NOVA SCHOOL OF SCIENCE & TECHNOLOGY

DEPARTMENT OF MECHANICAL AND INDUSTRIAL ENGINEERING

FRANCISCO BETTENCOURT QUADROS CASCALHO

BSc in Mechanical Engineering

A METHODOLOGICAL REVIEW ON LAUNCHING SMALL BUSINESS PROJECTS

FROM IDEA TO BUSINESS

MASTER'S IN MECHANICAL ENGINEERING

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À minha família e amigos.

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"No man ever steps in the same river twice,
for it is not the same river
and he is not the same man."
Heraclitus

ABSTRACT

A great deal of business ideas never makes it to the end due to a wide range of problems that extend from the flawed conception of the idea to the failure to capture investment for their enterprise.

The current most well-known methodologies are, many times, too theoretical to be applied in helping businesses in a pragmatic/realistic way on bringing an idea to the market.

The aim of this study is twofold: first, to understand if small tech entrepreneurs know and apply current well-known methodologies to bring an idea to the market. Secondly, it is intended to develop a more adequate methodology to help an entrepreneur/small business owner to bring an idea to the market.

Interviews to small business owners were conducted, to collect data on their previous knowledge of current methodologies, market and technology risks and difficulties faced in turning their project into a business. It was concluded that entrepreneurs use only known methodologies that are practical and essential on the context of their business, like SWOT analysis incorporated in Business Plans.

The purposed methodology aims to help the entrepreneur developing an idea into a business and has the advantage of a practical approach dividing the risk into market and technology risks. For sure the model considers a trigger that motivates the pursuit of a solution. After the division and mitigation, a product-market fit is conducted, and a Business model Plan is drawn. This methodology benefits entrepreneurs as it reflects the process of idea development in the context of a business while approaching the risks incurred in a comprehensive way.

Keywords: Technology risk, Market risk, Product-market fit, Strategic management methodologies, small businesses/Start-up.

RESUMO

Muitas ideias de negócio nunca chegam a realizar-se devido a uma vasta gama de problemas que se estendem desde a concepção errada da ideia até à incapacidade de captar investimento para o empreendimento.

As actuais metodologias mais conhecidas são, muitas vezes, demasiado teóricas para serem aplicadas a empresas para, de uma forma pragmática/realista, ajudar a trazer uma ideia para o mercado.

Este estudo tem dois objectivos: primeiramente, compreender se os pequenos empresários de tecnologia conhecem e aplicam as metodologias mais conhecidas para trazer uma ideia para o mercado. Em segundo lugar, desenvolver uma metodologia mais adequada para ajudar um empreendedor/pequeno empresário a trazer uma ideia para o mercado.

Foram realizadas entrevistas a pequenos empresários para recolher dados sobre o seu conhecimento prévio das metodologias atuais, riscos de mercado e tecnológicos e dificuldades enfrentadas para transformar o seu projeto num negócio. Concluiu-se que os empresários utilizam apenas metodologias conhecidas, práticas e essenciais no contexto do seu negócio, como por exemplo uma análise SWOT incorporada nos Planos de Negócios.

A metodologia desenvolvida visa ajudar o empresário a desenvolver uma ideia num negócio e tem a vantagem de envergar por uma abordagem prática que divide o risco em riscos de mercado e tecnológicos.O modelo considera também a motivação inicial que alimenta a procura de uma solução. Após a divisão e mitigação, é realizado um *product-market fit* e é desenhado um Plano de Negócios . Esta metodologia beneficia os empreendedores, uma vez que reflecte o processo do desenvolvimento de ideias no contexto de um negócio, ao mesmo tempo que aborda os riscos incorridos de uma forma abrangente.

Palavras chave: *Technology risk, Market risk, Product-market fit, Strategic management methodologies, small businesses/Start-up.*

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ACRONYMS

BMC	Business Model Canvas
BMP	Business Model Plan
CV	Costumer Value
DIANA	Define Increase Assess Narrow Act
IP	Intellectual Property
R&C	Resources and Capabilities
SWOT	Strengths Weaknesses Opportunities Threats
TIAGO	Tap Induce Analyze Ground Operate
TRIZ	*Teoria Reschenija Isobretatjelskich Zadatsch*
TRL	Technology Readiness Level
VCW	Value Creation Wheel

1

INTRODUCTION

This is the introductory chapter and contains the Motivation and Problem Statement and the Dissertation Structure chapters.

1.1 Motivation and Problem Statement

"Necessity is the mother of invention. "

Plato

The interest of this quote lies not solely in the words it transmits but also in the period those were written. To notice such truth and to document it in words and for those words to be remembered today means western society is following roughly the same path since the Greeks, 2500 years ago. That path is the path of continuous and persistent innovation. The fact that this quote would sound as true as if it has been said by anyone wise enough that still lives proves that despite 2500 years we are still holding to the same values and convictions. Innovation forms part of those convictions in a sense that it is one of the forces responsible for changing our realities, among others. Since the beginning, innovation has been tied to business. It is no coincidence that this quote was made by a citizen of Athens, a thriving business center, instead of its rival at the time, Sparta.

However, this relationship between business and innovation was not reinforced until recently, where companies and nations finance innovation and it is accepted that the more innovation there is in a company the more chances the company must thrive in the future.

A current way that nations have used to finance innovation is through financing start up ecosystems, because innovation also stems from bringing new people with new ideas into the market.

However, start-ups fail. According to a study from CBInsights (2021) analyzing 111 cases of start-up post-mortem since 2018, most start-ups fail because of one or more of these reasons:

1. Ran out of funds (38%)
2. There is no real need in the market for such a product (35%)
3. Not the right team (20%)
4. Get outcompeted (19%)

Analyzing the items above a relation can be made from points 1 and 2 in the sense that if there is no market for the product the company cannot generate revenue. In conclusion the company ran out of funds and cannot hire the right people for the jobs, getting outcompeted. In fact, point 3 and 4 can be speculated to be symptoms of point 1 since funds are tied to sales and to hiring a better team than the competitors, if not the right team. Hence, we can speculate that the single most important reason for startups to fail is that there is no market for the product being sold and from that reason stem a myriad of other problems. Is there a systemic path to take a technological idea to market while avoiding failure?

The aim of this study is to study the methodologies that can be employed to bring an idea to market and to propose a more direct and pragmatic methodology with key elements that systematize the idea-to-market path. The theme was motivated by entrepreneurial challenges faced by the author/the student of this study while attending the discipline of entrepreneurship at NOVA School of Science and Technology. At this discipline, the author felt that the process for transforming an idea into a business model could be less fuzzy and more objective with the inclusion of a methodology that helps building a business from a technological idea.

The objective of this dissertation is to gather several methodologies and analyze them in the context of the development of a strong business idea and model. Then interviews are performed to understand the utility of these methodologies to successful entrepreneurs during the process of founding the company. Lastly a new model is presented based on the analysis of the interviews.

1.2 Thesis Structure

This thesis is divided into six chapters.

First chapter, the Introduction, is divided into two sub-chapters with no sections each and presents the problem statement and motivation for the thesis.

Second chapter is called A Review on Strategic Management Tools and is divided into seven sub-chapters. This chapter pretends to provide a review on the principal methodologies and frameworks that have significance to a tech-based business.

Third chapter, called Critical Analysis of Existing Methodologies, presents a critical analysis of the frameworks exposed in the second chapter.

Fourth chapter, Interviews with Small Business Owners, has three sub-chapters and pretends to summarize the results obtained when interviewing small business owners.

