project's capacity and budget in order to apply for a grant for the Horizon 2020. Regarding the evaluation approaches and tools, there

[5] Retrieved from https://www.iapmei.pt/SOBRE-O-IAPMEI/Missao-Visao-Valores.aspx. Accessed in 14th of August 2019.

[6] Retrieved from https://www.iapmei.pt/PRODUTOS-E-SERVICOS/Assistencia-Tecnica-e-Formacao/Ferramentas/Ferramenta-de-Avaliacao-de-Projetos-de-Investiment.aspx. Accessed in 14th of August 2019.

are many possible ones to be used, both quantitative or qualitative, like the problem, effect or the decision diagram, interviews, focus group, survey, expert panel, case study, indicators, SWOT analysis, multi-criteria, cost effective, which is extensively explained for investment projects (European Commission, 2014; European Cooperation in Science & Technology, 2019), or even cultural and social analysis[7]. The overall results should be the budget inputs, direct and induced outputs, outcomes for the stakeholders, and the impact on the society. Finally, the European Commission has a financial self-check tool available to simulate the projects that seek investment[8].

2.1.11 Additional financial ratios and methods

Business and financial analysts, and engineers use some financial ratios to easily assess a project's viability, which are represented in Table 1 (Mondher, 2002; Neves, 2014).

Table 1 –Financial ratios examples

Model	Goal	Calculation Proceeding
Price to Earnings Ratio (PER)	Check the profitability in the stock market and its risk.	$$PER = \frac{Market\ Value\ per\ Share}{Earnings\ per\ Share}$$
Price-to-Book Value (PBV)	Evaluate if share values are worth more than the investment.	$$PBV = \frac{Market\ Price\ per\ Share}{Book\ Value\ per\ Share}$$ $$BV\ per\ Share = \frac{Assets - Liabilities}{Number\ of\ Shares}$$
Price Sales Ratio (PS)	Check the effect of a business on the market.	$$PS = \frac{Price\ per\ Share}{Annual\ Net\ Sales\ per\ Share}$$
Economic Value Added (EVA)	Calculate the value generated from the shareholder's investments, which can be negative and mean that the value of the invested funds is being eliminated.	$$EVA = (ROIC - WACC) \times Invested\ Capital$$

[7] Retrieved from https://europa.eu/capacity4dev/evaluation_guidelines/minisite/en-methodological-bases-and-approach/evaluation-tools. Accessed in 15th of October 2019.

[8] Retrieved from https://ec.europa.eu/research/participants/Ifv/IfvSimulation.do. Accessed in 15th of October 2019.

	This technique considers risk and the cost of capital.	
Cash Value Added (CVA)	Analyse the return from an investor's/shareholder's perspective for a specific year. Additionally, this model integrates strategic investments for new products or markets, and considers non-strategic ones as costs.	$CVA = Net\ Operational\ Result + Depreciations(Contabilistic - Economic) - Used\ Resources \times WACC$ $Economic\ Depreciation = \frac{Fixed\ assets \times WACC}{(A + WACC) - 1}$
Market Value Added (MVA)	Analyse the value created, considering the investment and its market.	$MVA = \sum \frac{EVA}{(1 + WACC)}$

Karibskii, Shishorin, and Yurchenko (2003) discovered a method which combines four decisive financial indicators, namely NPV, IRR, Payback Period, and Profitability Index (PI), calculated by the Equation *(1)*.

$$PI = \frac{PV\ of\ Future\ CF}{Initial\ Investment} \quad (1)$$

It is proposed that after one project or more are economically and financially evaluated with the previously mentioned models, each parameter has a specific weight and results on an economic efficiency value (E) combined with the optimal payback period (T). This integral index is calculated using the Equation *(2)*.

$$\begin{cases} E = \sum_{i=1}^{T} (m_x^2 \times (NPV + IRR + PI)\ ; where\ m_x^2 = specific\ weight, and\ x = 0,1,2 \\ T = optimal \end{cases} \quad (2)$$

Dixit and Pindyck (1994) declare two further techniques: a comparison method between the per-period value of an incremental unit of capital and an equivalent per-period-rental price, or between the capitalized value of the marginal investment to its purchase cost.

Merton's model (Mondher, 2002) is an analysis technique that evaluates the firm's value and the cost of gathering, processing and delivering information. Furthermore, this model associates itself with CAPM and the securities equilibrium and market place is inexistent.

The mean-variance analysis helps to identify whether the project reaches the expected return-variance for the company compared with previous projects, aiming to maximize attractiveness, as the return, and minimize risk, as the variance.

2.1.12 Sensitivity and Risk Analysis

A sensitivity analysis is the study of the impact when costs and benefits vary and the determination of which variables make the project reach NPV=0 or a required value of IRR or NPV. The variation of several factors, chosen in a subjective way and correlated or not, allows the calculation of a minimum RP (Conejos, 2016; Iooss & Saltelli, 2015). The process to carry out a sensitivity analysis begins with the selection of variables and its variation extension, and the determination of the effect in NPV and IRR (Asian Development Bank, 2017).

Any project has an associated risk/uncertainty, directly affecting the MARR. Risk is related to new technologies, high up-front investments, economic instability, and others, caused by internal or external factors, and risk sources represented in Figure 1.

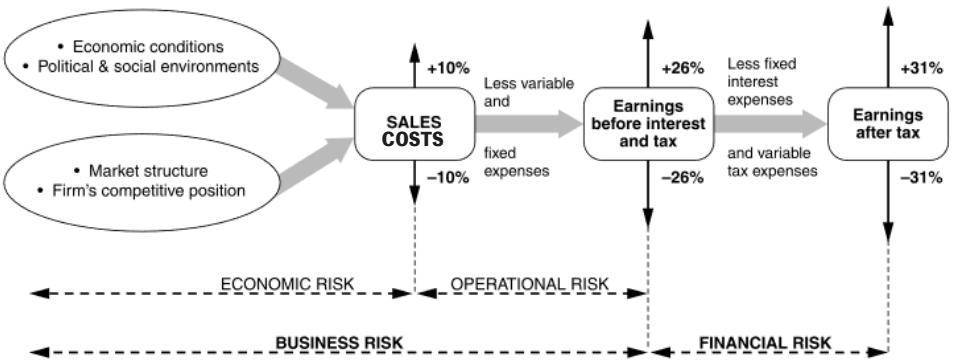

Figure 1 - Sources of Risk that affect Profit (adapted from (Hawawini & Viallet, 2015))

What differs a risk from a sensitivity analysis is that it estimates the probability weighted for NPV and the probability of IRR. A more basic process includes: identification, analysis, solution planning, and a monitoring and action plan.

For a more complex uncertainty analysis, an engineer should follow these steps: variables identification, establish probabilities distributions and their values, analysis-based values and parameters to estimate NPV and IRR, test and estimate final weighted probabilities of NPV and IRR. This proceeding is called Montecarlo Simulation software and is based on estimation processes and its best scenarios for these financial indicators and the analysis of the uncertainty distribution in certain parameters.

Consequently, it is possible to propose different scenarios for the project in hand, which delivers diverse results by changing important financial elements. Also, at this stage the analyst can study three scenarios: pessimistic, the one that does not meet the companies' predictions; probable, realistic and similar to the previous one; and optimistic, when results are better than the previous ones. Also, these results are obtained using the previous factors or variables identified in the sensitivity analysis (Conejos, 2016).

2.2 Decision-making strategy

Economic and financial evaluation occurs when an idea, project or a venture needs to monitor its current state and determine its viability, or when entrepreneurs and their teams want to take decisions regarding it. That being said, there are several options on the table in those decision-taking moments, represented in Appendix II – Type of decisions to consider in an economic and financial evaluation, regarding four categories: technology, business, resources, and , when entrepreneurs ask this question: ***"What should I do when I have an idea or product?"***. It is important to analyze the structuring of every aspect, specifically the technological characteristics, business strategy, and resources which will affect every cost element as well as the final result and financial indicators, from which the team deliberates its viability.

2.2.1 Technology Evaluation

In an initial stage, the team should evaluate the technology to analyze its current and future state, as well as its opportunity gap. Every decision can be postponed or used to give feedback about the need to pivot, in other words, significantly change strategy.

The first phase allows an initial evaluation of the state of the technology, specifically its feasibility and level of maturity, according to the TRL scale. It is important to frame technology considering market position and innovation interest, according to Figure 2. Afterwards it is possible to **understand the future status of the R&D process**, whether it should carry on or not, considering all proposed features for the MVP.

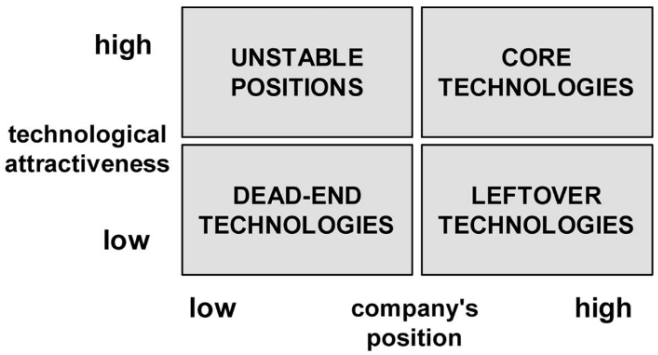

Figure 2 – Type of technology, considering position in the market and its innovation interest (Jolly, 2003)

The second stage pertains to the **technology supply**, as it can either be made internally, specified further in the *Planning required resources* section, or bought, which can also be internally or externally depending on the company. When the technology is acquired externally, it means that the team buys

technology from another firm without their support. In this situation, the team can reduce costs when the firm needs to build or improve their infrastructure in order to produce that specific technology with the required features and quality level. Also, externally acquiring can allow easier absorption of know-how and innovation. It is said that it is more productive and profitable when companies combine a make and buy approach. Critical factors for success can be delivery lead time for the supplier and their own company, integrating complexity into activities (Cassiman & Veugelers, 2002).

Next, the team or the allocated business/financial analyst should **analyze the type of technology used**. If it relates to a hardware solution, the bill of materials (BOM) can be kept or changed. If it relates to a software solution, the technological infrastructure can also be changed or maintained. These adjustments could force the need for more investment, as there might be added costs, possibly outside of the budget plan, that can impose limits to future development.

The fourth point concerns the **enforcement of intellectual property** over ideas, technology, designs, and inventions, which is a given right in a specific country over the product from the designated legal entity or institute of the team or the entrepreneur. In other words, the inventor can legally preventother entrepreneurs or firms from stealing and using its creation, although if necessary, the rights can be retrieved from the owner (Barros, 2016; Carmichael, Whittington, & Graham, 2007; Dixit & Pindyck, 1994). Registered intellectual properties (IP) are frequently required in R&D environments or when creating a startup. Also, an IP can be defined as a:

- Patent, which is an exclusive right for 20 years on an invention that includes descriptive technical information regarding the product, preventing situations where others make, use, distribute, import or commercialize it without their consent.
- Copyright, that is a legal economic and moral right that creators have over their expressions, for example, computer programs, advertisements or databases.
- Trademark, in other words, an exclusive right for a company's registered product or service to another enterprise, for example for a combination of words, letters, numerals or logotypes. These rights can last for 10 years.

The previously-shown types of IP can be associated with tangible assets, under confidentiality or employment agreements that protect data leakage.

Additionally, all types of IP can derive to licenses but, it is said that 75% of an idea is not commercially licensed or even disclosed. The ones who license have the tendency to acquire technology externally, transferring knowledge bidirectionally.

When the research environment is at universities or in companies internally, it is easier to enable an idea and detain an ownership. Also, in these cases, almost 50% of the researchers, included in R&D in firms, started a business based on patents (Neely & Rentocchini, 2012).

In summary, a license is an agreement between two parties that allows the licensee to manage their goods or services with their consent. It can be regarded as a passive income of around 25% in royalties, as well as strategic benefits with more partnerships and business opportunities that might be created. Ventures start to depend on internal application and outward licensing (Lichtenthaler, 2010).

Finally, the fifth phase concerns the **monetization of the developed technology** regarding its patent, which might be blocked when there is no opportunity to integrate the solution with others, there are security and privacy obstacles, and there is not sufficient investment in enlarging the idea's capacity (Capgemini Consulting, 2014). This phase is ideal for entrepreneurs to understand how they can translate hours of R&D and solutions into capital. Thus, entrepreneurs can either license the technology or sell the idea. Licensing an idea, the technology or a patent implies a full fee, for exclusive rights or royalties, which require the definition of the unit fee and the requested monetary amount. On the other hand, selling an idea can be a challenging decision due to the state of the patent that may be inexistent, approved, denied, or pending.

2.2.2 Business strategy outline and structure

The first step is **tracing the future course,** specifically deciding whether the team should continue or not with the idea or product, both depending on the project's rate of success, financial return and the time it takes, expected value of the project, and required time for success. When the team decides to continue internally or externally from an internal perspective, entrepreneurs can either:

- Create and initiate an internal project, when the idea is in the championing or implementation stage, where the idea is approved and converted into a tangible outcome, after its initial elaboration. This direction helps to move things on and adds pressure to advance from an idea to commercialization, although they are dependent on the top-level managements' decisions. Additionally, creating an internal project has its ups and downs, as it is said that 28% of IT projects are successful, 75% miss deadlines, 55% exceed their budgets and 37% do not meet project requirements (Perry-smith & Mannucci, 2017; Shenhar & Dvir, 2007).
- Create a new business unit, that has strategic plans with specific KPIs both tangible and intangible, which can be assessed separately and compared to other business units if required, deciding whether it generates value or not. It is said that it is easier to look backward and not

forward as it requires more critical thinking and forecasting data, in hypothetical and uncertain scenarios. Also, the establishment of a business unit should be aligned with the enterprise's goals, and have a clear focus on what segment of its stakeholders it targets, in other words what customer value proposition it focuses on. Strategic business units make the team more organized and efficient, help to focus on what is important for them, support segmented, targeted, and well-positioned development, and might get faster and bigger investments due to their specialization. To sum up, these units will increase customer satisfaction and the overall profitability of the business (Marr, 2006).

From an external perspective, the entrepreneur can (Pride, 2018; Tübke, 2005):

- Create a start-up, which is a decision with high risk for every shareholder involved, and where costs should be kept to a minimum in the beginning. Start-ups, framed in an unstable environment, are like a black box, where decisions are taken but, despite the team's caution and experience, the outcome can never be predicted. Nowadays, about three start-ups are every second, but 92% of them fail three years later, and 50% after five years. Capital support is becoming more difficult to acquire as experienced investors are more conscious in a germinal phase whether the idea is good or not. To conclude, it is said that a start-up usually starts to be profitable in the third year of operations. Entrepreneurs tend to make bad decisions and rush the normal process of a venture creation, as they truly believe in their product. Start-ups as spin-offs need time to evolve and mature, and their main success factors are: opportunity, individuals, in other words, experience and industry, sociological factors, founding team, motivation, a business strategy plan and available investment.
- Create a spin-off, which is a decision to grow separately from the parent-company but maintain their support, for examples in cases where maintaining the alliance is more beneficial than giving total control. The main goal is to refocus their strategies, increase the shareholder input value and gain access easily to targeted investment. The main success factors are similar to start-ups: motivation, organisation structure, and business activity.
- Merge or join ventures, which is a strategic alliance of two or more entities to be able to access the following benefits: cost reduction, share of markets, IP, assets and knowledge, and the number of clients and partners' increase in their portfolio. This action does not constitute a legal entity, but allows them to expand into larger markets. The success factors of joint ventures can be described as: independent structural independence, adaptive business strategy, existence of conflicts of interests, team motivation, and the flexibility of both entities.

When the team decides to stop, they can choose any of these alternatives (McCardle, Tsetlin, & Winkler, 2018):

- Giving up on the idea should occur when the entrepreneurs are facing the following situations: the marketplace is too crowded, and the entrepreneur is not ready to pivot the current idea, there is no passion left in the team regarding the solution's purpose and the path the business might take, and the demand is inexistent, over-optimistic or still taking too long. However, there is no precise method to evaluate whether this decision is the best one. That being said, all ideas are valuable, just requiring additional development, time and expert support, the place or time might not be adequate, and the entrepreneur might not be the right person.
- Abandon the project, from which companies can benefit more than continuing with it despite the previous investments made. It can become a difficult decision when there are already stablished client alliances and partnerships with other ventures, which can be taken considering KPIs like market share and profits reduction. This can happen due to inabilities to invest more or where there are other more interesting and profitable projects at hand.
- Deliver their idea to another project, which happens when the idea can be framed in a planned or on-going project, and their team has the right resources and is better prepared for its development or when the idea/solution passes on from the innovation to the executive team, or business unit, when the idea does not frame the strategies of the location where the project is being developed and the team is not prepared for this type of project, for example.
- Close the Business, considered as an exit strategy that needs the consent of all shareholders, including owners and partners, and requires certain steps like completing dissolution documentation, cancelling IP rights, applying labor laws, resolving financial obligations like taxes, and keeping all the financial records.
- Sell the business, by valuing the enterprise considering the past income, market state, in other words, other businesses and held assets.
- Transfer ownership, specifically the business shares, from individuals who own percentages of the firm, and stakes, from individuals who own percentage of stock involved. These decisions can involve an immediate transfer, gradual, or temporarily through a lease.