Fifth chapter has two sub-chapters with four sections each, two sub-chapters with no sections and it's titled A New Methodology Proposal. In this chapter a new methodology is proposed to be used in the conception of small business projects.

Sixth chapter is the Conclusion of the work.

2

A Review of Strategic Management Tools

In this chapter several methodologies are reviewed. Some of these methodologies deal with the general path followed by the entrepreneur from having an idea to implementation as a business. Other methodologies will deal with separate issues such as solving technical problems (TRIZ), gathering data about how product features are seen by customers (Kano Model) and analysis of whole picture (SWOT).

2.1 Business Model Canvas

The business model canvas is a visual scheme of a business model (Figure 2.1).

According to A. Osterwalder "A business model describes the rationale of how an organization creates, delivers, and captures value". The objective of this scheme is to clarify and enhance the discussion about the business model, giving a clear and logical picture of how a future business might work.

The Business Model Canvas is divided in nine building blocks (Osterwalder & Pigneur, 2010):

1. Customer Segments:

The costumer segment is the building block that defines the customer the organization is to serve, where the product is oriented and advertised to. The organization must choose which customer segment it should serve to carefully design a business model around its customer's needs. Customer segments is filled with customer groups that contain:

- Customers with the same needs

- Customers with the same type of relationship with the product
- Customers requiring the same offer
- Customers whose profitability is the same
- Customers reached through the same distribution channels

2. Value Proposition:

Value Proposition is the building block that describes the product/service creating value for the customer segment and satisfying that customer segment needs and wants. It is the reason for the choice of a product over other and it represents the aggregation of benefits the company has to offer to the customer. These benefits include newness, performance of the product, ability to customize the product etc.

3. Channels:

The Channels building block represent all the efforts the company incurs to communicate and deliver a product to its customer base. Among the channels function are:

- Raising awareness among customers about a company's product or service
- Helping customers evaluate a company's value proposition
- Deliver the Value Proposition to customers
- Allowing customers to purchase the company's product/service
- Providing post-sales services

4. Customer Relationships:

Customer Relationships describes the way a company presents itself to a customer segment. It depends on the company's intents, generally acquiring more customer, retain the customers and boosting sales. There are several categories of Customer Relationships, which may co-exist in a company's relationship with a particular Customer Segment:

- Personal Assistance
- Dedicated Personal Assistance
- Self-service
- Automated Services
- Communities

- Co-creation

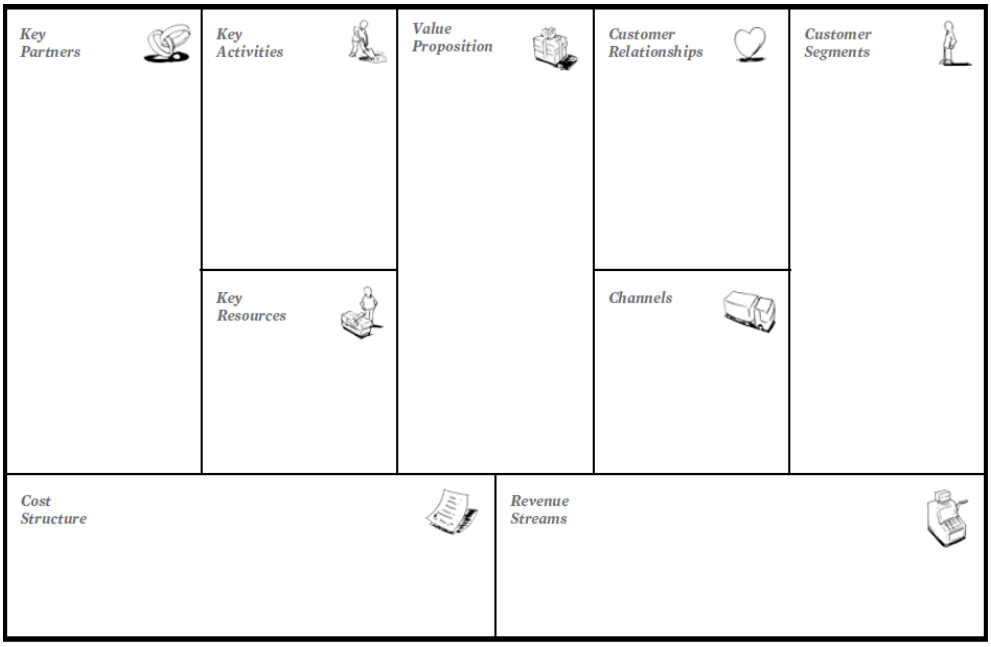

Figure 2.1 - Business Model Canvas (Osterwalder & Pigneur, 2010)

5. Revenue Streams:

Revenue Streams comprise every transaction return from the customer to the company. There are two types of transactions, a fixed transaction, and a recurring transaction, depending on whether the client buys or rents the product/ service. There are several ways to generate a revenue stream:

- Asset Sale
- Usage fee
- Subscription fees
- Lending/Renting/Leasing
- Licensing
- Brokerage fees
- Advertising

6. Key Resources:

On the Key Resources Building block are the resources that allow the company to create and offer the value proposition, reach markets, and maintain relationship with the customer and

earn revenues. Key resources are physical, financial, intellectual, or human. Key resources can be acquired from the key partners and can be traded to generate revenues.

7. Key Activities:

Key activities are the activities that lead and maintain the success of the company. Naturally they depend on the company's business model type. Examples of key activities are:

- Production
- Problem solving
- Platform/network

8. Key Partnerships

Key partnerships are the partnerships taken by the company to optimize the business model, reduce the risks and acquire resources. Motivations to create partnerships include reduction of risk and uncertainty, optimization, acquisition of specific resources and activities. There are four distinguishable types of partnerships:

- Strategic alliances between non-competitors
- Strategic partnership between competitors
- Joint ventures to develop new businesses
- Buyer-supplier relationships to guarantee reliable supplies

Partnerships have a range of motives to be created, in particular:

- Optimization and economy of scale
- Reduction of risk and uncertainty
- Acquisition of resources and activities

9. Cost Structure

The cost structure describes all the costs involved in the operation of a particular business model. Such costs are calculated easily after defining Key Resources, Key Activities, and Key Partnerships.

2.2 Value Creation Wheel

The Value Creation Wheel is a meta-framework that aims to guide the user of the methodology into solving a problem of any kind. It is composed by a theoretical framework, DIANA,

and by a tool, TIAGO, which helps developing solutions for specific problems and implements the DIANA framework (Lages, 2016).

The DIANA framework/TIAGO tool:

DIANA is an acronym for Define, Increase, Assess, Narrow, Act. The objective each letter of this acronym is to define better the corresponding step. The TIAGO, acronym for Tap, Induce, Analyze, Ground, Operate, follows the same principles of defining the steps closely to DIANA (Lages, 2016). Below the steps are described and illustrated in Figure 2.2:

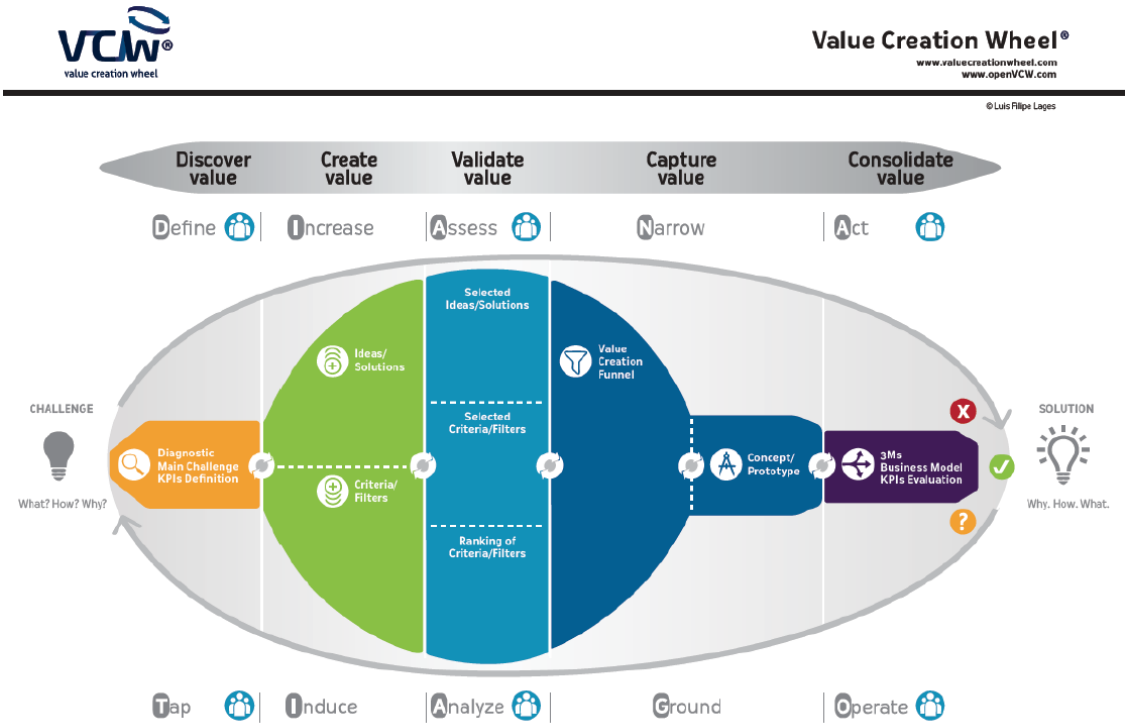

Figure 2.2 - Value Creation Wheel (Lages & Marques, 2020)

1. Define/Tap Step:
   The objective of this step is to define the problem and tap into the issue to find clues for the major challenge to face.
2. Increase/Induce Step:
   The objective of this step is to have as many ideas as possible, both ideas of solutions to the problem and ideas of criteria to accept/refuse those ideas.
3. Assess/Analyze Step:
   In this step ideas of solution and ideas of criteria get selected. After selection the criteria are ranked according to their order of importance.

4. Narrow/Ground Step:
   In this step the selected ideas are filtered through the criteria and the best idea is selected according to its score on the criteria. Then the concept is elaborated, or a prototype is assembled.
5. Act/Operate Step:
   In this step the business plan is made, and a pitch is developed to present the idea.

The VCW steps can be overcome recurring to one or more of the methodologies for each step, as in Figure 2.3:

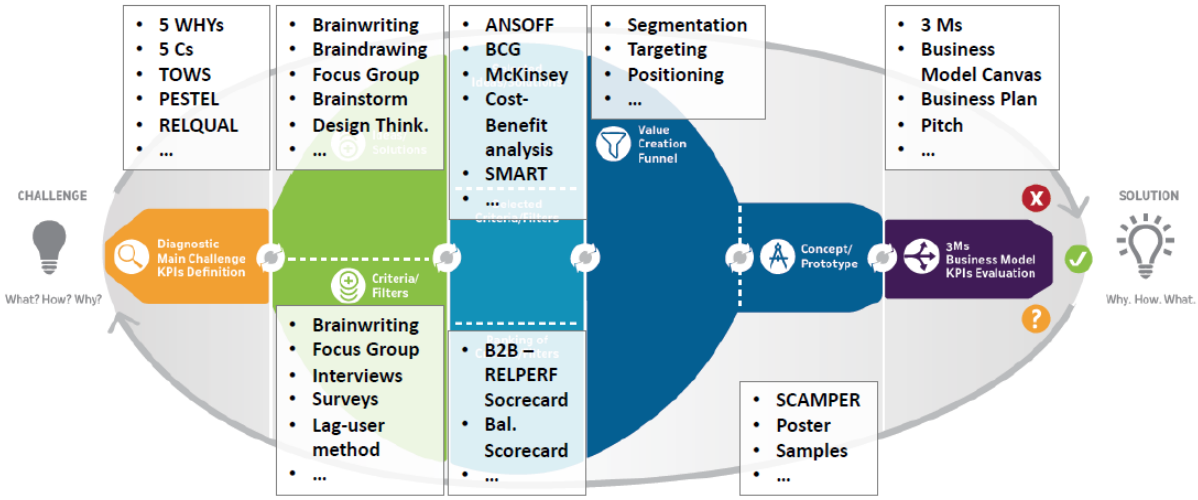

Figure 2.3 - VCW and its possible Methodologies (Lages & Marques, 2020)

There are many alternatives for each step thus indicating the flexibility of this macro model.

2.3 Design Thinking

Design thinking is a meta-framework that aims to help solving problems with what is technologically feasible while thinking from a customer perspective to create customer value and market opportunity (Balcaitis, 2019; Brown, 2008). This approach to design thinking is the Stanford/IDEO approach, that it is composed of five steps, which are sequential. These steps are illustrated in Figure 2.4:

1. Empathize:
   The goal in this step is to understand the people that the design aims to be for through interviews. The two objectives are to know who the product that is being

designed will be for and what is the problem that the customer buying the product intends to solve by buying it.

2. Define:
   In this step the objective is to define the customer problems, needs and challenges considering the findings from step one.
3. Ideate:
   In this step the objective is to develop solutions for the problems stated in step two.
4. Prototype:
   In this step solutions developed in step three are filtered and turned into simple testable prototypes.
5. Test
   In this step prototypes are tested on the customers and new insights are obtained. This process transports the designer to step two where these insights will contribute to an improved definition of the problem.

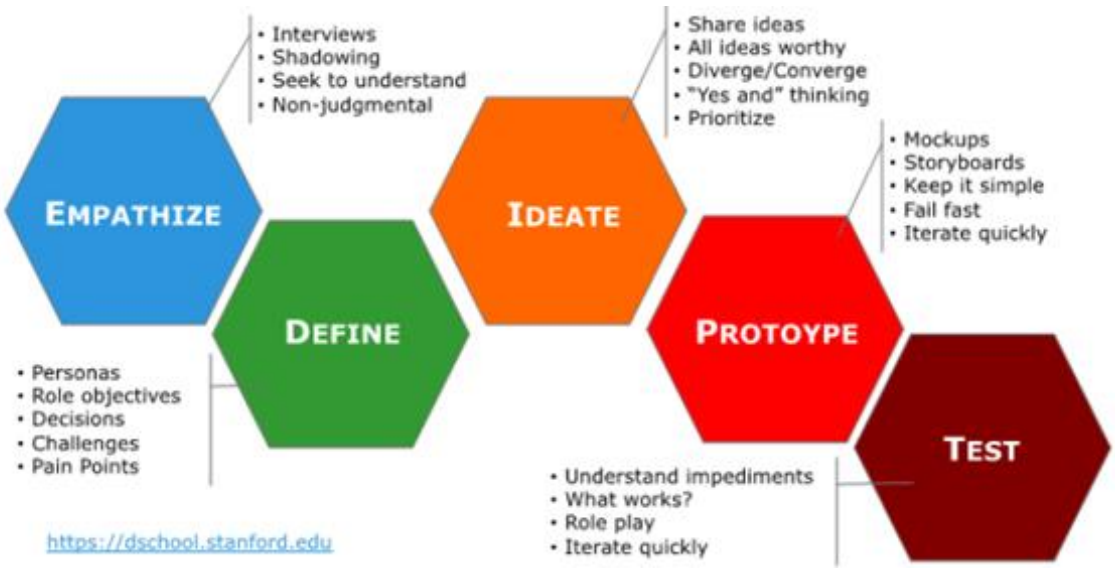

Figure 2.4 - Stanford d.school Design Thinking Process (Schmarzo, 2017)