The second step is to **draw up a business model (BM)**. It is essential that all stakeholders adequately plan and, if necessary, follow disruptive strategic approaches. However,, it is beneficial that the BM is done by an individual experienced in the area, as theoretical knowledge is insufficient to project or likely to generate a proper and successful business model for the venture in hand. These drafts are part of a

try-fail process, in order to create the most detailed and suitable BM. In order to develop the best BM for this solution, the team should (McGrath, 2010):

- Decide the most adequate channels, specifically whether the product or service is going to be promoted and commercialized directly from the producer to the client, or through intermediaries, for example using sales agents or other firms.
- Define the revenue model, in order to understand how the company is going to monetize the solution, how it is going to make a profit and if so how much.
    - Initially, it is important to decide whether the solution will be sold as a product or service, and its revenue acquisition strategy. It is said that more than 70% organizations do not have the capability to generate service revenues from their solutions.
    - Set price, which will dictate the clients' acquisition rate. Furthermore, the individual accountable for these decisions should specify whether they require a short- or long-term strategy, whether any type of discount will be applied, and, finally, what the final retail price will be. In addition, the price in general will be established according to units of business, for example a pay-as-you-go, one-time, pay-for-results, freemium, or subscription approach.

This second option might take time that is valuable for development, and does not include information specifically requested by certain stakeholders. Also, it involves certain problems that might affect its success: like the need to focus on the value proposition of the solution, technology development level, overvalue the need to reduce costs, globalization, complexity, innovation, strategy and management, and funding resources availability.

The third step concerns **elaborating the market plan**, with previous market/ industry research. The most important decisions to take are the definition, maintenance or changes of the market segment, and delineation of an adequate and pervasive market strategy that will create more impact among clients. The first concerns defining what is the target audience and its boundaries to a more effective enterprise, and decide if the team wants to scale the business or limit its size.

The second one involves a market strategy, like postponing, entering or exiting, in other words, launching the solution/product onto the market. The launch initially involves a testing phase, after the business plan elaboration. However, this moment allows the company to get the first results, like number of sales, revenue volume, and units sold. The first released version, the dev, is for early adopters that are interested in giving feedback, for example for requirements analysis and tests of software functionalities, and design. Afterwards, there is an alpha and beta release with acceptance and usability testing. The majority of these

releases contain almost all requirements, and need few changes in design and functionalities, but appear to have bugs or errors. Later, it is released to all customers, in the beginning loyal and early adopters, from whose feedback it is still possible to improve the solution (Ries, Brown, & Blank, 2011).

To conclude, this option helps the team to define a sales target and evaluate the business according to its objectives and capacities, delivering more precise financial results from the forecasting and scenarios analysis. However, it can cause problems when the team does not have much experience, the client is totally unknown, the market is uncertain and high risk at the precise moment, the industry network is too closed and information is not available for new members. Further, having a tight budget blocks innovation and quick action.

The fourth step involves **clarifying the products and/or services portfolio**. At this moment, the team must decide which solutions best fit their business strategy, and meet their development and production capabilities. If they have too many ideas it is important to filter all of them, and select the most interesting ones, and the ones that should be eliminated for this solution or passed on to other products/services/projects/teams.

The fifth step involves **defining the legal structure** when creating a new venture, balancing the pros and cons. This alternative includes the legal status (type of company to choose, the founding associates, and their percentages of shares of the venture capital with legal support), the enterprise's physical location, intellectual property, business offerings, which in 86% of the cases are services, employment size and financial capital, specifically if it is equity or debt. Entrepreneurs and new ventures should seek the advice of attorneys for these, seen as a fixed cost, for the preparation of legal documents when they are formalizing the venture creation, as well as to draft and negotiate contracts for alliances and partnerships. These procedures help them to avoid further conflicts between them and clients or partners, losses of IP, disagreements among founders' shares, scams from non-formalized alliances and capital losses. Additionally, the capital structure is usually at a mean of 40% of outside debt. Over 75% of enterprises have at least some equity, and 95% no family relation. The success factors are profitability growth, information asymmetry, type of industry, and personnel. (Robb & Robinson, 2014)

2.2.3 Planning required resources

The first decision involves **clarifying the production structure and size**, after deciding if they will make or buy the technology and the required production size. On one hand, the production structure can be maintained, when the business is already supported by another firm with a good production site, if a production line can be created or even a production site, if necessary. This decision depends on the

solution's budget, the market demand and supply, the team's background, and partnerships. On the other hand, a reliable supply network allows the team to have faster delivery times.

The second decision involves **defining indirect resources**. Any company needs indirect resources to support its operational activities. That being said, the resources can be acquired, specifically bought or rented, or its acquisition postponed.

The third decision involves **creating an adequate team for the sales and production volume and product portfolio**, which can be formulated by outsourcing or recruiting temporarily or permanently. Manpower is the powerhouse of a company, the most important element of a business, due to its value creation and the business' strategic goals achievement. In this perspective, this decision is the one that most affects costs and the business position in the industry.

2.2.4 Taking financial decisions

This fourth topic involves **choosing alliances and investments or funding opportunities**. When there is only an idea, investments might be smaller so teams have limited ability to grow and the loss has less an impact. On the other hand, when the future of the solution is predictable, enterprises or investors can bring in larger quantities of capital as the risk is lower. That being said, the initial investment is riskier than the following ones, as the CF is increasing, the solution is strengthening a market position, and the business is starting to be progressively more profitable, as it is represented in Figure 3.

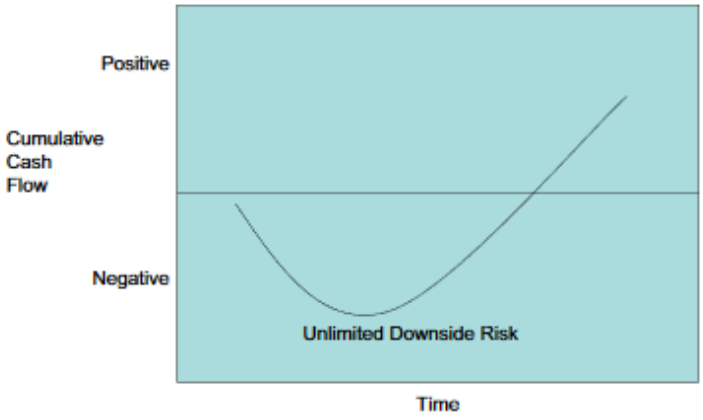

Figure 3 – "Black Hole" Investment Strategies, retrieved from (McGrath, 2010)

Investments run progressively bigger cycles if the project is growing in the right direction. From 1 to 3 years, a team fully invests capital from their funds. After investing, in 10% of the situations all funds are returned, and in 60% investments return less than their cost of venture capital so it is not sufficiently advantageous. The firms in riskier markets have a tendency to fail more often and the resilient ones are more valued (Nanda & Rhodes-Kropf, 2013)

The main success factors in investment rounds are: the market strength, the possibility to allocate aggregate capital to riskier investments, product cycles, market dynamics, regulatory processes, key personnel, technology, whether the product is and will be patented, preference to invest in a certain industry or stage of an enterprise, or even the tolerance to failure and risk. In general, there has been a high decrease, around 30% in capital investment, and a slow decrease in early-stage funding.

Taking financial decisions includes (Chaplinsky & Gupta-Mukherjee, 2016):

- **Planning the investment source**, which can be private or public, from individual investors, specifically entrepreneurial individuals, banks, government or communities. The IT sector is the one that receives more investment, approximately 49,75%. Less than 50% reach their investment goal, and about 20% deliver projects on time.
- **Projecting the required amount of investment or funds**, where on average 15% of an investment results in bankruptcies. The ideas or projects without investment for a time period of 5 years are called "living dead", having a lower probability of investment.
- **Planning partnerships,** as they might affect the investment acquisition, **receive mentoring support**, as mentors have a major role in helping a project with medium maturity level to grow and acquire new partners for their network, **and collect their feedback and apply their strategies.**

In order to identify the most common and important alternatives, a continuum line contemplating the most important decisions/strategies is represented in Figure 4, which was developed based on the knowledge retrieved from previous experience and some authors.

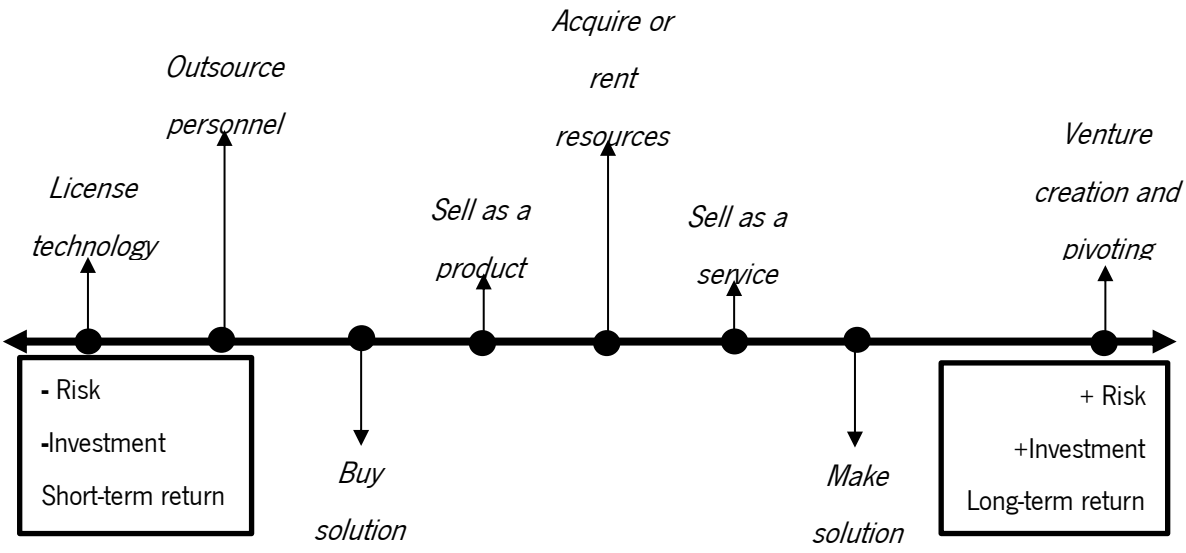

Figure 4 – Most important decisions, regarding investment amount, risk level and ROI period (own source)

To conclude, the alternatives pointed out the continuum are the most frequent and important ones for a new business idea or project. This is a representation based on what was read in the literature, as the positioning of each option can differ depending on the type of idea, industry, financing or funding source and amount, and team characteristics in terms of risk aversion, mindset openness, disruptiveness, and entrepreneurial experience.

2.3 Strategic Investment Decision-Making

According to the previously-reviewed literature, in sections 2.1 and 2.2, several authors develop and propose multiple project evaluation techniques as well as the decisions an entrepreneur takes while evaluating a business idea, project, or even an investment. All the possible alternatives are divided into four macro categories and then sub-divided into more specific ones. Both previous sections represent qualitative and quantitative aspects of an investment appraisal, along with strategic and financial elements, that appear at decision-making moments.

2.3.1 Investment Appraisal as an overall

Regardless of what is essential before evaluating a project economically, like the formulation of the value proposition, the definition of the business model and the market research, it is necessary to include both strategic and financial perspectives along with the investment appraisal. That being said, for a manager this can be seen as a strategic investment decision-making moment (SIDM), where these two viewpoints should be considered in parallel. This term represents the identification, evaluation and selection among one or more projects and, consequently, one or more respective scenarios, that might create value for the organization and, also, increase its profits.

The SIDM must be organized, follow an adequate logical process with required minimum phases and at a constant pace, in order to offset the fact that decisions and assumptions can change within time and space. (Harris, Northcott, Elmassri, & Huikku, 2016). Additionally, the more evaluations the team makes, the greater the likelihood of the business idea or project being successful (Moutinho, 2011).

Ekanem (2005) proposes a simple logical process for an investment appraisal, in a factory case example, in Figure 5. The scheme declares all the elements involved in these processes, such as the techniques, the hierarchical levels associated, the main phases, and the impact of external aspects.

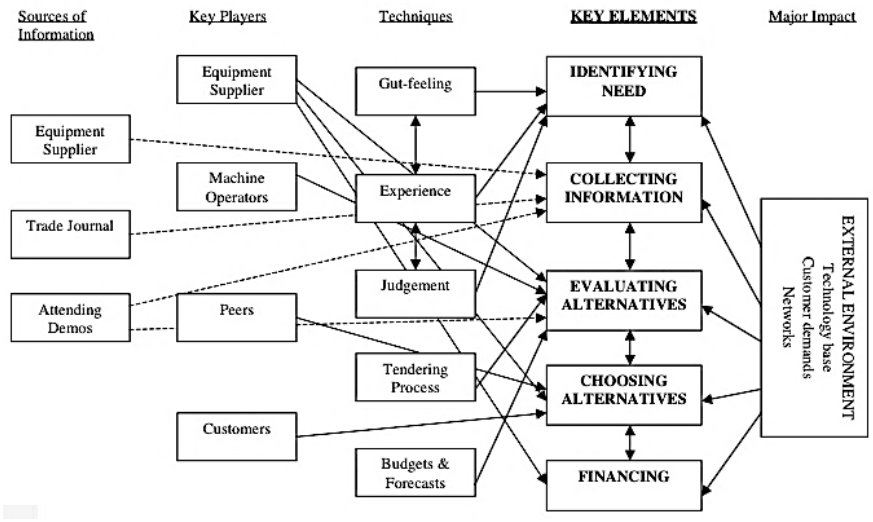

Figure 5 – Investment appraisal logical process (Ekanem, 2005)

The SIDM routine should contain pre-evaluations and post-control points applied to each management level, if necessary. Regarding the pre-evaluation stages, there are some mechanisms that can support the whole process like: formal policies and procedures, for example for expenditure authorisations, profitability requirements like standardized values for metrics, managerial involvement, financial, strategic and risk analysis. Focusing on the pre-decision controls, managers should be aware that this is the auditing and controlling phase where they can see it happen, monitor all the previous results, measure the accuracy and reliability of the pre-evaluation, and adjust any aspect of the investments (Huikku, Karjalainen, & Seppälä, 2018).

2.3.2 Strategic Perspective

One side of an investment evaluation is the strategic viewpoint, where the analyst must assess the idea or project's capability to fulfil a list of criteria that may vary between individuals, teams or corporations. The majority of aspects to take into consideration, which should be seen as priorities, are listed below (Alkaraan & Northcott, 2006):

- Fit to the business strategy
- Contribution to their competitive position in the market or industry
- Product quality
- Capacity to expand the business
- Customers' requirements.

In order to incorporate these characteristics, there are several techniques like the balanced scorecard, value chain, Porter model, SWOT, Technological roadmap, PEST Analysis, and others, which develop the strategic component and use both qualitative and quantitative data. Consequently, treated information can be gathered and delivered more efficiently to any stakeholder (Cunha, Afonso, & Leite, 2018).

Although these tools are not as exact as if they were only quantitative, their results and approval depend mostly on the analyst's and team's judgment and intuition, which are their best method in these cases. Human judgment varies from person to person, and the project's goals are sometimes intangible and long-term. Also, their background, experience, vision, and risk aversion can affect the decision.

In general, the uncertainty of the outcomes, the possible fit to the organizational culture and business strategy, the customer demands, and who gives the leading and last answer in case of bottom-up or top-down contributions, are the most important variables to consider (Harris et al., 2016).

2.3.3 Financial Perspective

The second perspective is the financial one, where mostly quantitative data is analysed. According to a study, no company uses only quantitative tools, as they have an "open approach" mindset, to be flexible vis-à-vis any investment appraisal at hands. The capability to use any tool can compromise costs and time as there is no standard process for an evaluation. Almost 70% of the firms stated that projects vary in time, costs and schedule, which corresponds to a total of 10 to 15% from the initial estimates (Akalu, 2003).

Managers adapt and change their evaluation techniques and use a variety of criteria, like accounting ratios, equity value, total return to shareholders, and so on, according to their industry and the idea or project maturity. The majority of the companies, according to the study, use more than one technique in order to optimize the final solution. Traditional methods are the predominant ones being used, which may be the DCF, where 94% of the companies use payback, and 69% the IRR or NPV, and market related measures, neither of which are proven to be the best tools for R&D projects. The choice of the previously explained techniques can also depend on the firm size, business capacity, team background, growth opportunity, and the manager age. In case of bigger firms, they tend to choose the IRR as it is standardized for internal criteria, or for smaller ones, the NPV and payback are more important as they must assess their short-term sustainability and are in initial development stages (Alkaraan & Northcott, 2006).

Next, the risk analysis is the last step of an investment appraisal, usually undervalued, and theoretically associated with the cost of capital or the initial investment. Risk can either be evaluated by qualitative tools, such as value management to maximize it, or quantitative, like sensitivity analysis, CAPM, payback,

ROI, discount rate, or DCF models. This step is not related to the effectiveness of the evaluation process, but can provide different scenarios for a flexible perspective of the business (Alkaraan & Northcott, 2006).

2.3.4 Main criteria for decision-making

In Portugal, 25% of projects are not formally evaluated, and more than 50% use non-financial criteria, which matter equally to these decisions (Petty & Gruber, 2011). Enterprises rely on qualitative and non-standardized approaches whether or not with strategic projects. Furthermore, R&D projects tend to use first qualitative and then quantitative models, based on critical thinking and prior experience. These investment evaluations depend on the company's authority, where there can be a shared responsibility or a decentralized assessment, depending on the project's life span and capital requirements (Alkaraan & Northcott, 2006).

Generally, there are numerous criteria that affect the investment decision and may vary throughout time (Maxwell, Jeffrey, & Lévesque, 2011). First, the internal one depends on the organizational culture, firm size, type of product or service, entrepreneurial characteristics, capital budgeting, short- and long-term business strategy, turnaround effort, historical financial performance, and the innovation rate.

The firm size can be a major factor due to whether they are a large enterprise, use more sophisticated techniques, and need to focus on the long-term capital expenditures, owners' best interests and stakeholders' wealth, business' growth, maximum value created and profit generated. When they are small to medium enterprises, they have a bootstrapping mindset to firefight constantly, in other words, to get quick and practical solutions to the problems. They take less-rational decisions, that are sufficient yet not optimal. Also, they are more focused on the productivity of the company and human resources capacity for the business strategy. That being said, 20% of this type of companies do not use any evaluation tools to assess investments.

On the other hand, the external criteria relate to the competition, market or industry status and volatility, evolution of technology, price fluctuations, customer preferences, policies, and other demographic, economic, political or social dimensions (Ekanem, 2005; Moutinho, 2011).

Carr, Kolehmainen & Mitchell (2010) proposed a correlation between the market orientation and flexibility, to the innovation rate and type of investment as well as the evaluation tool to apply, represented in Figure 6. For example, businesses with a weak market orientation might focus more on financial results and not so much on strategic aspects. Then, four categories to characterise firms were created: **value creator**; **market creator**; **refocuser**, for both strategy and financial considerations; and **restructurers**, who are extremely averse to risk and tend to control their financial results.

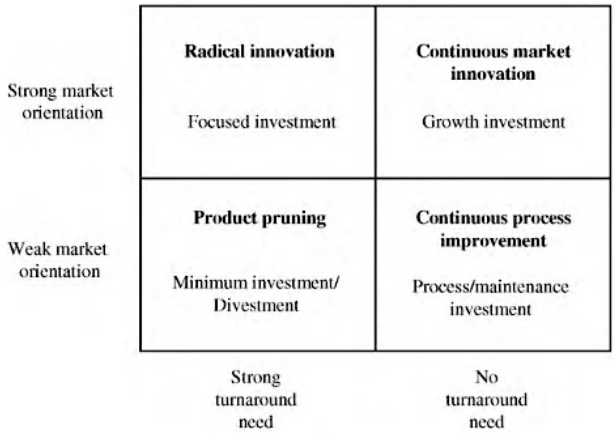

Figure 6 – Management models in investment appraisal (Carr et al., 2010)

To sum up, the following were defined as critical factors to accept an investment, in descending order of criticality (Maxwell et al., 2011):

- Adoption of the product or service, in terms of interest and innovation
- Product status and its development risks
- Protectability, regarding possible IP registrations
- Customer engagement and market validation
- Route to market, specifically the operational resources and partners needed
- Market potential in size, growth and competitiveness
- Relevant experience of the industry, the team and its managers
- Financial model and its results as cash-flow, profitability ratios and its reliability.

According to a study developed by Petty & Gruber (2011), the acceptance of an investment was analysed and it can be stated that financial results play a leading part, as well as the product or service being developed, the focus of the venture capital and the marketing strategies, in Figure *7*.

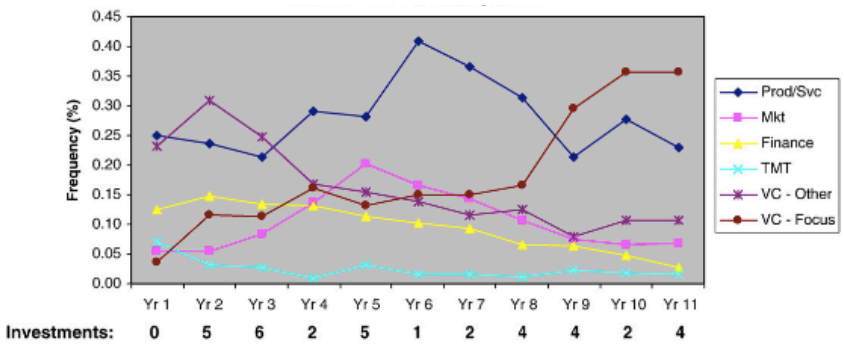

Figure 7 – Reasons for rejecting an investment in relation to the number of years and investments (Petty & Gruber, 2011)

2.3.5 Current frameworks

Some authors proposed a MAUT framework based on quality, strategy and financial aspects, like NPV and Payback. This framework was only studied in an industry with low risk, and weighting non-financial criteria more, which seems adequate as there are fewer cost elements and volatility in this market. This tool requires a lot of data which is not available with innovative ideas, but supports the decision on both qualitative and quantitative criteria, as well as financial and non-financial measures (Frank, Souza, Ribeiro, & Echeveste, 2013).

Another study was recently carried out based on all relevant literature. It presented a framework that lists all the strategic and financial criteria that can be applied in parallel, taking into account criteria, goals, entrepreneur and the team's characteristics. However, it presents an overview of the SIDM elements but not in a logical scheme for investment appraisal. Finally, the main goal should not be the maximisation of a company's profit, but the estimation of the investment, the analysis of the business growth, and the definition of risks (Cunha et al., 2018).

2.3.6 Problems encountered

After reviewing the current state of the art, it is possible to encounter several problems regarding the evaluation models for investments and the criteria for entrepreneurial decision-making moments.

First of all, the resources required, such as time and people, are extremely difficult to obtain and maintain due to the need to input estimates and forecasted values and to deliver reliable and fast results. Also, the quality of the human resources is questionable when there is lack of accounting understanding and strategic mindset, which makes it difficult to take decisions and correctly weight either the criteria and the evaluation results. Last, the fact that information in investment appraisal can pass through quite a few professionals, feedback loops generate information asymmetry and, consequently, less reliability, is important.

Second, the current investment appraisal techniques can be inadequate because of their intangible nature, uncertainties, and risk or untrustworthiness if data and estimates have been badly calculated. Some models that consider only the financial elements ignore several attributes of the investment and demonstrate no flexibility for future changes, or the need to redo all calculations to test different scenarios. When a project is being evaluated from scratch it has no previous or historical data, and so requires a good technology study and market research.

Third, there is the presence of bias, such as tendency to depend more on one perspective than on another (strategic or financial), self-interest errors, affection for the project, consideration of all the stakeholders'

opinions, past success stories in similar investments, lack or reliability of information, and an over-optimistic assessment. Additionally, managers can tend to confuse between plans or targets, corresponding to ambitions, and forecasts or estimates, representing the accuracy of data (Lovallo & Sibony, 2011).

Fourth, companies are affected by a lot of changes throughout the investment process, so subjective and objective criteria should be considered, either financial or not. Also, the most current advances in evaluation tools in literature are not being applied practically, but traditional and common techniques like DCF, NPV, IRR, and Payback. That being said, the strategic and financial perspectives are still separate.

2.3.7 Opportunity Gap

A good investment appraisal framework, model or practical tool is the parallel inclusion of the strategic and the financial perspective, using both qualitative and quantitative data to increase its reliability and counterbalance possible bias or errors. Moutinho found that the most important decisions are strategic, financial, technical, and commercial, occupying more than 70% of relevance, and the political and social ones occupy around 20% (Moutinho, 2011).

The strategic tools have been used for many years in businesses associated with several industries, which makes them adequate. The studies lack the understanding of the best weight interval for each qualitative adaptive criterion, and how it can be integrated in the financial and economic evaluation model.

The post-decision phase is used for monitoring what can happen, in practice, by graphical results from the developed models.

The financial techniques appear to be too sophisticated and not practical for daily usage. The consequent risk analysis needs to be further studied as there is not much evidence on the best tools to evaluate it as well as what kind of decisions can come from these evaluations. The tools for this purpose lack a clear identification and evaluation of the uncertainties and risk that might affect the business.

The study of both has not been done to a sufficiently significant level for all industries and companies in general, which does not allow statements regarding the different usage of these investment appraisal models. Besides, there is no study about why a certain technique was used, for example due to organizational barriers, knowledge gap, technological challenge, business unit strategy, rewards and incentives, and financial structure. The many criteria to consider have already been studied in depth, but not the correlation between the different techniques and some factors, like the industry, level of experience, firm size, product quality, market, and goals, and its impact on the results.

An interesting point is the correlation between these strategic tools and financial tools. It has not yet been proved as studies only propose the frameworks and models and do not test them on sufficient samples in practice. There is still no consensus on which model and criteria should be used in which type of investment, industry, market volatility, and other factors.

As a matter of fact, there is no knowledge regarding the effectiveness of a manager's, analyst's or entrepreneurs' assessment work while using software that could automatically perform its different levels of evaluation and present information as textual or graphical. Moreover, the evaluation model should be adequate for either a totally new innovative project or an investment to be made inside a robust company. Furthermore, the most traditional methods can be inadequate for some industries and projects, too complex, and do not measure the value created for every stakeholder. Each evaluation process should be led by a major objective, such as the investment at hand, the maximum data possible, and deliver the best outcomes and payoffs. Besides that, the evaluation model should consider scenarios of risk and sensitivity analysis incorporated in the traditional methods of financial evaluation.

However, "the only certainty in business is the uncertainty of the future", so an evaluation process needs to be flexible and contemplate all possible elements (Lefley, 1997).

To sum up, the development of an economic and financial evaluation model that can mitigate the current difficulties, while evaluating an investment and R&D project will certainly deliver outcomes for future researches. Additionally, its application to a case study effectively assesses the main phases and its problems, while evaluating a project with no products or services on the market and depends on estimates and forecasts.

3. Research Methodology

The purpose of this chapter is to declare the procedures to conduct the research to answer the proposed research question (RQ). Thus, it details the applied methodologies, how and when to question theoretical and real data; and methods, which are the type of techniques used to gather and analyze data, following the normal procedure of a research process. However, the definition of the research structure is a priority beforehand, as it will support planning, define the best direction, and evaluate the study's viability/reliability, and boundaries.

3.1 Research Process

Research is a systematic approach to collect, explain, criticize, and analyze data, producing results for the current literature and future research (Saunders et al., 2009). A key aspect for a good research is planning, where the researcher selects the research topic, defines methodologies and techniques, and outlines the study scope (Paltridge, 2002).

In the Business and Management area, research is said to be more difficult because managers have less time to share knowledge and support the researcher. Also, the project itself occurs in a real situation, giving the student an opportunity to find practical relevance and value to the organization (Easterby-Smith, Thorpe, Jackson, & Lowe, 2008). Furthermore, Johnson & Clark (2006) stated that, as a business and management researcher, it is necessary to be conscious of the decisions taken, as they can significantly impact the project.

This is pure research, as it includes the accurate development and validation of a model for project' evaluation circumstances. The nature of this structured study is applied research, where the work aims to be an improvement of a corporative process or problem and is adequate for this specific context. It is also both descriptive and correlational, as it describes thoroughly a decision-making situation for enterprises, the common methods, limitations and problems, and what is the relation between the evaluation model, or the type of decisions taken, and the course and level of success for the project.

3.2 Research Topic

First, the main research question was defined as: ***How can organizations evaluate R&D projects economically and financially in an early phase to avoid unsuccessful investments?***.

The main objective of this research, which is the development of an economic and financial evaluation model for R&D projects and the research and application of a case study in Bosch Car Multimedia S.A., was divided into goals (Table 2). To plan more effectively, SMART criteria[9] were used, in order to only define goals that were good for the pace of the project (Doran, 1981).

Table 2 - Dissertation Goals

Goals	**Benefits/Results**
Study and analyse previous and current evaluation models, in the literature review phase	Have total knowledge of what was studied, and developed in this area
Determine TRL/maturity level of the project, when assessing the current technology in an initial phase	Give feedback on the state of the project to the company, and know which evaluation model is more adequate
Understand the Business model framework for this case with the team	Define the project's business model, and develop the financial model
Develop an evaluation R&D project model during the whole dissertation project	Deliver a standard evaluation model for future R&D projects, shortening the evaluation-time and avoiding bad investment situations
Evaluate the project economically and financially and pass results to the company	Study all the financial aspects of the project and its viability, and give feedback to the company
Understand a start-up or spin-off creation viability	Define the project evolution, and scalability

3.3 Literature Review

This phase is iterative and involves the critical review of the most current and well-cited literature and state-of-the-art, its findings, and future research opportunities, in order to fit its research scope into the gap and support the knowledge required for the research (Saunders et al., 2009). The researcher needs to be aware of the chosen literature, considering publication date, journal ranking, authority, objectivity, and relevance. The literature review started from a superficial level and evolved into a more detailed one.

[9] S.M.A.R.T. criteria is an acronym to define goals, which are specific to a focus area; measurable; attainable; realistic, for stating results that can actually be achieved; and time-related.

The five criteria for a great literature review should be the justified coverage of knowledge, good synthesis of what has been done previously in the same field, research methodologies, approaches and well-defined strategies, relevant significance of the work being developed and a coherent structure (Boote & Beile, 2005).

The literature proceeded with an overview search of more detailed studies, and then ended with a summary of the most relevant findings. That being said, the literature review followed the main concepts from a clustering method application, represented in Appendix III – Keyword Clustering Method, using Google Scholar, Scopus, Springer, Elsevier, Google Books, Wiley Online Library, and RepositóriUM.

3.4 Research Design

The research process was structured according to the Saunders' onion, represented in Table 3.

Table 3 – Saunders' research onion application *(Saunders et al., 2009)*

Philosophy	**Approach**	**Strategies**	**Time Horizons**	**Choices**	**Data Collection and Analysis**
Pragmatism	Deductive	Case Study	Longitudinal	Multi-method	Quantitative and Qualitative

The followed philosophy is pragmatism since the research question is the main guidance during work. The researcher adopts both objective and subjective points of view, only valuing what brings the best results, while neglecting "outliers". Also, this philosophy suits this project as it is applied to enterprises and contains a practical component. The researcher can interpret data externally, by assuming a financial analyst or consultant position, or can take decisions as a development team member.

The approach was deductive, as literature was first studied, and then an economic and financial evaluation model was applied to the case study, which delivered sufficient and reliable conclusions.

The research strategy is Case Study, where a practical research is done in a real-life situation, uses several different data and produces a general conclusion to an extension of context. This project is a single-case situation, which is typical for this context. The problems regarding this type of strategy are " lack of rigor ", biased results, and insufficient practical examples to reach a reliable conclusion.

A case study includes: an RQ, propositions, unit of analysis, connection between data and the assumptions, and interpretation criteria. The researcher focuses in answering *Why?*, *What?* and *How?,* characteristics ofan explanatory study. Specifically, it intends to understand the difficulties in standardizing evaluation models, the existing available models, and how they can be evaluated. This is a

holistic case study, as it represents the analysis of a project as a whole in a specific department (Yin, 2003).

During the research but specially at the data collection and analysis point, it is crucial that the information and the project is validated (Scandura & Williams, 2000):

- Internally by direct superiors or even the team, to check if the research is meeting the goals and targeting the expected results
- Externally by the academic mentor or the university, so the research is designed adequately and can end within the established timeframe
- By triangulation, when reviewing literature, relying on sample surveys, collecting data at the field, computer and software simulating, and by testing the scenario in question
- Statistically by data analytics approaches, its formulation and application.

The work was developed longitudinally, as this research project went through various relevant development stages. It began when the team had an unclear idea and untested prototype; passed to the concept and prototype testing stage, where the minimum viable product (MVP) was matured and tested on the first potential client; formulated the business model and defined the market segment; gained investors, as well as reached a point where a new venture can be created and the product is ready to be launched onto the market. That being said, although there were time constraints, due to the company's availability and the academic deadline, it was possible to observe all the events and behaviours for this research, in order to deliver reliable results of changes over a period of time.

Finally, the major constraints of the project were identified as:

- Individual planning and performance
- Project's major scope, boundaries and expected results
- Available time and deadlines throughout the project
- Accessible and obtainable information
- Company's support in the whole dissertation and the team and mentor's availability.

3.5 Data Collection and Analysis Methods

The researcher used mixed method simple with qualitative and quantitative data collection and analysis, creating numerical and non-numerical data in parallel or sequentially. Data was gathered using primary and secondary observations, specifically when observing directly or collecting statements from the people involved.

For primary observations, the researcher adoped the roles of complete observer not included in the activities of the study; participant as observer, when revealing the researcher's identity and taking an analytic approach; and observer as participant, observing without integrating into the activities. Additionally, non-structured interviews were conducted with the managers, the team, and the clients.
The main data collection techniques was semi-structured interviews, and observations, as primary data. As secondary data, journals, census, internal reports and guidelines, and confidential databases from the case study were used .The main resources for data analysis were the Excel software, for the development of the evaluation model, statistics and graphs; and *VBA Macros*, simplifying the task of evaluating business ideas and R&D projects in enterprises.

3.6 Research Steps

This project was developed using Scrum, an agile project management framework incorporating the tasks in the enterprise and the academic research, in parallel. This framework gave the ability to go straight to the essential, prioritize, frequently keep track of the work in progress, and monitor risk beforehand (Rubin, 2013). Additionally, Scrum can contribute financially by reducing the possibility of risk occurrence, due to increments in productivity. Also, this research followed the next steps:

1. **Assessment of the maturity state of the Project and Support in the Value Proposition and Business Model formulation:** This was a diagnostic phase where the project was analysed at a macro and micro level, the technology was studied, the value proposition was defined and the most adequate business model were proposed, in collaboration with a colleague. The business and financial analysis of the project was done from scratch and all the data produced served as input for the evaluation models.
2. **Development and validation of the economic evaluation model:** Based on previous theories and concepts from the main knowledge fields and Excel software, an economic and financial model to evaluate a R&D project was delivered. Then, it was validated with experts.
3. **Evaluation model application and results validation:** The model application results of this case study allowed the team to state which was the best direction for the project. Also, its validation provided evidence regarding its suitability for other projects, enterprises, or industries.
4. **Final assessment and conclusion regarding the conditions for a Start-up/Spin-Off Creation:** As the innovative device has been tested with a strong potential client, the organization is expecting to create a start-up from the R&D project at hand, enabling it to grow without limited creativity.