2.4 Business Model Plan

A Business Model Plan is a written document that describes a business and delivers detailed projections about the said business future. It covers the financial aspects of starting and expanding a business namely how much money is needed and how incurred debts will be

paid back. The business plan improves a business concept and is crucial to attract venture capital into the company. A business model plan is composed of (McKeever, 2007):

- Plan Summary
- Problem Statement
- Business Description
- Business Accomplishments
- Sales Revenue Forecast
- Profit and Loss Forecast
- Capital Spending Plan
- Cash Flow Forecast

Plan Summary

A plan summary serves to introduce the principal ideas in your plan and includes a statement on the total amount of money sought. The plan summary is important because it will be the first thing investors read on the business plan. The goal is to paint a clear perspective of who is behind the business, what is the business about, how much money is needed and how much money the business is expected to make, all in one page (McKeever, 2007).

Problem Statement and Business Description

The Problem Statement is where the problem the business will solve is described. It is essential to understand if the customer finds the problem important and meaningful to solve and if the customer is willing to trade money for the solution. The Business Description is where the business that will solve the customer's problem is described. To successfully perform this step, a list of questions needs to be answered (McKeever, 2007):

1. What problem do I solve for my customers?
2. Who is my typical (target) customer?
3. How will I communicate with my target customer?
4. What products and/or services will I provide? Are there any products or services my customers may expect me to provide that I don't plan to provide?
5. Where will my business be located?
6. Where will I buy the products, I need?
7. What hours will I operate?
8. Who will work for me and how will they be paid?
9. Who will handle critical tasks like selling, ordering, bookkeeping, marketing, and shipping?
10. How will I advertise and promote my business?
11. What are the competition's strengths and weaknesses?

12. How am I different from the competition, as seen through the eyes of my customers?

Business Accomplishments

The Business Accomplishments part is where the person opening the business writes everything accomplished that has a direct impact on how the person will meet the business objectives. The aim of this part is to gain investors trust on the person opening the business. It is important to be transparent and honest and to refer past mistakes that are relevant for the business plan. Next are shown a list of items to consider when writing the business accomplishments (McKeever, 2007):

- Knowledge of the business the individual is starting
- Specific positive business accomplishments
- Education
- Hobbies
- Community Involvement

Sales Revenue Forecast

The Sales Revenue Forecast is the most important part of the business plan. Depending on the business area of activity there are different ways of obtaining the figures that sustain the forecast (McKeever, 2007):

- Retail Sales Revenue Forecast

  Find a similar shop and calculate how much they earn on sales per square meter then do the same calculations for your business.
- Service Business Sales Revenue Forecast

  To forecast the service business sales, one needs to understand the steps that it takes to make a billable sale. Then one needs to forecast how many complete processes one does in a day and how much revenue is to derive from those steps. It is also important to consider time for marketing and internal matters (around 20 to 40% of the time should be dedicated to nonbillable activities).
- Manufacturing or Wholesale Sales Revenue Forecast

  Methods of Service and retail combined plus knowledge about the business should be enough to deliver an estimate.
- Project Development Sales Revenue Forecast

Project Developers need to know for how much they are going to sell the project before they begin work because the project is the only source of revenue for the company

Forecast Fixed Costs

Fixed costs are the costs the company is committed to pay every month and that keep the business viable. These include (McKeever, 2007):

- Rent, including taxes and maintenance
- Wages, including payroll taxes etc.
- Utilities
- Advertising
- Telephone
- Supplies
- Insurance
- Freight
- Accounting/Legal
- Bad debts
- Miscellaneous

Fixed costs should also include expenses that change time to time due to the business owner decision, such as fluctuations in advertising spending according to the season. Expenses that do not enter the balance are for example the cost to open the business, loan repayments or the costs of goods for resell or use in the manufacturing or development process (McKeever, 2007).

Forecast Gross Profit for a Start-up Business and Break-Even Sales Revenue

For a new business, calculate the average gross profit by following these steps:

1. Each product/service sold takes labour-hours and resources to obtain. Adding all those resources with a price tag on them, including commissions one obtains the total product cost.
2. After that, one should determine the selling cost of the product/service and sub-tract it to the total product cost to obtain the gross profit for that product/service.
3. Then dividing the selling price into the gross profit will determine the gross profit percentage.
4. Then one should repeat this process for all the groups of products.

5. After that one needs to predict how much each product group will sell and multiply the gross profit percentage by the total dollar sales to derive the dollar gross profit for each group of products.
6. Add the total dollar gross profit of each product to derive the total dollar gross profit from the sale of everything.
7. To calculate the break-even sales revenue simply divide total dollar gross profit calculated on point 6 by the annual sales revenue to obtain the gross profit percentage and then divide the gross profit percentage by the fixed costs to obtain the break-even sales revenue.

This number is the amount of money the company will have to sell to start making a profit (McKeever, 2007).

Profit and Loss Forecast

A profit and loss forecast is a projection of how much the company will sell and how much profit it will make. It is the foundation of the business plan, and it gives potential backers the information necessary to decide whether your business will succeed. A business profit is the sum of three-dollar figures:

- Sales revenue
- Cost of sales or variable cost
- Fixed costs

The sum of these three variables over a given period of time gives the profit of the business. These numbers should be presented in a monthly basis for at least two years as for long range trends to be observed (McKeever, 2007).

Deriving The Average Cost of Sales

To get the average cost of sales one needs to know the cost per sale in percentage for each product group, which equals its gross profit percentage subtracted to 100%. Then one multiplies the obtained percentage for the forecasted sales revenue for each product group, repeating this step for every product group. After that one sums the costs per sale to derive the total cost of sales. That cost of sales divided by the total forecasted sales revenue gives the average cost of sales (McKeever, 2007).

Cash Flow Forecast

The cash flow forecast is different from the profit and loss forecast because the money comes into and flows out of business at different paces. This forecast is about how much money the company needs to start operating or expand. It is divided in two parts:

- Capital Investment

  The money spent before opening or expanding business.
- Initial working capital

  Cash reserves to keep business afloat before break-even.

Commonly, cash flow from monthly sales is not enough to cover monthly expenses for the first months of operation. One needs to make sure to have enough working capital to cover this first few months.

Capital Spending Plan

The capital spending plan is the list of all the things to buy before the business opens. Then assign each thing a value with a margin of 10%. Below in Table 2.1 a list of items is presented.

Table 2.1 - Common Items in a Capital Spending Plan (McKeever, 2007)

Common Items in a Capital Spending Plan

Here's a list of common items businesses need to buy before opening. Note that they fall into two categories—capital items and expense items.

Capital items generally have a useful life of more than one year and can be depreciated for tax purposes. They include:

- permanent signs, heaters, air conditioners, cooking and refrigeration equipment
- equipment, including machinery, large tools, and other expensive items
- racks and display fixtures for retail selling areas
- office furniture
- leasehold improvements or any alterations you make to the building, including walls, bathrooms, and carpeting
- computers, typewriters, fax machines, adding machines, cash registers, phone systems, and other small equipment you purchase.