4. Economic and Financial Evaluation Model

This chapter presents the developed economic and financial evaluation model, which was built using the knowledge acquired from the literature review and known used models for innovation projects. Additionally, it explains how the development process took place, and its structure, specifically the main characteristics, main assumptions, and organization in the Excel file. Finally, a representation of the process of evaluating a R&D project is presented, from an economic and financial perspective.

4.1 Development Process

Whenever we have a business idea or project and are willing to pursue it, evaluation should be part of this procedure. This model should be complete and adequate enough for any individual using it, for example, from a business or financial analyst to a software developer; with different levels of complexity and visualization profiles; standardized among finance and business experts or the industry, so it becomes a unified tool and, consequently, a communication language for these evaluation situations.

According to the literature review, companies and entrepreneurs have difficulties in knowing how to correctly evaluate a new idea or project, inside or outside a company, and which following steps are better. In general, they spend a lot of time and resources on this kind of project, in other words, take poor decisions that lead to financial losses.

Therefore, an economic and financial model was developed, named FINECON Model, with the main goal of providing a tool to simplify decision-making and ideas or project evaluations, which is easily understandable and customizable. Also, other main goals for the model are the possibility to be considered a standard among R&D evaluations and unambiguous. Its users can vary from inexperienced individuals, entrepreneurs, investors, to business individuals, and finally, R&D teams inside companies. This model can support decisions that vary from resource acquisition or production, outsourcing or internal recruiting, venture creation, and others, which might appear at any time during the growth of an idea. Also, the financial evaluation methodologies and indicators are similar to other known models, as they are concepts and formulae drawn from the knowledge area.

Finally, the FINECON model structure was developed gradually, with the previously acquired knowledge from literature, the questionnaire results, and direct observation that showed that the necessary requirements were.

4.2 Model Structure

4.2.1 Characteristics

The FINECON Model is defined through the use of basic economic and financial formulae and indicators, common among project evaluations and in the area of finance and business analysis. This model can be used at a conceptualization, implementation, or closure phase. This last one is when the product has already been launched on the market, or even when an individual has a business idea and does not know what to do with it, trying out multiple alternatives. The FINECON Model helps the entrepreneur to hypothetically experiment every scenario formulated and to compare and choose the best one.

The model was developed using "Visual Basic for Applications" (VBA), as it is add-on accessible and easy-to-use programming tool in Microsoft Office Excel, taking minimal time to adapt as well as to install. Also, in the business and financial area it is usual for experts to use this software and the add-on as they can manipulate a large volume of data, easily construct graphs, and generate visual interfaces according to what needs to be analyzed. Consequently, this software allows the development of an automated model, increasing efficiency and effectiveness and diminishing extra-processing. The model as a one scenario is described by Figure 8.

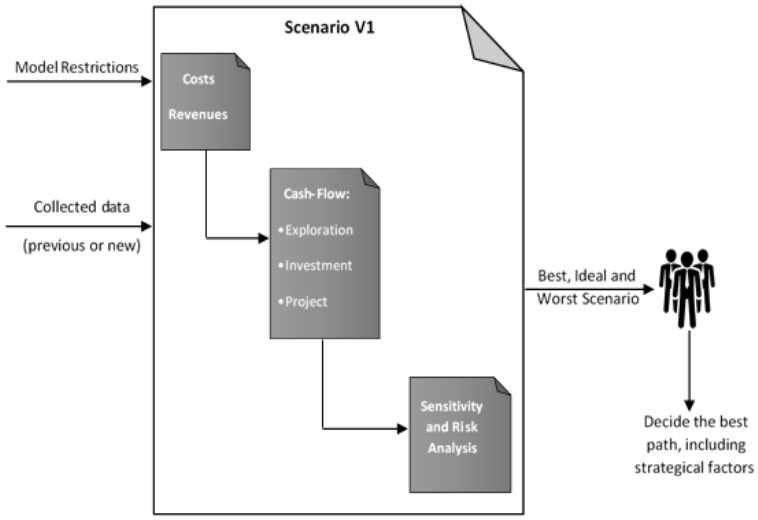

Figure 8 – FINECON Model usage in one scenario situation (own source)

When there is more than one scenario, the FINECON model follows the representation in Figure 9, where each scenario is analyzed in the same way.

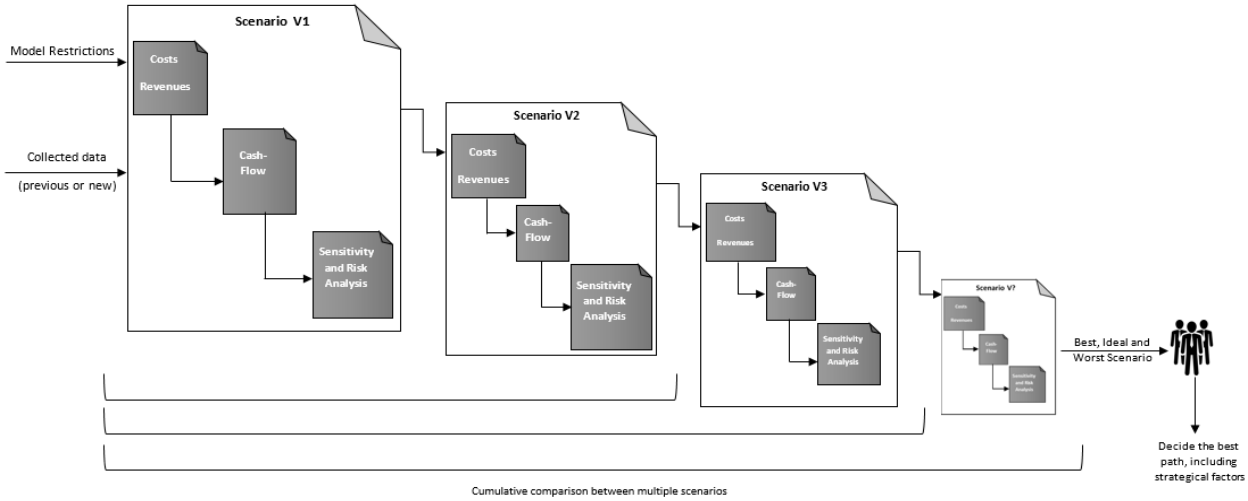

Figure 9 - FINECON Model usage in multiple scenario situation (own source)

4.2.2 Organization

Data can be collected, stored and analyzed, can support decisions, help the creation of business/strategic plans and transform a business idea and its team into an agile and flexible environment. So, the level of complexity and type of outcomes from the FINECON model fulfilment depends on the quality and quantity of input fields. Also, all the important data is stored in the last worksheet "DataBase", which is blocked.

This model is, initially, separated into eight sheets, which are described below, and presented in Appendix IV – FINECON Model

1. Main Menu

This worksheet contains the author and current version; a brief explanation of how to correctly use the FINECON Model, by clicking in the magnifying glass icon; and a button that starts the model usage and goes to the "Assumptions" page.

2. Assumptions

In this second worksheet, the user can edit every main and default assumption of the model.

The main assumptions include: the company and file creator name, and the possible consideration of perpetuity and graphic representation. The current date is not editable, in order to prevent misunderstandings when these evaluations are being assessed by coworkers, investors, or other stakeholders, so it is clear when it was prepared.

When clicking on the plus icon, the user can change default assumptions that have been preset for a usual scenario in a Portuguese company.

What distinguishes this model from the existing ones, is the final box of options, where the user can customize the model for various situations:

- Single analysis, from which he can create a single scenario or import an older file to check its results
- Different scenarios comparison, from which he can create new scenarios or import data from other files, and compare new, old, or both types
- Different completed files comparison, from which he just compares different files with various scenarios and filters what he wants to analyze.

After choosing all the different options in the model, the user clicks on the button "Proceed" at the end of this worksheet to go to the next page and start inputting data.

3. Costs

This worksheet allows the input of data related to all elements of cost, considering the portfolio of products and services. As there is no standard way for individuals and companies to list them, the model provides the possibility to choose specific cost listing types, between a simple list, variable and fixed, direct and indirect, or a normative format. All the introduced cost elements are eliminated when changing between different listing formats, as there are pre-defined categories and user-changeable ones.

On the left-side of the worksheet there is a fixed menu to support the user on every page. It provides several options, such as:

- Adding a new cost line, that can be selected from a previously defined category or a new one
- Calculating total costs
- Going to the previous or the next page.

Each cost worksheet presents unitary costs, total units, and total cost, independently of the cost-listing format. The user can add cost elements as new lines that may vary from period to period. If the user does not introduce the final value in the "total cost" column, the button "Calculate total costs", from the menu, automatically delivers the correct value for the selected line or active worksheet.

Also, in this worksheet the user can either directly input the wages and salaries of the required team members or determine, using a pop-up form, the individual salary cost for the enterprise and, then, the total cost for all the team.

4. Sales

After having total knowledge of each product and/or service sold, according to the quantities sold of each one and its unit growth rate, the model calculates the yearly sales volume. On the other hand, the user

may have no knowledge of how many units will be sold during the forecast period, so he adds a specific sales growth rate.

5. Financial Charges

At this phase, the user might want to know what will be the best investment to get in order to achieve certain KPIs. So, he can leave that field blank, and at the end ask for the ideal investment value.

On the other hand, when the user already knows the investment or funding he had or will have. In addition, the user can insert multiple investment or funding rounds. That being said, the user can detail all investment and funding rounds during the forecast period.

Finally, for every asset, either intangible or tangible, there is always a linked amortization or depreciation so the model calculates that value according to the number of years, calculation method, for example linear, sum of yearly digits or diminishing balance, amortization or depreciation rate, payment frequency, and initial monetary amount. If the user does not know the associated rates for each item of equipment, there is a "Help" button to support him complete the worksheet, according to the Portuguese National Bank.

6. Financial results

This is the most important worksheet as it stores all the financial results for the forecast period, and is totally dependent on the previous input worksheets. Also, the financial results can be presented as the user chooses: using an profit and loss statement; a balance sheet, or a cash-flow map. The fact that the model is totally customizable turns the evaluation process into a more efficient and adequate one.

On this worksheet it is possible to filter every element the user is willing to see or not, for example: a detailed version of every financial element or a general version of it, previously defined KPIs or new ones added, and an analysis from the entrepreneur's or the investor's perspective.

7. Sensitivity and Risk Analysis

The model allows the user to assess sensitivity and risk by analyzing the variance of some factors, like the headcount, production costs, sales, and others, in financial indicators, such as NPV, and IRR, which can be presented in the form of a tornado chart, in a deterministic form.

8. Graphical Analysis

Finally, and if the user has chosen to visualize graphs, this model provides a set of default graphs commonly applied in several project evaluations, almost like a dashboard. The graphs can be:

- Cash-flow per period of time
- Headcount variance
- Yearly costs per category

- Sales during the forecast period
- Yearly cost of goods sold
- Comparison between yearly costs per category and sales
- Comparison between sales, cost of production and gross margin
- Net Income during the forecast period
- Comparison between the initial budget and the total investment the project requires
- Variation of KPIs during the forecast period, like the return on assets, return on equity, working capital ratio, and so on
- Others customized by the user.

4.2.3 Evaluation in a loop

All the previously-explained worksheets provide an in-depth economic and financial analysis and results sufficient to evaluate a business idea or project in only one scenario. The most interesting feature of the FINECON Model is the possibility to evaluate multiple scenarios. If the user has multiple scenarios for the same products or services, varying their resources, costs, or other factors; or even if the user does not know whether to commercialize its technology as a product or a service, the model supports both decision-making moments.

After filling in all these ten worksheets for one scenario and, if the user did not choose the single analysis option in the worksheet "Assumptions", the model asks if the user wants to analyze a second scenario that can either be a totally new one or imported from another file (which should contain previous scenarios). The evaluation can be inserted in a loop as every time the user confirms he wants to add a new scenario the evaluation process occurs again. The new scenarios can be, either from totally new data, or from imported data of previous files.

On the other hand, the user can also compare different scenarios only from imported data from previously completed files.

Consequently, when there is more than one scenario, a new worksheet called "Comparison scenarios" is added and presents the main KPIs, as well as graphs of the different scenarios, to easily understand which one is more viable.

To sum up, the FINECON model includes all the necessary steps when evaluating a business idea or innovative project, delivering all possible outcomes and respective visual representations to ease the process.

5. CASE STUDY

This chapter is divided into five parts, presenting the case study framework, specifically the company and its R&D project; the research structure; the application of the developed evaluation model and its results, and consequently the business and financial plan.

This real case allows the researcher to understand the industry and to collect evidence related to the research question. This case study can bring knowledge to the current research and future studies, regarding project evaluation processes and tools, at the end of the chapter.

5.1 Company Presentation

5.1.1 Bosch Group

Bosch was founded by Robert Bosch in 1886, as a "Workshop for Precision Mechanics and Electrical Engineering", in Stuttgart, Germany. Their first product was the magneto ignition devices represented in the corner of their trademark.

Between 1901 and 1923, Bosch was able to define itself as a market leader in automotive technology. Until 1945, Bosch created new business units, such as household appliances, heating systems, and smart-cities innovations.

Nowadays, Bosch incorporates sustainability in their strategy, as well as the introduction of new technological concepts, connected mobility, and so on. Their business divisions are: mobility solutions, industrial technology, consumer goods, and energy and building technology. It is located in approximately 60 countries, 268 production sites and 130 engineering sites. Moreover, it retains several subsidiaries, like the Robert Bosch Venture Capital, which aims to support the development of internal ideas.

The mission statement is "We are Bosch", which represents their strategy to adapt in a complex, and unpredictable world, ensuring strong product development, and preserving financial independence. Bosch focuses on the customer by *inventing for life*. Additionally, their mission is "We Lead Bosch", as they focus on empowering their human capital, collaboration opportunities, business growth, and complex and innovative business models.

In the year 2018, Bosch reached 78.5 billion euros in sales, a headcount of around 410,000 employees, and established partnerships with a total of 68,700 R&D associations, spending around 7.3 billion euros on innovation.

5.1.2 Bosch Portugal and Car Multimedia (CM) Division

In Portugal, this division includes five locations. During 2018, these locations have been showing good financial results, such as, a sales volume of 1,7 billion euros, which was an increase of 13%; a 95% export rate; and a headcount of 5.503 individuals, 850 more than the previous year. Consequently, Bosch Portugal obtained an investment of 111 million euros to improve its innovation centers and expand its production site[10].

Bosch CM, in Braga, has been part of Bosch Mobility Solutions since 1990, providing consulting services, system design, and product build. This division is in charge of navigation systems, infotainment panels, and instrumentation systems. It has 9,200 associates worldwide and has generated 2.6 billion euros in sales this year. Their main goal is to "make mobility an enjoyable and safe experience" by providing great connectivity and intelligent solutions that interact with the passenger and pursue the edge of competitiveness and quality.

5.1.3 R&D department and the Innovation Process

Framed in the Bosch CM, this dissertation project is included in the Engineering Department (ENG), an R&D center that was created in 2002, and reached its stability in 2015. This department, with an up-front investment of 19 million euros, promotes the growth of innovative and disruptive ideas that are suitable for the market as a product or service, due to the mobility demand forecast by 2050. The department focuses on software and hardware development, project management, electrical and mechanical design, and innovative product development[11].

The Bosch Business Sector Mobility Solutions (BBM), is a business sector that contains a solid network of suppliers that can provide technical and commercial support, as well as strategies aimed at the main goals, customer, region, technology, functionalities and product. These strategies should filter the projects portfolio, and fulfil every compliance and KPI requirement. These benefits allow a business idea to receive initial support and strategic guidance from experts. The innovation process occurs by applying the Bosch Innovation Framework (BIF) that involves the customers and stakeholders requirements as well as their sufficient satisfaction levels. The BIF and other internal processes are constantly changing and not of

[10] Retrieved from https://ionline.sapo.pt/artigo/657668/portugal-bosch-aumenta-vendas-em-13-para-1-7-mil-milhoes-de-euros?seccao=Dinheiro. Accessed in 19th August 2019.

[11] Retrieved from https://www.dinheirovivo.pt/vodafone-business-conference/de-autorradios-para-a-conducao-autonoma-o-polo-de-inovacao-de-braga/. Accessed in 19th of August 2019.

common knowledge among employees, for example when professionals with the innovative business idea are not familiar with the process because it is not related to their daily work.

When submitting an idea, it is necessary to have a robust business plan, aligned with their strategies, policies, and compliance, have performance measurements, for example the cost progress, define all opportunities and consequent risks, and a clear perspective of the value created.

For the evaluation, decisions are taken using a Top-Down-Approach, where leaders estimate, evaluate the assumptions, measure operational results, and assess the idea's financial target and market size. Additionally, the current forecast should be translated into turnover, other variable costs measurements, and their cost target. This evaluation process may be in the same location as where the idea was created, to centralize functions and reduce headcount costs. When evaluating the product and associated technology, that breaks down the design and requirements, and validates and verifies the whole system, either related to SW, HW, a system, or mechanical engineering.