Expense items generally are shown as either fixed expenses or costs of sale at the time they are purchased because they last less than one year. They include:

- opening inventory (sometimes you can get a deferred payment schedule from suppliers, but you will usually have to pay for many, if not most, goods before you sell them)
- lease deposits
- tax deposits
- business licenses and permits
- opening marketing and promotion
- insurance
- telephone installation
- utility deposits
- office supplies and stationery
- legal fees, costs to incorporate, and CPA fees to establish your business
- contingency reserve.

Preparing the Cash Flow Forecast

Once the capital spending plan is completed and there is knowledge of how much the company needs to open, it is also important to consider how much it needs to stay open in the first months of negative cash-flow. Initiate your cash-flow forecast charts by importing the figures developed in the profit and loss forecast. The work is now to adjust each month profits according to the collecting and spending money. As the profit and loss already considers the fixed costs one does not need to worry about rent, wages and so forth. Next the cumulative cash flow is derived in each month by adding the figures months prior together with the actual month.

Required Investment for Your Business

The amount of money needed to start a business is the sum of two figures:

- The maximum negative cash-flow
- The total figure obtained in the capital spending plan

This value will be handed out to investors in the plan summary as the funds needed for the business to start.

2.5 SWOT Analysis from a Resource Based View

SWOT stands for the capitals in Strengths Weaknesses Opportunities Threats. The objective of this analysis is to find enhancers and inhibitors of a firm's performance coming from external and internal environments. Strengths and Opportunities are enhancers of performance coming from internal and external contexts respectively. Weaknesses and Threats are performance inhibitors coming from internal and external contexts again respectively. Differences between internal and external context are that the firm can control factors from the former context but not factors from the latter (Leigh, 2006). The factors are then organized in Table 2.2:

Table 2.2 - SWOT Analysis (Adapted from Valentin, 2001)

	Internal Factors	External Factors
Favorable Factors	STRENGTHS	OPPORTUNITIES
Unfavorable Factors	WEAKNESSES	THREATS

Therefore, there are four different combinations arising from these two dichotomies. Although this analysis seems simple and easy to perform at glance, on a more careful look one

discovers a complex and vague problem to be solved. Hence the resource-based view Valentin (2001) proposes is based on a resource-based view of the firm and on the competitive forces' paradigm and value net frameworks.

The Resource-Based View of the firm

A company is a unique set of resources that interact in a particular way to form capabilities, with higher level capabilities being formed from a given set of resources and capabilities (Valentin, 2001). Figure 2.5 highlights the relations between the various elements of the set.

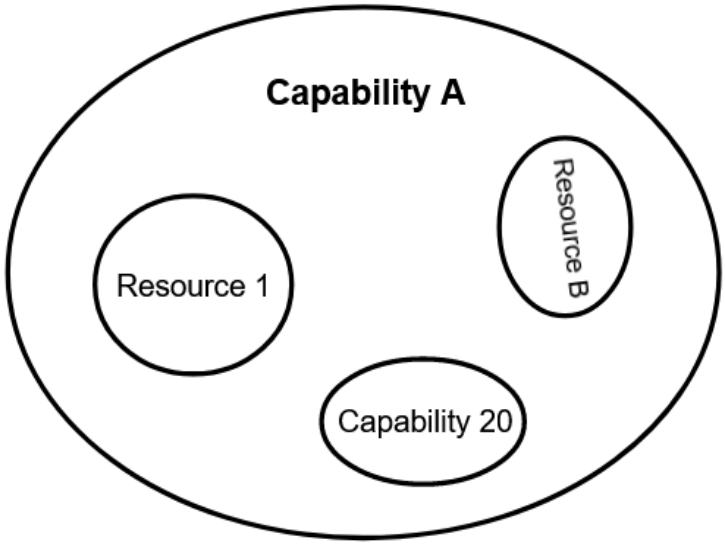

Figure 2.5 - Resources and Capabilities

In this example capability A is composed of resources 1 and B and Capability 20. There is no relevant distinction to be made between a capability and a resource, only between R&Cs in different hierarchical categories. The product/service a company sells relates directly with the R&C at the top of these hierarchical system. Resources are of different types as presented on Table 2.3 .

Table 2.3 - Types of Tangible and Intangible Resources (Adapted from Valentin, 2001)

Area	Resources
Financial	Cash and access to financial markets
Physical	Facilities, equipment, configurations, and raw materials
Intellectual	Expertise, formulas, and discoveries
Legal	Trademarks, patents, and contracts that protect intellectual property
Human	Employees' individual expertise and skills
Organizational	Culture, customs, shared vision and values, routines and working relationships
Informational	Customer and competitor intelligence
Relational	Strategic alliances, relations with customers and stakeholders, which often are affected by bargaining power and switching costs
Reputational	Brand names that reduce perceived risk and have symbolic value

Any product or service being sold by a given company is the result associated with a top hierarchical capability or a set of top hierarchical capabilities. For example, the top capability of an aircraft company is its plane production. That capability is composed by Organizational capabilities such as the supply chain of parts, Intellectual Resources such as the plane design and part manufacturing techniques (Valentin, 2001).

Hence, the Resource-view analysis systematizes the inner works of a company and the mechanisms it uses to generate value. This facilitates the task of finding vulnerabilities across the resource types.

Defensive and Offensive Analysis

Resource-Based SWOT Analysis must not be carried out without doing a defensive and offensive analysis because identifying the SWOTs of an organization are interactive rather than sequential tasks. Defensive and Offensive analysis probe the organization and the environment

it operates looking for means of satisfying two objectives respectively: " ... hang onto claimed product-market turf and claim additional profitable turf. "(Valentin, 2001).

Defensive Analysis

The objective of the defensive analysis is to analyze the vulnerabilities in competitive position and profitability of a given business strategy or enterprise. As product revenue depends on its cost and CV, those will be the two parameters analyzed. Defensive analysis comprises of three steps:

1. Depict the focal business' internal context
2. Identify and assess non-competitive forces that affect CV and cost
3. Identify competitive forces and contestants' advantages, disadvantages, and profits.

Depicting Internal Context:

To depict the focal business internal context, we must develop both CV and R&C profiles. These profiles are developed independently and obey different rules:

- The CV profile is composed of the benefits that outputs of the company provide or fail to provide to the target market segments.
- The R&C profile is made by listing a company's resources and capabilities from the types listed in table 2.1 that contribute to outputs, benefits, CV, and costs.

Next non-competitive forces affecting CV and cost are probed. By non-competitive it means forces that affect profit even in an environment with no competition involved.

Non-competitive Forces Affecting CV

- Changes in Customer Perception:
  Customer Perception of a product's performance and benefits is shaped by personal experience, advertising, and word-of-mouth communications. It negatively affects the CV when customers overestimate performance and compare it to objective performance information.
- Spontaneous and Socially Induced changes in Needs and Preferences:
  Customer's needs and preferences may change spontaneously or due to societal or governmental agents. Alcohol consumption may depend on the time of the year, alcohol law and anti-alcohol campaigns and religious and cultural background of customers. Social changes affecting CV and demand are predictable often. Nonetheless their impact and timing can be highly uncertain.
- Complements:

A product's CV can be limited because of its complements. Those can alter performance criteria, reduce needs, change combined costs, perform poorly or being unavailable or non-existent.

- Networks:
  The CV of any communication device or software increases if the number of users increases.
- Technological Induced Changes in Customer Needs and Preferences:
  Technological developments affect customer needs directly and indirectly. Table 2.4 gives us several types of technological developments and their competitive/non-competitive impacts.

In Figure 2.6 it is seen how technology affect indirectly the CV through more than one matter. In fact, technological developments seem to be a driving force behind a strong CV together with network effects and spontaneous forces. This means that firms that can make the most of a technology and that can harness the potential of technological advancements (through a research and development unit) will generally produce products with a higher CV.