Finally, the complexity of assessments in order to get the idea or new business validated internally is challenging, and results from the financial planning, risk action plans, price analysis, commercial coordination, and business process. To sum up, this process is demanding for an inexperienced entrepreneur with no support.

5.2 Case Study Overall

5.2.1 Problems and Motivation

The dissertation began with an idea that was at an initial maturity stage, prior to any business planning or economic and financial evaluation. Since there was no data collected and processed from a business and financial perspective, the team could not consider the best scenario and its respective costs. The founding team consisted of academic software and hardware developers, so there was not anyone sufficiently skilled in business development and finance that could formulate different business scenarios for the project, form the business plan, and forecast it financially. Indeed, the project had an innovative idea and mature prototype, but the team did not know what the next step should be.

Consequently, there was no solid financial data to get investment or, even, to strategically launch the product to the market.

From the beginning of the research it was possible to understand that there were standardized internal processes, methodologies, guidelines and tools to entirely mature the idea, build a VP and a BM, evaluate its viability, and eventually create a new venture or BU. These standards were only adequate for experts

in the area, which made it difficult for software and hardware engineers or innovation leaders to analyze the project and take reliable decisions regarding its future course. That being said, it was necessary to economically and financially analyze the project and then propose an optimal scenario that would be validated by the team leader.

5.2.2 Goals

The main goal is to support a year of product and business development, financial forecasting, and future steps planning. The core tasks were: the assessment of the current maturity of the project, gathering as much information as possible about the used technology and business, proposal of various scenarios, economic and financial evaluation or viability evaluation, and, finally, determination of the best decisions for the project at this stage.

5.2.3 Structure

Initially, it was necessary to understand the whole project and collect the maximum data through previous technical documentation; networking with the team and respective leader; and meetings with the first key customer and partner. The first outcome was a business plan, developed with a team colleague. Afterwards, all the financial elements were detailed, the viability was assessed by applying the developed model from Chapter 4, and a financial plan was formulated to support the next steps of the project.
This process took a long time as the project, before this dissertation work began, was developed not considering all required and adequate infrastructure, headcount, future technology, and its costs in order to be viable. Consequently, the model results were progressively improved and updated, as well as its inputs.

5.3 Business Plan

This information, included in this early-stage business plan, serves as main assumptions for the following financial plan, incorporating the project evaluation and the best scenario for its viability. However, the following data will act as a learning plan with several hypotheses and assumptions due to the uncertainty, volatility, and imperfection of new business ideas. As a note, this part was drawn up in cooperation with a work colleague responsible for the part of the elaboration of the VP and the BM.

5.3.1 Business Opportunity

Until 2050, the population will increase to 9.8 billion people, and noise and air pollution will exponentially increase, as well as urban congestion. That being said, the world demands more sustainable and efficient

mobility services, and using public transportation can be a solution. In the mobility sector, specifically in urban transportation using buses, there is a lack of real-time data analysis, and information availability, for example real-time schedules badly calculated and not easy accessible. This leads to problems of long waiting times at bus stops, commuter complaints, and inefficient transportation systems.

Nowadays, the solutions to monitor bus fleets are expensive, not standardized, and do not have a high level of reliability regarding time estimates. Also, they are not adequate for what the company is looking for. On the other hand, technological solutions are being implemented through partnerships with city councils, which can block any entrance of a new venture onto the market.

According to a market researcher "Markets and Markets" (2019), fleet management systems sales are expected to grow globally from 14.3 billion euros in 2018 to 28.4 euros in 2023, and have a compound annual growth rate of 14,7%.

5.3.2 Product

The project for this dissertation work, called **MobiBUS**, was developed through a collaboration between the Bosch ENG department, and the university. The team was initially constituted by one senior product owner and team leader, who is a Bosch professional and a lecturer in this university, and five students that were in charge of hardware (HW) and software (SW) development and implementation. Consequently, the IP is legally owned by the team leader at the moment, but there is still no agreement by both parties. Its mission is to solve the need to make public transportation services more appealing and diminish traffic congestion. Their vision is to be a leading startup in delivering fleet management solutions, creating a positive impact on all the factors that affect commuter satisfaction, such as comfort, schedule estimates and forecasts, and security. The main values of the team are transparency, quality, comfort, innovation, and reliability.

The solution, developed on cloud-based microservices architecture, integrates HW components, such as mini computers working as sensors that gather raw data in every bus, and SW technology that receives and analyzes that raw data, and displays information in real-time. The solution incorporates two components for the end-user: a **Decision Support Systems (SAE)** and a **Mobile app**, in Figure 10.

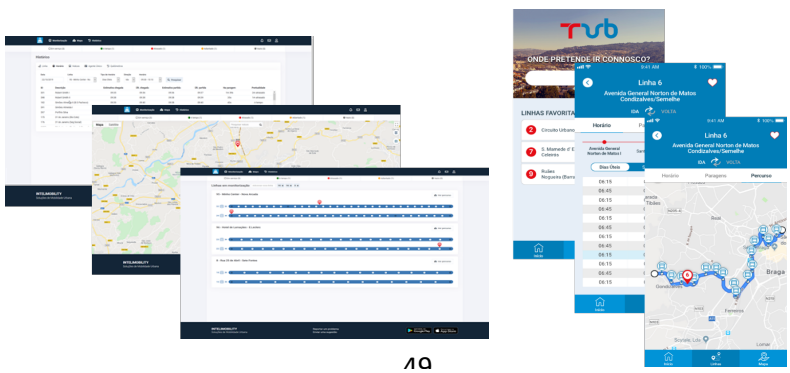

Figure 10 - SAE Front-end and the Mobile app

The SAE contains the following features: real time bus geolocation, fleet monitoring by dashboards, and alerts and complaints management. The mobile app is used to: display the bus geolocation in real time, the arrival time estimate and forecasting, bus schedules for every bus stop, and trip planning.

The proposed solution provides treated data to bus companies, city councils, and passengers, applying concepts of Big Data and IoT. The solution gained continuous feedback from the first potential partner, the Braga Urban Transport Company (TUB) which is regularly seeking innovative strategies and solutions to deliver efficient bus services to regular commuters or tourists. Therefore, this partnership promoted a collaborative environment for a gradual product development and testing process, as well as a promotion among other clients and stakeholders. Their suggestions allowed the team to be more focused, as they knew beforehand what the market and the industry was expecting.

During the tests, the team found that, when comparing their equipment with the current SAE implemented in TUB, their schedule estimates and forecast had an error of 1.5 minutes and 0.1 minutes, respectively.

5.3.3 Market analysis

According to a study, 39% of European individuals take 45 minutes to complete one trip daily, and in Portugal 22 minutes. Also, out of 34% of the citizens use public transportation rather than their own, and 44% arrive late to work [12].

The target market is urban, inter-city and international road passenger transportation companies, which totals 680 companies in Portugal by 2016, and in Europe 300.000 companies by 2017. It was discovered that 27,3 million citizens on average are transported by this type of urban transportation service, and 18.833.156 trips were made in Portugal in 2017 [13].

According to the Portuguese National Bank, road passenger transportation services represented 1.4 billion euros in sales in 2017, which was a 10,6% growth compared to the previous year. These financial results continue to improve and represent the appearance of future market opportunities in this sector [14].

From a European perspective, Spain, France and Switzerland are the best-ranked countries and markets in the urban transportation sector [15].

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[12] Retrieved from https://www.tomtom.com/en_gb/traffic-index/ranking. Accessed on 10th July of 2019.

[13] Retrieved from https://www.pordata.pt/Subtema/Portugal/Rodovi%c3%a1rio-405. Accessed on 29th October of 2019.

[14] Retrieved from https://www.bportugal.pt/comunicado/nota-de-informacao-estatistica-analise-das-empresas-do-setor-dos-transportes-2017. Accessed on 29th October 2019.

[15] Retrieved from https://www.michaelpage.pt/not%C3%ADcias-estudos/estudos/transport-and-commute. Accessed on 29th October of 2019.

Every urban transportation company should have a fleet management system in order to, in real time, monitor every fleet vehicle's location and schedule fulfilment, as well as solve any urgent problem or complaint. In Europe, the regional growth rate is expected to be medium. This market is highly fragmented, there are no dominant players but it is highly competitive, which means that it can be easy to enter but difficult to stand out from competitors.[16]

The identified main worldwide players in this sector are Cisco Systems Inc., AT&T Inc., and IBM Corporation. The main operators in Portugal and Spain are GMV, Indra, TecMic, and Moovit. The providers are following trends like the delivery of cloud-based solutions, using big data, data mining, IoT, and machine learning, and the selling of these solutions as services, just like MobiBUS.[17]

From the perspective of market size and share MobiBUS will gain, in a 10-year forecast projection, 5,7% of the Iberian market, which totals 50.445 buses, and represents a B2B market as their solution is to be sold to bus companies. As a result, they need this type of solution to maintain their service quality level and keep urban transportation interesting for citizens. On the other hand, the mobile app is available for free download for commuters, so the B2C strategy is not considered. Finally, the expected market growth is represented in Figure 11.

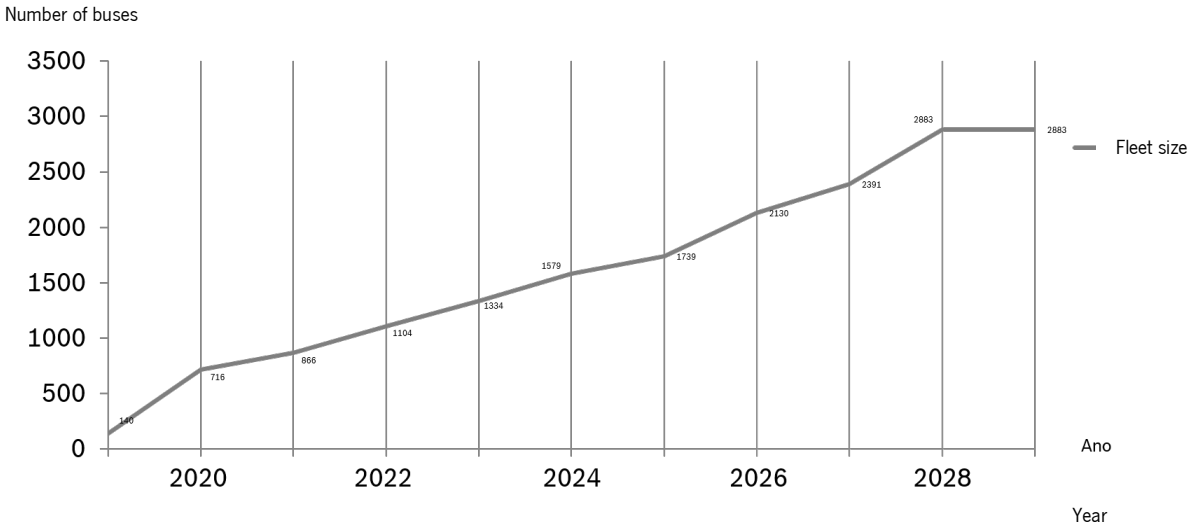

Figure 11 – Market growth forecasting

To sum up, MobiBUS initially establishes its market position at a medium quality, high innovation level, and low price point.

5.3.4 Strategic analysis

[16] Retrieved from https://www.mordorintelligence.com/industry-reports/global-fleet-management-software-market-industry. Accessed on 29th October of 2019.

[17] Retrieved from https://www.marketsandmarkets.com/Market-Reports/fleet-management-systems-market-1020.html. Accessed on 29th October of 2019.

In order to get investment and succeed, Figure 12 represents a MobiBUS' business analysis.

Strengths	Weaknesses
- Reliability of data (real time bus geolocations, arrival time estimate and forecasting) - Product development directly with client - Customization - Solution that is constantly evolving - Price-friendly solution - Mobility network contacts - Up-to-date technological resources	- Unexperienced developers - Current team with low motivation - Market already offers a lot of variety - Weak network in the industry - Application of a trial-error architecture, as they do not have total knowledge of its maximum capacity - Depending on the fleet size, it can take a long time to implement the whole solution and give explanations to the fleet operational managers
Opportunities	**Threats**
- The market is exponentially growing and is still under-exploited - Sustainability awareness that demands more urban and more efficient transportation services - Competitors are delivering inadequate solutions for the bus companies, for example with needless features, without prior explanations, and in different languages than the ones used - No solution aggregates several functionalities as MobiBUS plans to have	- Highly competitive market - Technology not yet patentable - Technology applied to a lot of companies (cloud applications) - Lack of investment due to insufficient business traction - Solution life cycle of 8-10 years and HW life cycle of 5 years, according to other companies on the market - Various and separate fleet management' functionality offerings - Submissions bound to public tenders with a specific list of requirements - Budget limitations for the bus companies

Figure 12 –SWOT Analysis

5.3.5 Marketing and sales plan

Adopting the 5 P's strategy of marketing, MobiBUS intends to maximize their sales by the following actions related to:

- **Product**, where MobiBUS should publicize their schedule estimates forecast minimal errors, integrate GTFS into the technology, and personalize the solution for each customer, as there is a MVP and the team wants to sell additional features' packages.
- **Price**, as other competitors can easily acquire the HW, it is important that the solution price is sufficiently attractive and accessible in an initial phase.

As a first approach, the known market price was around 890.000€ for a single payment for eight years. This value was provided and proposed by a competitor of TUB with a fleet of 150. So, that value corresponds to 741,67€/year/bus or 61,81€/month/bus or 2,81€/day/bus (considering 22 working days in a month). Considering what the market is offering, it was found that this type of solution can be paid as a subscription service per bus, starting from around 35€ to 250€ per year or 13€ to 70€ per month, depending on the fleet' size.

As the team has total knowledge of these type of suppliers, it is easy to obtain each HW component for a lower cost of 104,66€, on average, according to the BOM in Appendix V – Bill-of-Materials (BOM) of the HW and all costs defined in Appendix VI – Detailed Product' Costs. The adopted pricing strategy, from a short-term perspective, is fixed according to the product features, and the fleet size of the client, as well as being negotiable depending on the country the solution is being sold to. Finally, the retail price, according to all costs during the first operational year, should ideally be **114,84€/bus/month**, represented in Table 4 – MobiBUS' calculated retail price and considering a fleet of 150 buses.

Table 4 – MobiBUS' calculated retail price

Direct Costs (lasting 5 years)		15.699 €
Yearly Indirect Costs		169.122,41€
Yearly cost per unit		**1.148,41€/bus**
Contribution Margin (20%)		**229,68€**
Price as a Service	**Yearly**[18]	**1.378,09€/bus**
	Monthly	**114,84€/bus**
	Daily[19]	**5,22€/bus**
Price as an one-time payment (for a five-years contract)		**6.890,45€/bus**

[18] It is assumed that this solution has a maximum lifetime of 8 years in total.
[19] There are considered to be 22 business days per month.

This calculated retail price is around two times higher than the known market price. As a result, the team must lower the retail price in order to gain and retain customers, creating a strong brand in the market and industry, as well as reaching financial stability. This strategy to lower prices must be tested while analyzing the financial projections, as well as considering what the crucial operational costs are that should be maintained.

On the other hand, selling as a service is a very attractive option for customers, as they do not have to make a great investment beforehand and commit to a product for a longer period than necessary, as technology can rapidly become obsolete.

Finally,

- **Place:** as the user-interface usage of the product can vary between clients, the ability to perform demos and let them test and try out the system is what can retain them as customers. The MobiBUS team prefers to sell in face-to-face appointments, mobility conferences, exhibitions, trade shows, and other relevant events, so that the solution's functionalities may be visualized and tested. However, online presence is crucial these days, and it is also possible to order via the website. Thereafter, as the solution includes HW and SW components, the client must be aware of all material and team transportation costs involved, even when the transaction is made between different countries and continents. Otherwise, the customer should outsource a technical team to install all the HW and SW equipment. The main offer that MobiBUS provides is the supply of a complementary mobile app, using the same data as the SAE, which can be implemented in their daily urban transportation services.
- **Promotion:** similarly to the direct sales method, the promotion should be applied to the same type of events. Without commercial representation, MobiBUS can be promoted by advertisements on bus companies' websites, and on MUPIS. As an online presence, it can be intensely promoted with ads in related mobile apps on Google Play and App Store, or through social media platforms like Facebook and Instagram. The team can monitor their reach by the number of visits on the website, and the number of mobile app downloads and feedback
- **People:** the sales representatives will be in charge of applying these marketing strategies and should contact customers and stakeholders with confidence and reliance on the project.

Regarding the raw material, as it is only ordered at a client's requests, there is no need to have a warehouse or retailers.

5.3.6 Action Plan

At this phase, MobiBUS is negotiating an IP agreement and intends to create a startup by the end of this year. As the team had already participated in trade shows, it was possible to start to grow the sector's network and get interested investors, as well as other potential clients.

For the next 10 years, MobiBUS intends to focus only on bus transportation services in the Iberian region. However, the team is totally aware that their solution is suitable for other locations and types of mobility services, like trains, metropolitan transport, and shuttles.

Regarding the MVP features, the team brainstormed and came up with several innovative ideas for other future functionalities the market is already discussing and progressively demanding.

5.3.7 Strategic alliances

The most interesting alliances MobiBUS can develop are with city councils, and the companies that manufacture bus bodywork or internal equipment like ticketing systems.

On one hand, the bus companies can either be private or public, but city councils have to manage the transportation services in their respective cities and have direct contact with them. That being said, it would be easier to persuade them to arrange meetings and test demos. On the other hand, collaborating with the bus producers would imply either selling a system for the whole fleet or just for a couple of buses. Also, sales could be more limited as it would incorporate the partner's interests.