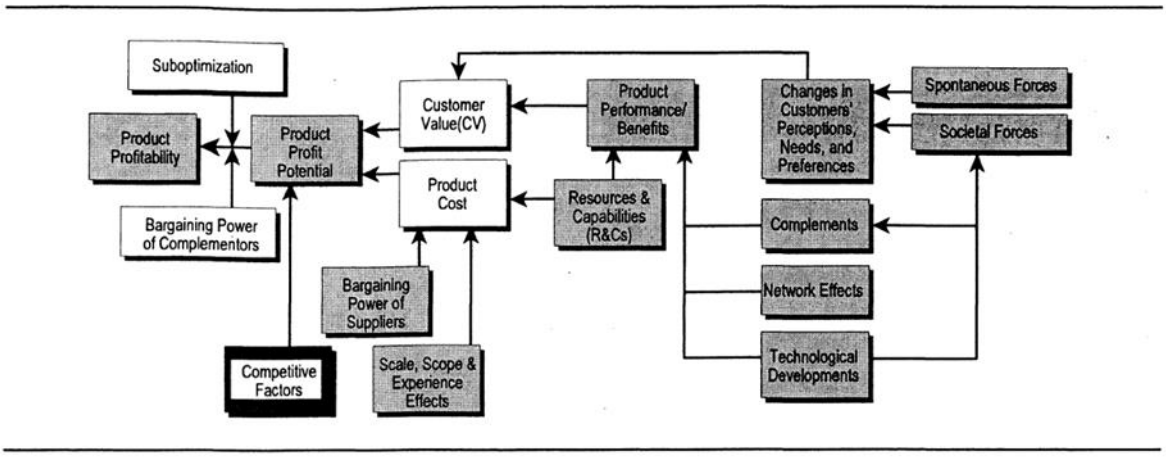

Figure 2.6 - Indirect effects on CV and Product Cost (Valentin, 2001)

Non-competitive forces affecting Costs:

- Product Improvements:
  May increase or decrease cost. Quality improvements reduce customer defections and overall replacement costs
- Scale, Scope, and Experience Effects:

Scale Scope and Experience commonly enhance efficiency. Scale effects are felt as the output volume of a product increases and its unit price decreases. Scope effects are felt when costs are spread across multiple products, thus reducing incremental and average costs. Experience effects are felt as production of the outputs occur, in a learning-by-doing fashion, with each unit of production affording and opportunity to gain experience from.

- Process Innovations:
  JIT (Just-in-time) inventory management is an example of a technique that reduces inventory costs. Other processes may be directed at manufacturing, packaging distribution or promotion costs. However, if a technology that reduces costs has to be acquired it means the seller has the bargain power and can appropriate most of the savings. In similar fashion, new technologies are only useful if they improve CV without pushing up costs.
- Complex Indirect Effects:
  By putting further economies of scale in the range of companies, both the internet and the railroad are examples of technologies that reduced manufacturing costs indirectly.

- Bargaining Power of Suppliers:
  Assets can be depleted over time: raw materials used up, patents expire, people leave the organization etc. Replacements can be costly or unavailable, which raises cost and decreases CV.

Table 2.4 - Consequences of Technology Advances (Adapted from Valentin, 2001)

Technological Advances may:	
Create direct substitutes for end products	Quartz watches replaced mechanical watches
Reduce needs	PCs greatly reduced the need for correction fluid
Catalyse societal changes that affect lifestyles and shopping patterns	Amazon revolutionized online shopping, fridges and automobiles made a weekly trip to a supermarket desirable
Produce complements that change the performance of the referent product	Software improvements enhancing PC performance.
Produce complements that impose higher performance standards on the referent product	New software often demands more processing power from PCs
Spawn environments that lift constraints	Transportation and communication systems allowed for expansion of economies of scale
Alter cost structures	Electric arc technology lowered the minimum efficient scale in steel industry
Create substitutes for industrial processes and products that enable their users to enhance CV, reduce costs or compete more effectively	Advances in robotics and modular construction make mass customization a reality for the consumer, enabling firms to enhance CV and reduce costs without having to standardize parts excessively

Additional Non-competitive Forces:

- Suboptimization:
  Perfect profit optimization and suboptimization sit at the ends of the optimization spectrum, one being impossible and another constituting mismanagement. One must be careful on cost-cutting policies albeit calculated risks must be taken. However unprofitable, some ventures can create powerful foundations for future ventures, due to the employment of previous assets into the new endeavors.
- Power of complementors:
  CV created by advances in a product is often dependent on advances in another. When two products are complements, to the total CV is added a differential calculated by the subtraction of the sum of the CVs the two products have independently to the CV of the system. That differential is split between the two incumbent products. If one is scarcer than the other, the one that is scarce will take most of the CV with him to the system.

Analyzing Fundamental Competitive Forces:

Defensive competitive analysis is about regarding other firms as potential aggressors, meaning that a competitor's advantage is our firm's disadvantage and that other firms may exploit ours in areas that are defendable or not. This has to do with our firm R&C structure and if the structure's blocks (R&Cs alone or equivalent substitutes) are identifiable, accessible, and exploitable.

- R&C Identification:
  It is often difficult for imitators to find specific R&C that correlate with profitability in the pacesetters firm as competitive advantages are not just made of a few transparent elements, such as patents, but often they are made from a chain of well executed skillful tasks.
- R&C Access:
  A product is as vulnerable as broader the access of challenger to R&Cs needed to imitate the original product at a competitive price. New entrants cannot start a brand with as much prestige as the original product let alone imitate the distribution and communications capabilities needed to reach customers effectively and efficiently possessed by the original brand. Path dependency (the effect a company's past has on its future) makes catching up very costly or impossible.

- R&C Exploitation:
  Imitation may be possible in certain cases but predictably unprofitable due to the nature of the market. For that reason, Microsoft remains unchallenged in the market for operating systems.

Analyzing Dynamic Competitive Forces:

The strategic landscape is continually changing. Societal values and laws change, companies and customers learn, markets grow, and technology advancements create new possibilities and cost structures. Defensive analysis must inquire over potential effects of dynamic competitive forces on the focal enterprise. The following topics highlight important findings.

- Maintenance and Expansion Costs:
  Resource advantages can be lost when depleted assets are replaced or need to be increased to support growth. In this case the advantage is lost because the price paid to increase the asset is not inferior to the price paid by competitors
- Diminishing Comparative Scale Scope and Experience Advantages:
  All these effects tend to diminish incrementally as the variable to which they are related increases. Scale effects usually decrease incrementally as market volume increases. Scope effects decrease too as the range of product lines increases. Experience effects decrease as time goes and as the output increases since the learning opportunity from each unit of output diminishes.
- Market Growth:
  When markets are too small, they cannot sustain more than one contestant. However, market growth is likely to attract new entrants.
- Differential Technological Potential:
  New technologies have more potential for improvement than old technologies. Therefore, eventually, new technology and the substitutes it spawns will replace products with old technology, due to offering superior performance/cost ratio than the old technologies.
- Advances in Process Technologies:
  New process technologies tend to alter competitive positions. Steel industry is an example, with electric arc furnaces lowering minimum efficient scale to the point an increase in capacity is no longer desirable in terms of costs. Companies already established in steel manufacturing misjudged the technology due to it only producing low-

grade steel at first. This gave an opportunity to poachers to claim market by improving the process, consequently producing more efficiently.