5.4 Financial Plan

A financial plan is a statement of a business idea, project, or firm's long-term objectives of financial stability and viability for either 5 or 10 years, presenting all financial details as inputs or outputs that can help in decision-making circumstances. With an early-stage business idea, a financial plan helps outline and keep within a budget, be aware of the capital already invested, plan an emergency fund, and strategically outline the business.

5.4.1 Assumptions

The team came across several scenarios and decisions at hand that were chosen regarding:

- Producing or buying the technology required for the solution
- Own assembly or outsource technicians
- Whether to outsource the team or not
- Deciding if the business is capable to grow its client portfolio during the forecast

- If a partnership with a HW supplier would be viable
- Only deliver a SW solution with the HW requirement.

Regarding the market risk, the main assumptions for a 10-year forecast period are presented in Appendix VII – Main Assumptions. Also, the business model could be: renting the HW and SW, selling both HW and SW, or, finally, renting the SW and selling the HW, adopting software as a service model.

Finally, the considered price in the financial projections was for the HW the value of 125,59€/bus and a SW fee of 40€/month/bus, as the price is still between the usual retail price of these softwares.

From the costs perspective, the team defined the yearly cost elements as the ones in Appendix VIII – Yearly Costs, and represented in Figure 13 – Yearly Costs on a 10-year forecast.

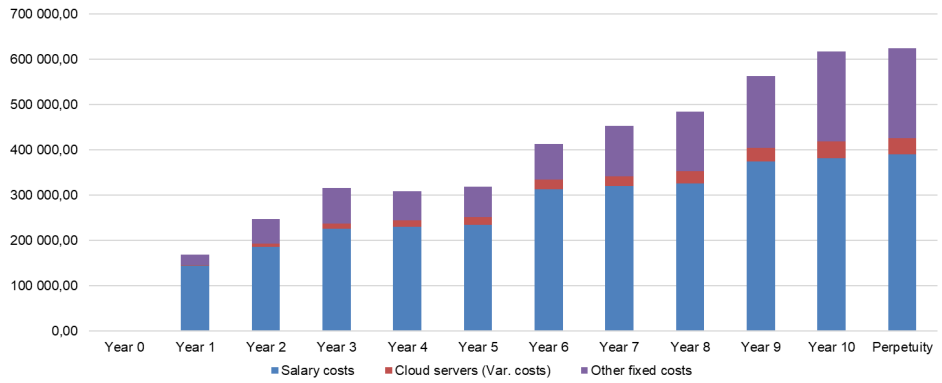

Figure 13 – Yearly Costs on a 10-year forecast

5.4.2 Sales Forecast

From Figure 14 - Sales Forecast, the growth of sales appears to be regularly evolving.

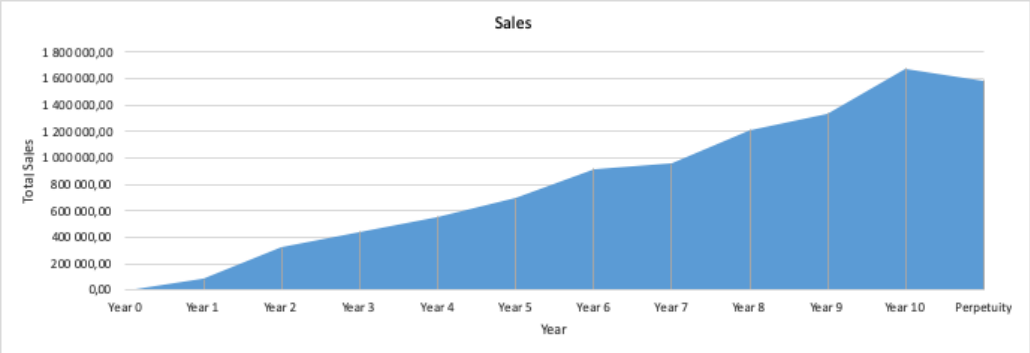

Figure 14 - Sales Forecast

5.4.3 Personnel Plan

The projected personnel for the forecast of 10 years is represented in Figure 15 – Headcount for a 10 year forecast period. As the clients portfolio is increasing, it is adequate that the capacity of the business

increases too, specifically in maintenance representatives as they are required for all the installations on the buses.

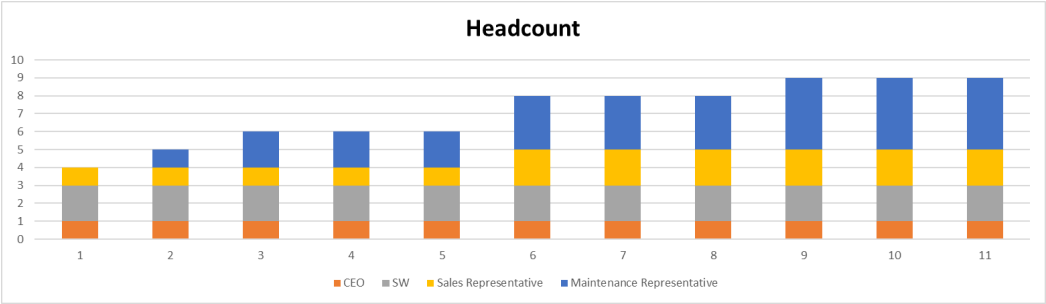

Figure 15 – Headcount for a 10 year forecast period

5.4.4 Cash flow statement

The next figure demonstrates the variability of FCF through the forecasting period, which demonstrates how slowly a business grows in a software as a service business model.

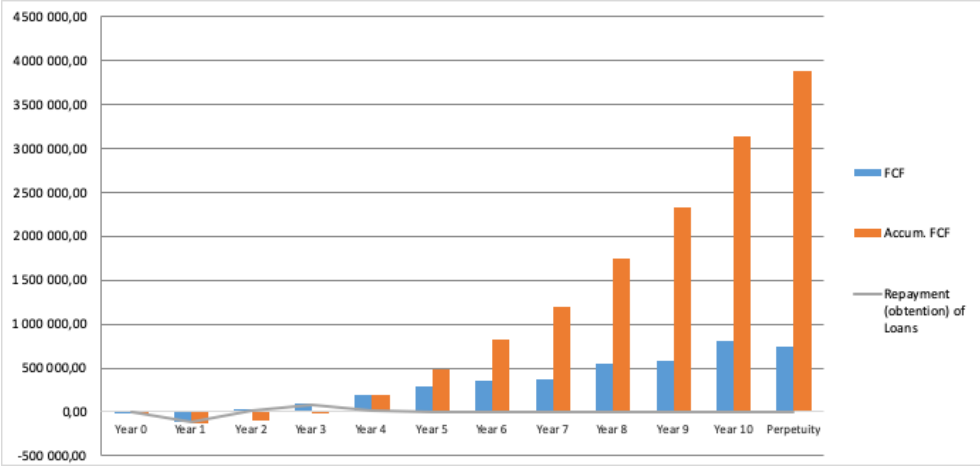

Figure 16 – CF statement

5.4.5 Financial indicators

For the worst scenario, with a retail price of 20€/month/bus for the software, the final financial indicators are the followings: a NPV of 2.142.016,30€, and an IRR of 17,82%, from the investment perspective. From the investor's perspective, the NPV is 1.988.015,21€ and the IRR of 15,83%, with a payback of 7,7 years. The break-even was determined to be 7,7 years, the expected value for a company selling its products as a service, requiring long-term investment, as well as the persistence to maintain a good business infrastructure and motivated team, as the business takes more time to return the initial investment.

For the more optimistic scenario, shown in the figures, the payback was of 3 years, with an IRR of 84,16%, and a NPV of 9.120.484,51€. It turns out to be a very profitable business if the right customers are

gained and retained at the correct time. This is crucial in this project due to the fact that companies usually change their software solution in an average of 10 years from the implementation date.

5.4.6 Risk and sensitivity analysis

After analyzing MobiBUS from a risk and sensitivity perspective, it is possible to determine the factors that mainly impact the NPV value. As it decreases, the SW fee and the number of buses also diminish, contrary to the market risk, specifically the cost of capital, and the equity' percentage that increases.

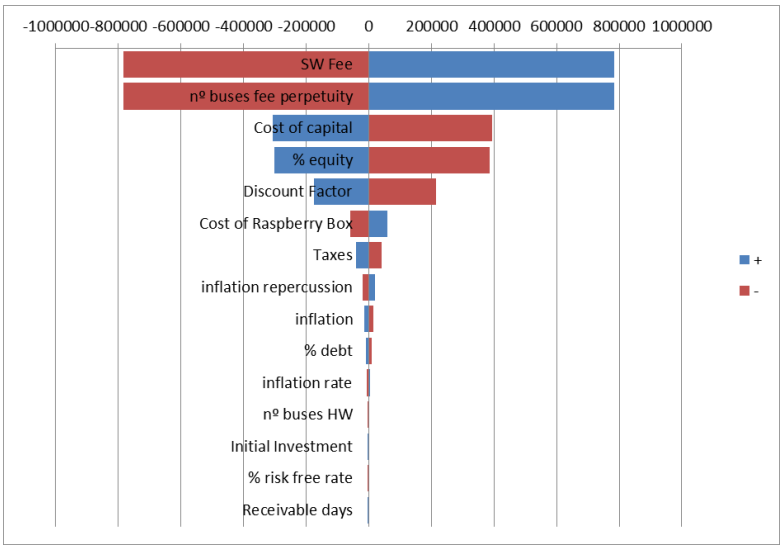

Figure 17 – Tornado chart representation for sensitivity analysis

It can be concluded that the SW fee and the number of buses are the factors that affect the most the chosen financial indicator, in other words, more revenues mean more NPV. Secondly, the cost of capital refers to the rate used to discount cash-flows in NPV calculations, which means that lower the WACC, and also the discount factor, higher the NPV. Aditionally, the discount rate relates to beta, which is the market risk indicator and the risk-free rate, which will lower NPV as it increases. Thirdly, the equity percentage is usually higher than the debt one, usually on a ratio of 85%-15%. If there is more equity, then the WACC can be lowered, as well as if the debt is increased. Although equity and debt are inversely proportional. Fourth, the cost of the raw materials increase will also increase the NPV as it means that the price can get more attractive.

5.5 Conclusions

To sum up, the team needed to decide if they should create a startup, an internal project, or withdraw and give up. In conclusion, as the trend of this business sector is selling the solutions as services, the team decided to go forward with creating a new venture and look for the support of investors or mentors from a financial or strategic perspective.

6. ANALYSIS AND DISCUSSION OF FINDINGS AND RESULTS

This chapter describes and explains the main findings and their importance for the research study, and respective literature review, the R&D project in hand, and the enterprise. Also, the obtained results are analyzed critically along with their relation to the goals and RQ. Finally, this chapter examines the strengths, weaknesses and limitations of the conducted study.

6.1 Model validation

The FINECON model had a totally customizable interface, adequate for any user, which is interesting due to the fact that mostly innovative software development teams do not have business or financial analysts. This model supports their decisions through the development of their business idea and can provide clear results of how the forecast might be when choosing a certain path.

Second, the fact that the model was automatic diminished the difficulties in having to input in the cells the correct formulae, or even customize whenever a forecast period needed to be changed. As it is said, time is money and a tool that can turn decision-making moments on easier ones, is highly requested.

Thirdy, the software had some limitations in terms of inputting data, as it is Microsoft Excel it can become too slow and inadequate with high volumes of data. Although, this software was chosen as it is the easiest to have on any individuals laptop, and it is the one most frequently used for investment appraisal drafts.

6.2 Case study validation

The developed model was validated by its application to the case study, and thereby it was possible to understand all the necessary perspectives when evaluating a R&D project. Although the model only included economic and financial data, it is always necessary to have a strategic pre-evaluation, and assess the financial outcomes with that in mind. According to all the variables, the model showed that besides that, a financial evaluation has a strong weight in this type of decisions, and is strongly required.

In Braga, there is no active "gate" that handles all the process from the conception of the idea, to the financial evaluation of the project. All those processes are centralized in Germany which makes it more difficult for a project to be accepted, even if it is interesting but not on the company's viewpoint. That being said, this project has a small dimension compared to the ones being held there, and in those cases it might not fit the enterprises' mission and vision.

However, it was found that it is important to be constantly evaluating a project not only on a strategic perspective but also on a financial one. In this case, the team started to lose focus, as they did not know what the future would bring them, and if the technology was the most adequate in a case where the business scaled. Additionally, the team was demotivated and started to think of quitting. These financial results supported their effort and kept them from giving up on the project.

Finally, the project was evaluated as profitable in the vision of the entrepreneur and some investors.

6.3 Answers to the RQ

As the RQ was formulated, it was possible to understand that the most useful tool for a business and financial analyst is still a simple but automatic excel file that allows the team to assess the investment. As the model can gather an enormous amount of criteria and variables, and types of assessments, the developed model would suit as a tool to help teams avoid unsuccessful investments. Although, it was included a strategical phase prior and after the evaluation was done, it could be interesting if there could be some strategical criteria on a tangible format that could be included in the model.

7. CONCLUSIONS

This chapter summarizes not too broadly what was done, key results and conclusions from the case study application as well as the own development of the FINECON Model. It also states the main arguments to answer the RQ and how the goals were met, the problems encountered during the research period, as well as opportunities and recommendations for future research in the area.

7.1 Main Contributions

The organization of this dissertation project, which was simultaneously coordinated and developed with a colleague on the same master degree course, followed the four validations methodology suggested by Afonso and Fernandes (2018). As a result, during the dissertation project some tasks, which were apart from the main focus of the project but supportive to its development, were performed such as the first three steps of the company project:

- Formulation, validation and refinement of the value proposition (VP), elaborating the respective canvas and using direct observation and non-structured interviews to gather better and more data about our target market and clients
- Market analysis and research, and the study of the competition and industry
- Development and validation of the Business model (BM), elaborating the respective canvas that will support the next phase
- Economic and financial analysis, which was the focus of this dissertation project.

These tasks underlined the importance of a good-value proposition and business model prior to any economic analysis, in order to get closer to the predicted scenario.

During the application of the case study, it was necessary to prepare a bill-of-materials of the product so engineers could deliver it to the production site to get prices, delivery time and materials availability.

Afterwards, the VP and the BM required team brainstorming activities, meetings with the team and the client to gather and create new features and generate ideas. Direct observation and non-structured interviews to refine the product and respective value proposition also played a part.

There came a time where it was necessary to start presenting the results of the project internally and externally, specifically for investors, Bosch leaders related to this area, and to potential clients. So, this dissertation work also included the creative elaboration of pitch presentations that could briefly present the project and its competitive advantages to attract investors.

Finally, the team participated in the SMART CITIES SUMMIT 'FIL 2019, in Lisbon, where it was possible to directly contact potential clients, enlarge and strengthen the mobility network, and test the market/industry to check interesting partnerships for MobiBUS.

As the software development team was deeply involved in maturing the MVP, it was necessary to motivate and coach them towards what was best for the project and what made them feel more useful, as well as supporting the integration of a new team member.

The organization itself got more clarity regarding the difficulties an entrepreneur can encounter when developing their business idea and getting support, as the regulations are extremely strict and take time to implement. The project has a potential investor that is willing to inject capital, and the team is handling the legal procedures such as the shareholders' agreement and the consequent venture creation.

7.2 Future Work

For future work, the research can pursue other similar projects, perhaps in the same industry to gain more information on the variety of factors affecting the development of a business idea. The researcher can define which economic evaluation models the projects or entrepreneurs use, their difficulties and test several others. Additionally, using the delphi method it would be possible to validate all the considered investment decisions. Also, on consulting companies and other R&D institutions, this type of model is useful to ease the task of evaluating a business idea, project or new venture and make it more efficient.

The FINECON model can be applied to several case studies and compare results between other models in order to verify its reliability and error percentage, and an indicator out of it. In order to include the strategical perspective, it would be interesting to add weighted criteria previous to the economic evaluation phase.

The business world is uncertain, and there is no possible way to standardize the process of evaluating and developing a business idea, as well as the decision-making moments that can vary with many factors like, the industry, team, investors, product and the economy itself.