- Advances in Peripheral Technologies:
  Technological developments affect products and businesses circuitously. Thus, advances in one product can alter the performance criteria of the complementary products. Moreover, numerous technological breakthroughs can create environments together where simple extensions of conventional technologies can thrive, for example the market for smartphone covers would not exist if smartphone didn't exist.

Offensive analysis

Offensive analysis has two phases:

1. Search, in which the R&Cs are thought to be used in ways that create new or markets for pioneer products or to expand with a new product to an already established market
2. Evaluation, in which findings from search are scrutinized

The following section gives us a more detailed view on these two phases.

Search:

Opportunities may be spotted by outside-in or inside-out analysis, both approached being more intuitive than algorithmic and identify new fields of opportunities to apply proven business strategies.

- Inside-out Approach
  Inside out approach follows directly from a resource-based view, first focusing on the R&Cs of the company and then focusing on the markets to probe. From an inside-out perspective, opportunities exist in markets where a firm's R&Cs can be deployed without incurring in great disadvantages.
- Outside-in Approach
  Outside-in Approach applies conventional marketing wisdom present in the maxim "find needs, then fulfil them". First the attention should lie in unfulfilled consumer needs and then on the R&Cs needed to create a product or service that should fulfil their needs.

Evaluation:

Pursuing opportunities leads to new markets that have or have not competitors in them. Evaluating a venture includes evaluating the prospective of creating CV that exceeds

costs and then evaluating the vulnerability of the enterprise to attacks with imitations and substitutions.

2.6 Kano Model

The Kano Model was designed by Noriaki Kano in 1984 and aims to improve any product by defining a framework for classifying product features regarding the customer opinion/experience (Sauerwein et al., 1996). A feature is any characteristic of the product relevant to the customer that can be modified by the brand. The objective of this model is to assess the impact of the feature in the customer experience provided by the product to the customer(Navas, 2017).

The Kano Model is therefore a very useful tool to test how future product enhancements can appeal to the target market or to assess customer satisfaction with a product at use. The methodology consists of an experiment that allows an effective interpretation of customer needs with the following steps:

1. List the features that the product has/should have and what it should do and what it could hypothetically do.
2. Write two types of questions:
   - A direct question asking in a clear direct way about the opinion of the questionee if the given feature is included in the product.
   - An indirect question asking about the opinion of the questionee if the given feature is not included in the product.
3. Compute the answers, assigning each feature with one of five categories based on the answers given and analyze the results (Navas, 2017).

The five categories and what do they mean:

A category is a group to which features are assigned regarding how they are viewed by the target audience responsible for answering the question. The audience can treat a feature in different ways which will assigning a feature to a category of quality. Below is presented Table 2.5 summarizing the issue:

Table 2.5 -: Categories and Features

Category which contains feature	Customer reaction if the feature Exists	Doesn't Exist
Attractive Quality (A)		
Must-be Quality (M)		
Unidimensional Quality (U)		
Indifferent Quality (I)		
Questionable Quality (Q)	 ?	 ?
Reverse Quality (R)		

Either a feature present in a given product is relevant in a positive way, not relevant at all or relevant in a negative way. If the product is missing the same feature, it can also affect the customer in a positive/negative way or not affect the experience at all. After inquiring about the impact that the existence/inexistence of a given feature in a product has on the customer, one can map the information and assign the features to the 5 different quality categories:

Attractive quality:

If attractive quality features exist there is an exponential growth in customer satisfaction and its absence does not cause negative impact. These are the 'fashionable' the 'differentiating' features that lead to a competitive advantage, because of the potential they must delight and attract potential customers to the company.

Must-be Quality:

Features in this family are standard features: their existence does not increase customer satisfaction but if the product lacks a standard feature the customer satisfaction will be affected negatively in an exponential way. These features satisfy customer needs and are what customers expect from a product when they purchase it.

Unidimensional quality:

As the name implies, features which quality is unidimensional are 'quantifiable' in a certain way and can be related in an incremental way with customer satisfaction. These features are generally associated with performance of the product and a certain amount of performance increase corresponds to a certain amount of customer satisfaction increase.

Indifferent Quality:

Features in this category do not relate to customer satisfaction at least directly, they have therefore no marketing value and may be irrelevant to the product. A good example is a car with a fuel pump that was painted pink. It does not add much value to the vehicle itself in the eyes of the customer.

Reverse Quality:

These features are those that the customer does not want in their product, therefore potentially harming products sales on the market. Features in this category should be minimized

Questionable Quality:

This category exists to signal to the entity making the questionnaires that something is not right in the process of thinking about a feature and making questions regarding the feature. Generally, this category only applies to ill-made questions and non-understanding or indecision or dishonesty of the inquiree.

These categories can be plotted in a graph that depicts the happiness of the customer as function of the adoption of the features in the three categories of interest: Attractive quality, Unidimensional quality, and Must-be Quality. Figure 2.7 illustrates the graph:

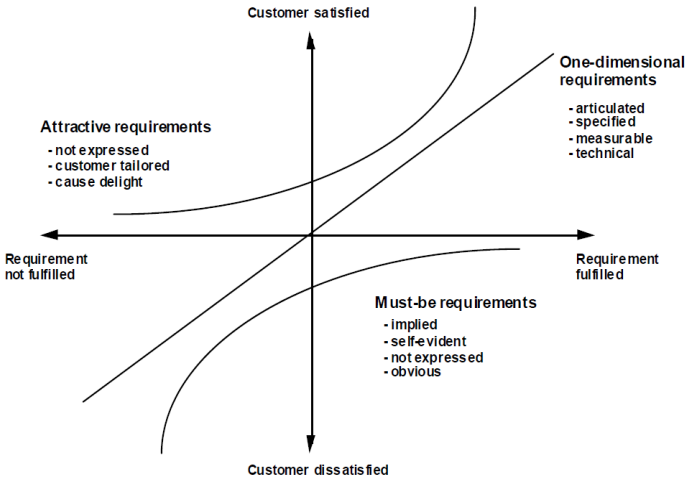

Figure 2.7 - The three types of requirements (Berger et al., 1993)

The 'arrow of time' that goes diagonally left-to-right signals the trend that is followed as time passes, which is features that denote attractive quality sooner or later become of unidimensional quality and features of unidimensional quality become of must be quality (Navas, 2017) as seen in Figure 2.8:

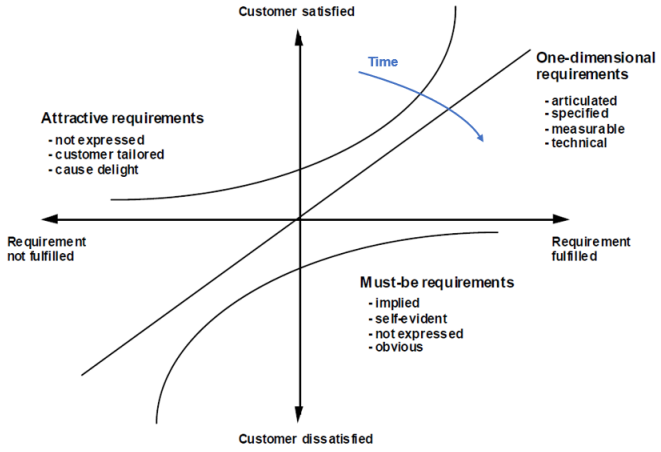

Figure 2.8 - The Arrow of Time (Adapted from Navas, 2017)

Attractive qualities will become standard in the market as competitors start catching up therefore competing on the same level. By then the feature has moved to being unidimensional as each company struggles to improve it and cause a bigger impact on customers. After some time however, Unidimensional features move to must-be features and no longer impress customers enough to be decisive in a purchase no matter how sophisticated and fine-tuned they are.