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APPENDIX I – DATA COLLECTION TECHNIQUES FOR EVALUATION PROCEEDINGS

I. Data Collected Directly From Individuals Identified as Sources of Information

A. Self-Reports: (from participants and control group members)

1. Diaries or Anecdotal Accounts
2. Checklists or Inventories
3. Rating Scales
4. Semantic Differentials
5. Questionnaires
6. Interviews
7. Written Responses to Requests for Information (for example, letters)
8. Sociometric Devices
9. Projective Techniques

B. Products from participants:

1. Tests
    a. Supplied answer (essay, completion, short response, and problem-solving)
    b. Selected answer (multiple-choice, true-false, matching, and ranking)
2. Samples of Work

II. Data Collected by an Independent Observer

A. Written Accounts

B. Observation Forms:

1. Observation Schedules
2. Rating Scales
3. Checklists and Inventories

III. Data Collected by a Mechanical Device

A. Audiotape

B. Videotape

C. Time-Lapse Photographs

D. Other Devices:

1. Graphic Recordings of Performance Skills
2. Computer Collation of Student Responses

IV. Data Collected by Use of Unobtrusive Measures

V. Data Collected from Existing Information Resources

A. Review of Public Documents (proposals, reports, course outlines, etc.)

B. Review of Institutional or Group Files (files of student records, fiscal resources, minutes of meetings)

C. Review of Personal Files (correspondence files of individuals reviewed by permission)

D. Review of Existing Databases (statewide testing program results)

Figure 18 – Data Collection Techniques (Stevens, Lawrenz, & Sharp, 1993)

APPENDIX II – TYPE OF DECISIONS TO CONSIDER IN AN ECONOMIC AND FINANCIAL EVALUATION, REGARDING FOUR CATEGORIES: TECHNOLOGY, BUSINESS, RESOURCES, AND FINANCE

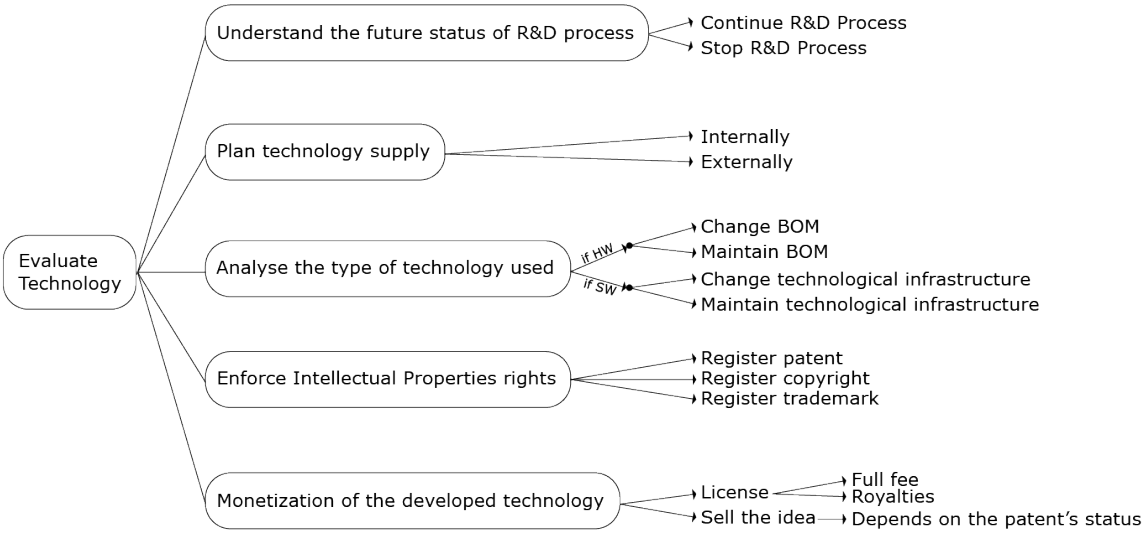

Figure 19 – Alternatives for Technology evaluation (own source)

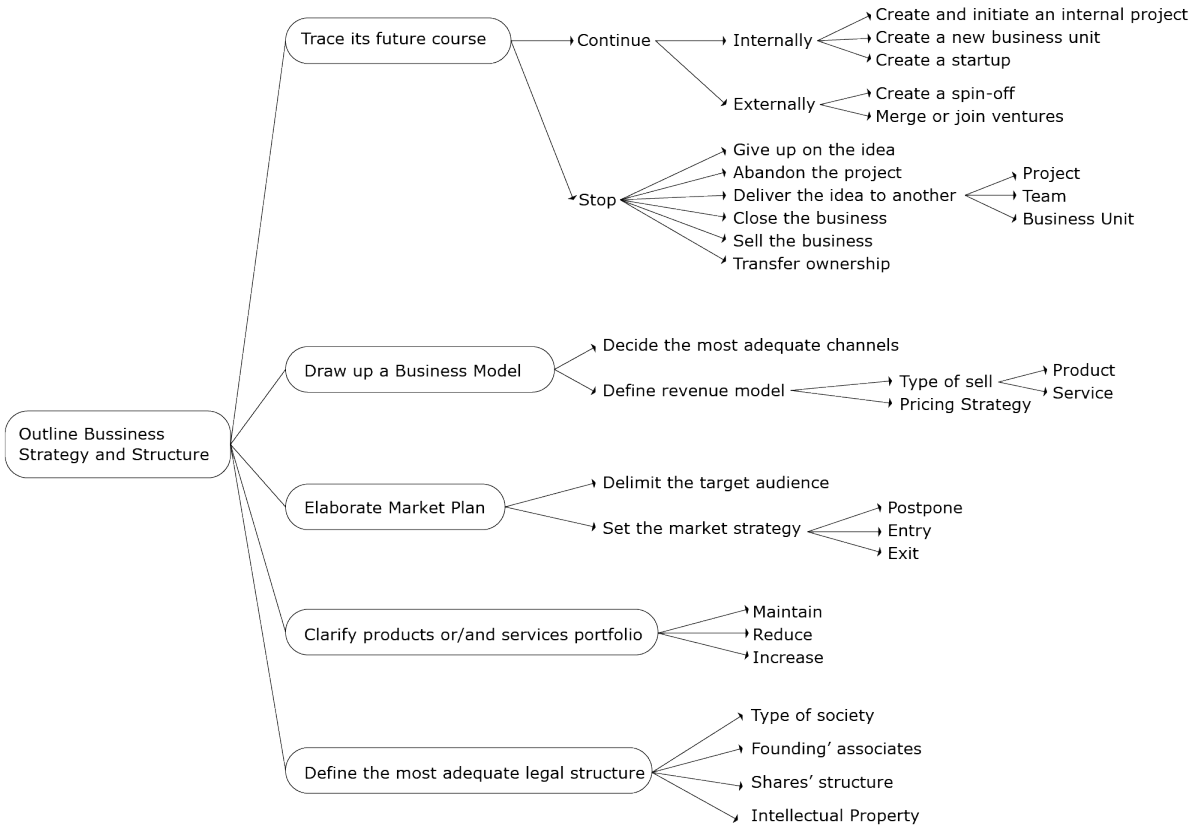

Figure 20 - Alternatives for Business strategy and structure (own source)

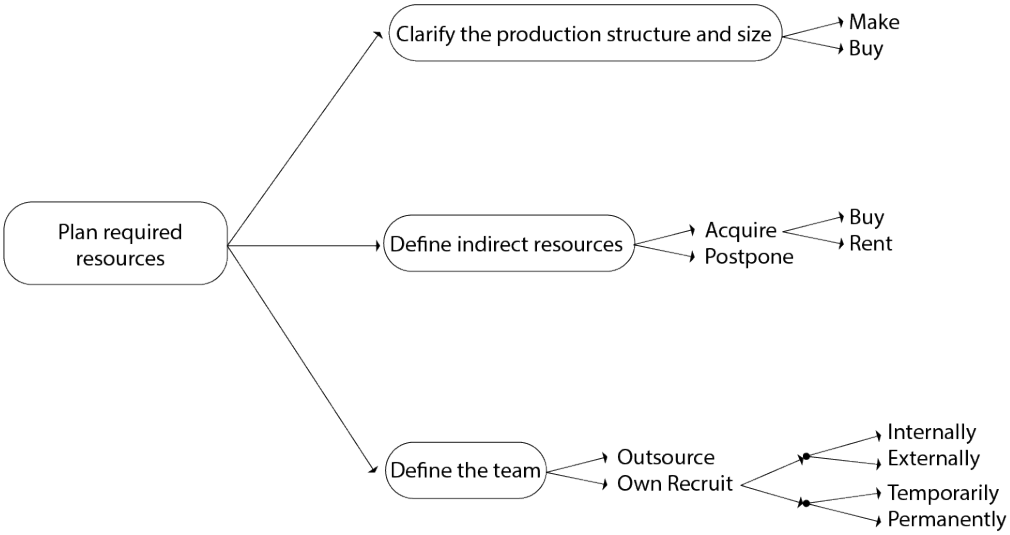

Figure 21 - Alternatives for Resources planning (own source)

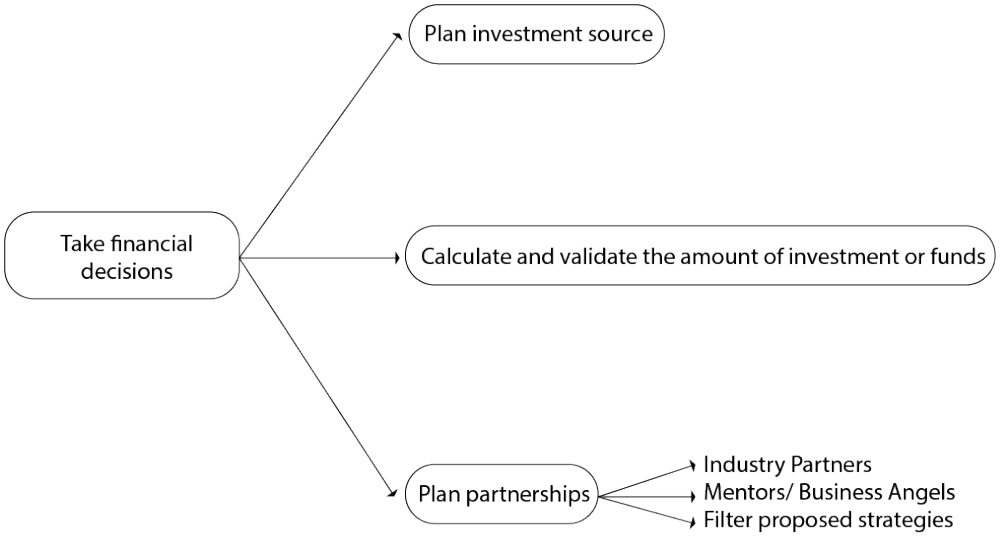

Figure 22 – Alternatives for financial decisions (own source)

APPENDIX III – KEYWORD CLUSTERING METHOD

In this dissertation' project, the clustering method supported good planning and was a tool for the search engine optimization (SEO) strategy, while researching through literature databases. As ideas started to come up from the only statement of guidance for the research, in other words the main goal, it was possible to define the study' boundaries and the keywords for the project (Saunders et al., 2009). At the first stage, the concepts and terms were withdrawn from the word group of the main dissertation' goal, and a keyword collection was created, represented in Figure 23.

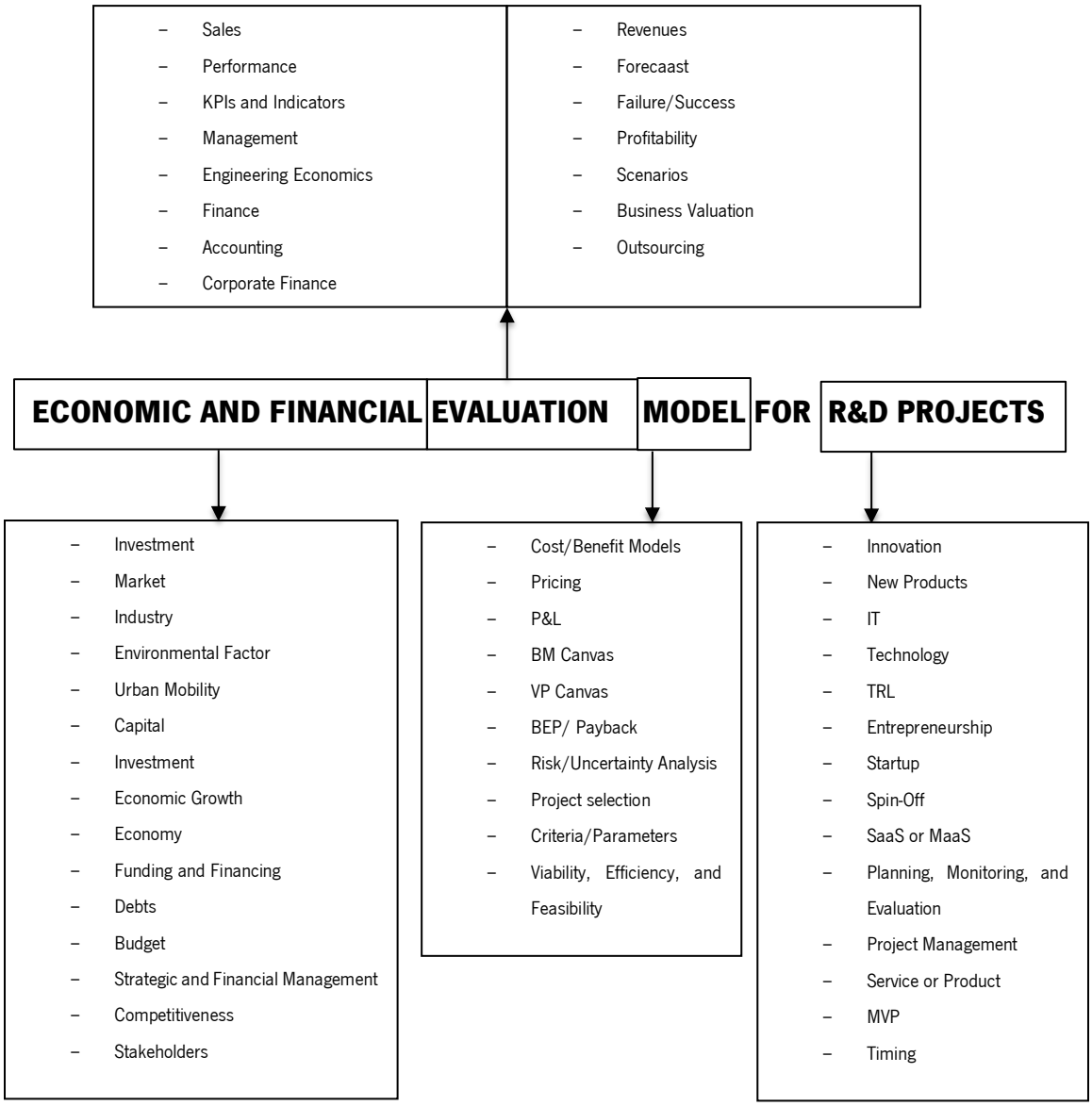

Figure 23 – First phase using Brainstorming Technique

In the second phase, a list of the most important words organized into categories was selected, represented in Figure 24.

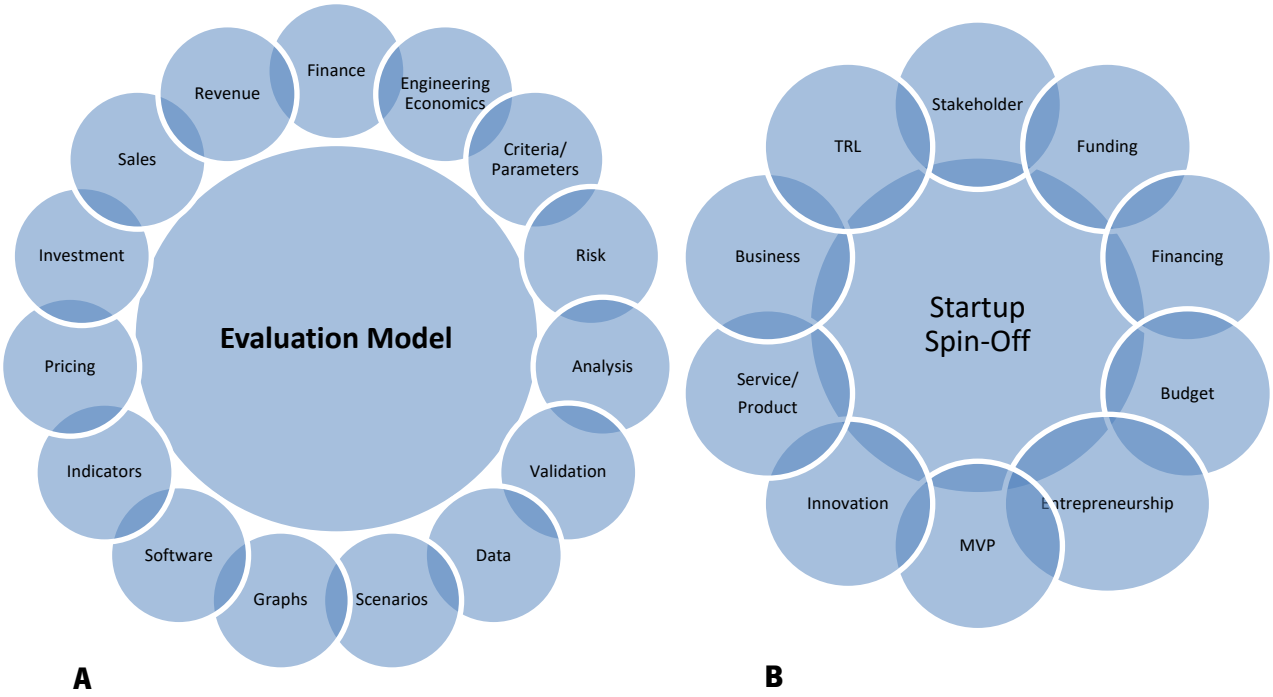

Figure 24 – Categorized Keywords into (A) and (B)

In the third phase, it was found that the most adequate keywords for this dissertation project would be *R&D Projects, Entrepreneurship, Innovation, Financial and Economic Analysis*, and *Investment Appraisal.*

APPENDIX IV – FINECON MODEL

Figure 26 – Home Page

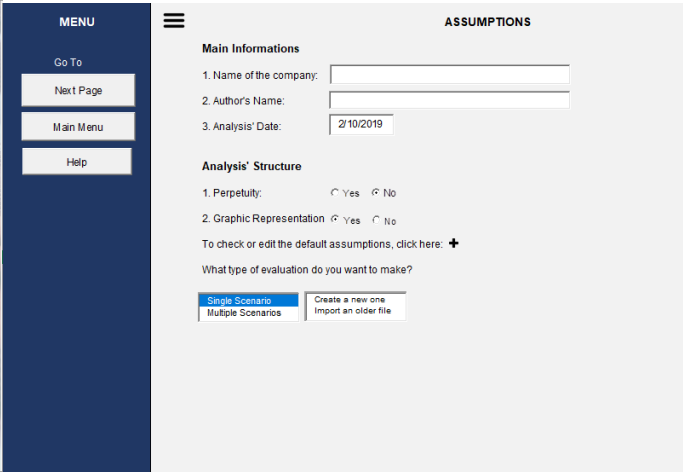

Figure 25 – Assumptions

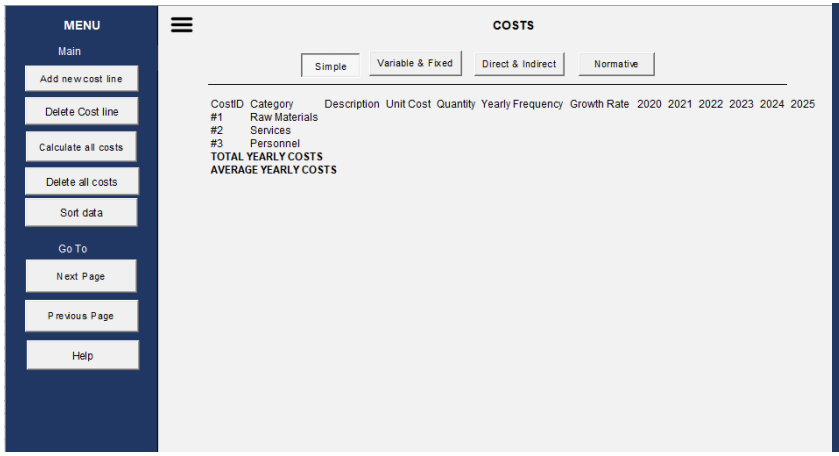

Figure 28 – Costs

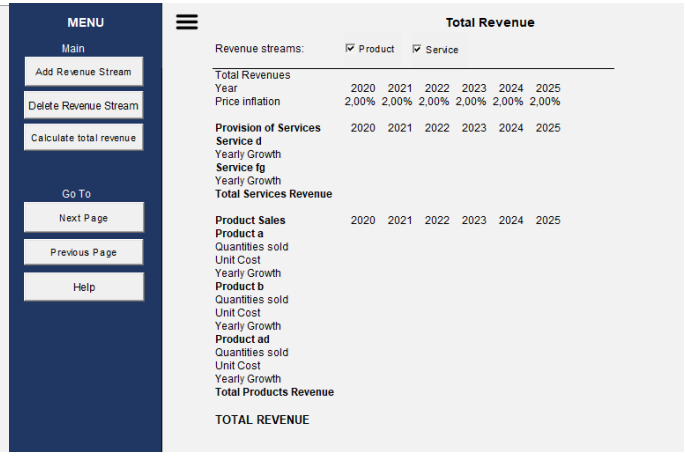

Figure 27 – Total Revenues

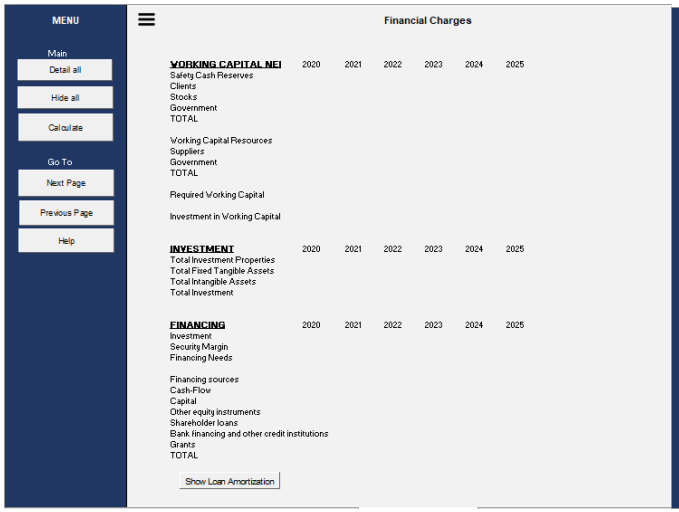

Figure 29 – Financial Charges

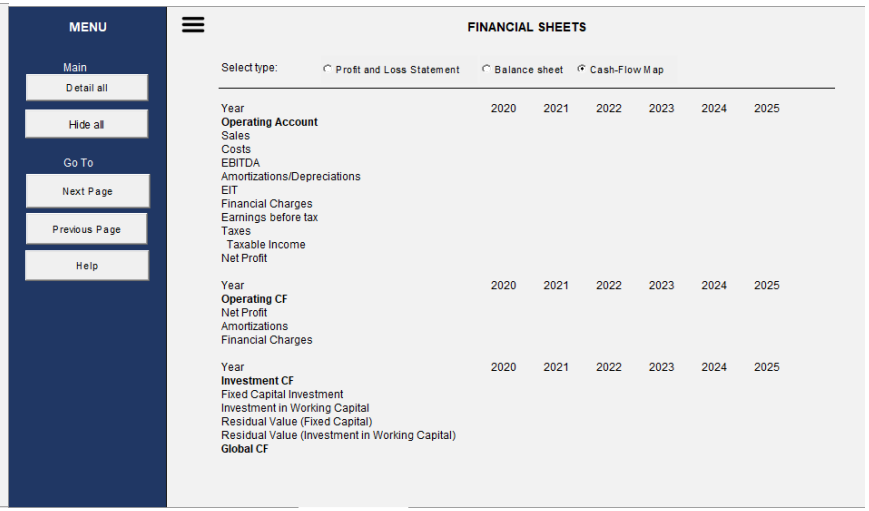

Figure 30 – Financial Sheet (CF Map)

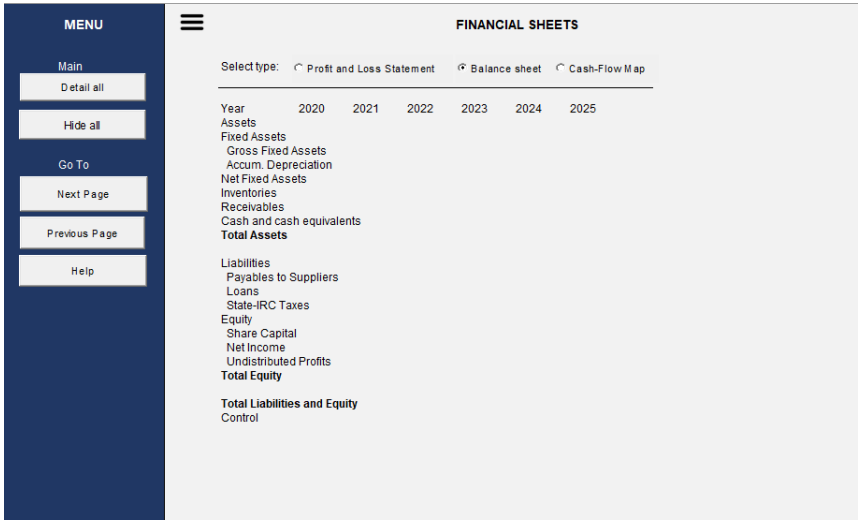

Figure 31 – Financial Sheet (Balance Sheet)

APPENDIX V – BILL-OF-MATERIALS (BOM) OF THE HW

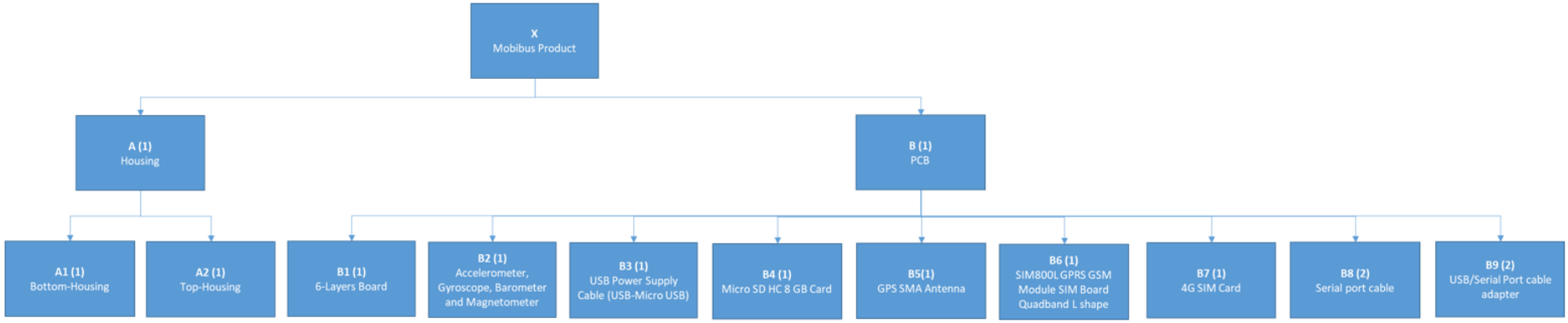

Figure 32 – BOM of the HW for the MobiBUS' solution

APPENDIX VI – DETAILED PRODUCT' COSTS

When the project evaluation began, the team was acquiring raw materials for the SW and HW with the designated costs in Table 5.

Table 5 – 1st draft of solution' cost, specifically physical, installation, software and structure.

A) Physical Cost			
Category	**Quantity**	**Unit Cost**	**Total Cost**
1-Materials			**177,4 €**
Raspberry Pi 3 Kit	1	73,40 €	73,40 €
Accelerometer	1	29,50€	29,50€
GPS SMA Antenna	1	9,50€	9,50€
Huawei 3G/4G Modem	1	65€	65€
2-Operations			**8,73 €**
Turn on, install, and test accelerometer	0,17h	(20€/h) 1 person	3,4 €
Turn on, install, and test GPS	0,083h	(20€/h) 1 person	1,66 €
Install and configure SW on Raspberry Pi	0,05h	(20€/h) 1 person	1 €
Create a service to run SW on-bot	0,05h	(20€/h) 1 person	1 €
Assembly and connect devices	0,083 h	(20€/h) 1 person	1,67 €
3-Structure and Indirect	**-**	**-**	**0 €**
4-Resources	**-**	**-**	**0 €**
Total			**186,13€**
B) Installation			
Category	**Quantity**	**Unit Cost**	**Total Cost**
1-Materials			**11,59 €**
USB-Micro USB Cable	1	1,69 €	1,69 €
Serial Port-USB Cable	1	9,90 €	9,90 €
2-Operations			**5 €**
Install SW	0,083h	(20€/h) 1 person	1,66 €
Install HW	0,167 h	(20€/h) 1 person	3,34 €
3-Structure and Indirect			**8,00 €**
Box and Screws	1 h	8,00 €	8,00 €
4-Resources	**-**	**-**	**0 €**
Total			**24,59 €**
TOTAL (A+B)			**210,72 €**

C) Software/ Structural Cost (for the complete solution)			
Category	**Quantity**	**Unit Cost**	**Total Cost**
1-Materials	-	-	**0 €**
2-Operations			
Test mobile app and SAE	0,5 h	2 people	20,00 €
3-Structure and Indirect	-	-	**0 €**
4-Resources	-	-	**0 €**
Total			**20€**
TOTAL (A+B+C) €			**210,85**

However, after researching on suppliers platforms and taking into consideration the future features that will be implemented, it was possible to propose a lower cost solution presented in Table 6.

Table 6 – Low-cost solution, specifically physical, installation, and software and structure.

A) Physical Cost			
Category	**Quantity**	**Unit Cost**	**Total Cost**
1-Materials			**61,32 €**
Raspberry Pi 3 Modell B - Quad-Core Prozessor / 1GB RAM WiFi Bluetooth onBoard	1	31,99 €	31,99 €
Accelerometer, giroscopy, barometer, and magnetometer sensor	1	5,55 €	5,55 €
GPS SMA Antenna	1	6,01 €	6,01€
SIM Board Quadband GSM Module	1	7,86 €	7,86 €
Micro SD HC 8 GB	1	4,57 €	4,57 €
Power supply (USB Cable/ Micro USB)	1	1,29 €	1,29 €
Housing	1	4,05 €	4,05 €
2-Operations			**11,12 €**
Turn on, install, and test sensors	0,17h	(20€/h) 1 person	3,4 €
Turn on, install, and test GPS	0,082h	(20€/h) 1 person	1,66 €
Install and configure SW on Raspberry Pi	0,05h	(20€/h) 1 person	1 €
Create a service to run SW on-bot	0,05h	(20€/h) 1 person	1 €
Assembly and connect devices	0,033 h	(20€/h) 1 person	0,66 €
Final tests	0,17 h	(20€/h) 1 person	3,4 €

3-Structure and Indirect	**-**	**-**	**0 €**
4-Resources	**-**	**-**	**0 €**
Total			**72,44€**
B) Installation			
Category	**Quantity**	**Unit Cost**	**Total Cost**
1-Materials			**15,88 €**
USB-Micro USB Cable	2	1,69 €	3,38 €
Serial Port-USB Cable (SAE + Ticketing system)	2	6,25 €	12,5 €
2-Operations			**1,34 €**
Install SW	0,083h	(20€/h) 1 person	0,67 €
Install HW	0,083 h	(20€/h) 1 person	0,67 €
3-Structure and Indirect	**-**	**-**	**0 €**
4-Resources	**-**	**-**	**0 €**
Total			**17,22 €**
TOTAL (A+B)			**89,66 €**
C) Software/ Structural Cost (for the complete solution)			
Category	**Quantity**	**Unit Cost**	**Total Cost**
1-Materials	**-**	**-**	**0 €**
2-Operations			
Test mobile app and SAE	0,25 h	(20€/h) 3 people	15,00 €
3-Structure and Indirect	**-**	**-**	**0 €**
4-Resources	**-**	**-**	**0 €**
Total			**15 €**
TOTAL COSTS (A+B+C)			**104,66 €**

APPENDIX VII – MAIN ASSUMPTIONS

The bond yield and market beta are presented in Figure 33.[20]

Figure 33 – Market assumptions for a risk free rate for Portuguese bonds

When the Beta value is higher than 1, it means that the security is theorically more volatile than the market, which in this case means that the price is 45% more volatile than the market. This value just takes into consideration the historical data of the market, and stock.

Table 7 – Market risk values

CAPM (5 years)	0,0734856
Risk Free Rate Portuguese Bonds	-0,14%
Beta	0,92
CAPM (10 years)	0,1138355
Risk Free Rate Portuguese Bonds	0,48%
Beta	1,45

[20] Retrieved from https://www.investing.com/rates-bonds/portugal-10-year-bond-yield. Accessed on the 20th July 2019.

APPENDIX VIII – YEARLY COSTS

Table 8 - Yearly Costs

Year		0	1	2	3	4	5	6	7	8	9	10	Perpetuity
Variable Costs	COGS	15 965,88 €	46 113,94 €	32 572,03 €	26 804,02 €	43 652,26 €	84 832,43 €	53 423,34 €	77 897,68 €	59 684,98 €	100 196,17 €	19 663,81 €	15 965,88 €
	Cloud Hosting	1 883,40 €	7 232,26 €	10 936,28 €	13 924,60 €	16 812,48 €	20 554,17 €	22 462,68 €	27 497,64 €	30 636,64 €	36 814,19 €	36 814,19 €	1 883,40 €
	Google Maps: API requests	4 783,80 €	33 888,60 €	38 994,00 €	41 004,00 €	41 024,10 €	51 524,37 €	61 815,57 €	93 975,57 €	112 708,77 €	145 150,17 €	145 150,17 €	4 783,80 €
	Salary and wages	144 446,25 €	185 619,97 €	226 277,58 €	230 803,14 €	235 419,20 €	313 652,48 €	319 925,53 €	326 324,04 €	374 456,83 €	381 945,97 €	389 584,89 €	144 446,25 €
TOTAL VC		167 079,33 €	272 854,77 €	308 779,89 €	312 535,76 €	336 908,04 €	470 563,45 €	457 627,12 €	525 694,93 €	577 487,22 €	664 106,50 €	591 213,06 €	167 079,33 €
Fixed Costs	Company's Vehicle				15.000 €				15.000 €				
	Cellphones for testing	2 000 €			2.000 €				2.000 €		2.000 €		
	Mockups license	150,00 €	150,00 €										
	Apple store license		88,96 €	88,96 €	88,96 €	88,96 €	88,96 €	88,96 €	88,96 €	88,96 €	88,96 €	88,96 €	88,96 €
	Google Play Store license		25 €										
	Commercial representation		5 000 €	5 000 €	5 000,00 €	5 000,00 €	5 000,00 €	5 000,00 €	5.000,00 €	5 000,00 €	5 000,00 €	5 000,00 €	5 000,00 €
	Marketing campaign			3 000 €			1 500 €						
	Office equipment	6 549,95 €											
	Travels and fuel		11 000 €	11 000 €	13 300 €	13 300 €	13 300 €	13 300 €	13 300 €	13 300 €	13 300 €	13 300 €	10 000 €
	Project planning/ monitoring SW (Jira, BitBucket, Confluence)	20 €	340 €	520 €	520 €								
Total FC		8 720 €	16 604 €	19 609 €	18 909 €	18 389 €	19 889 €	18 389 €	13 389 €	18 389 €	18 389 €	18 389 €	15 089 €
Total Costs		175 799 €	289 459 €	328 389 €	331 445 €	355 297 €	490 452 €	476 016 €	539 084 €	595 876 €	682 495 €	609 602 €	182 168 €