Identification of product requirements

To identify the features of the product being analyzed an interview guide that was of use in other studies(Högström et al., 2010; Sauerwein et al., 1996) is used (Table 2.6):

Table 2.6 - Identification of Customer Problems (Sauerwein et al., 1996)

1. Which associations does the customer make when using the product x?
2. Which problems/defects/complaints does the customer associate with the use of the product x?
3. Which criteria does the customer take into consideration when buying the product x?
4. Which new features or services would better meet the expectations of the customer? What would the customer change in the product x?

The answers to the first question are vague but allow for a general understanding of the attitude the customer has towards the product, its field of application and purpose. These generalizations can spark new innovative ideas for the product in question.

The second question is meant to gather not only the problems but also the desires the customer has over the use of the product.

The third question's answers indicate the unidimensional requirements the customer considers when buying the product.

The fourth question is useful to identify new features corresponding to customer desires that have not yet been implemented in the market.

Acquiring data through Kano inquiries

To place a feature inside one of these five categories, one has to hand-out inquiries to a meaningful population. The objective of the questions is to understand the change in products perception by the customer if the 'new' listed feature is present or absent. What the customer effectively does is to compare its idea of the status quo of the product with two other products that have or have not the 'new' feature. Table 2.7 gives an example of a Kano inquiry.

Table 2.7 - Example of General Question Handout (Adapted from Sauerwein et al., 1996)

	1. I like it	2. I expect it	3. I am neutral	4. I can tolerate it	5. I dislike it
How would you feel if [insert product] **has/has more of** [insert feature]?	☐	☐	☐	☐	☐
How would you feel if [insert product] **has not/has less of** [insert feature]?	☐	☐	☐	☐	☐

The next step is to cross the answers to both questions and assign each feature a category based on the answers given in the inquiries as shown in Table 2.8:

Table 2.8 - Feature to Category Table (Adapted from Sauerwein et al., 1996)

Customer Requirements		Dysfunctional/Negative Question				
		1. I like it	2. I expect it	3. I am neutral	4. I can tolerate it	5. I dislike it
Functional/Positive Question	1. I like it	Q	A	A	A	O
	2. I expect it	R	I	I	I	M
	3. I am neutral	R	I	I	I	M
	4. I can tolerate it	R	I	I	I	M
	5. I dislike it	R	R	R	R	Q

The final step is to count the answers of each inquiry in a table according to the answers obtained as in Table 2.9.

Table 2.9 - Product Requirements

Product Requirements	**A**	**O**	**M**	**Q**	**I**	**R**	Total	Category
Feature 1	a_1	o_1	m_1	q_1	i_1	r_1	$\{a_1,\ldots,r_1\}$	$Max(\{a_1,\ldots,r_1\})$
…	…			…			…	…
Feature n	a_n	o_n	m_n	q_n	i_n	r_n	$\{a_n,\ldots,r_n\}$	$Max(\{a_n,\ldots,r_n\})$

In this table, all the answers are considered, sorted, and counted, with each category having a number of answers. After the sorting and counting they are first subjected to two simple metrics: the total and the Max function represents merely the mental operation one does in assigning the feature into the most voted category of quality.

2.7 TRIZ Methodology

Idea generation methods used on problem solving usually rely on the intuition and knowledge of the participants in the method. This leads to such methods having unpredictable and unrepeatable results (Royzen, 1993).

TRIZ (*Teoriya Resheniya Izobretatelskikh Zadach* in Russian) literally Theory of Inventive Problem Solving is an organized and systematic approach to problem solving, with the

development of new solutions being driven by the Laws of Engineering System evolution (Ilevbare et al., 2013; Royzen, 1993).

Laws of Engineering System Evolution

The Laws of Engineering System Evolution are the theoretical basis of TRIZ. TRIZ considers the important steps in the evolution of engineering systems to be similar of nature, therefore constructing a system of possible steps a system can incur (Royzen, 1993):

- Increasing the degree of approaching the imaginary Ideal System.
- Contradiction Elimination.
- Reducing and increasing the number of subsystems.
- Increasing the degree of dynamism.
- Increasing the degree of control.
- Transition from macro to micro level.
- Application of different power fields in engineering.
- Matching and non-matching characteristics.
- Removing a human from taking part in performance and control of an engineering system.
- S-curve lifeline and three stages of the development of an engineering system.

These are called Laws of Engineering System Evolution (Royzen, 1993).

Increasing the degree of approaching the imaginary Ideal System.

TRIZ considers developments that are aligned with the path towards the Ideal System. The Ideal System is a system that does not exist, but its function is performed. The Ideal Solution is an approach to the Ideal System (Royzen, 1993). By the law of ideality any technical system shall approach the ideal solution as time goes on and discoveries and improvements are made. These improvements tend to reduce costs, energy wastes, reduce space and dimensional requirements, increase effectiveness, reliability, and simplicity (Navas, 2013).

Engineering Contradictions Elimination

An engineering contradiction Altshuller analysis of many patents reveals that the inventive value of different inventions is different across inventions (Navas, 2013) and that good solutions presented by an invention often mean the elimination of engineering contradictions

(Royzen, 1993) An engineering contradiction is a situation in which the improving of something in the system causes the deterioration of something else.

Solutions to eliminate contradictions are divided in 5 levels (Navas, 2013; Royzen, 1993):

First level solutions

First level solutions do not eliminate engineering contradictions, being feasible solution that can stem from 10-15 alternatives. Possible alternatives are well known, and improvement of a system is not very significant. They comprise 30% of the total patents analyzed.

Second level solutions

Second level solutions eliminate engineering contradictions by applying knowledge from the same discipline as the problem. They comprise 45% of the total patents.

Third level solutions

Third level solutions eliminate engineering contradictions by applying concepts from the same field of science as the problems, in example, solving a mechanical problem with a physical solution. In this level we find 20% of the total, and it is where creative design solutions appear.

Fourth level solutions

Fourth level solutions bring a solution from a different field of science to solve the problem, for example, solving a mechanical problem with a chemical solution. This level comprises about 4% of the total.

Fifth level solutions

Fifth level solutions are based on new scientific discoveries that define a new set of rules on which one can eliminate the contradiction. They comprise about 1% of the total.

To conclude, the higher the level of the solution the more significant is the system's improvement or cost reduction, and the higher level the solution the more alternatives there are to the solution. TRIZ problem solving tools help the user find solutions of the third and fourth level where the application of traditional engineering techniques does not produce results (Navas, 2013)

TRIZ Problem Solving tools include (Royzen Z., 1993):

- Principles and Chart for Eliminating Engineering Contradictions
- The Substance-Field Analysis
- The Standard Solutions for Inventive Problems
- The Algorithm for Inventive Problem Solving

However, the techniques used in this dissertation will only be the Principles and Chart for Eliminating Engineering Contradictions and the Laws of Engineering System Evolution.

Principles and Chart for Eliminating Engineering Contradictions

After a thorough analysis of patents, the findings suggest that there are 40 different principles for solving contradictions (Table 2.11) and 39 basic characteristics (Table 2.10) of a given system.

Table 2.10 - Engineering Parameters According to TRIZ (Navas, 2013)

1. Weight of moving object	21. Power
2. Weight of non-moving object	22. Waste of energy
3. Length of moving object	23. Waste of substance
4. Length of non-moving object	24. Loss of information
5. Area of moving object	25. Waste of time
6. Area of non-moving object	26. Amount of substance
7. Volume of moving object	27. Reliability
8. Volume of non-moving object	28. Accuracy of measurement
9. Speed	29. Accuracy of manufacturing
10. Force	30. Harmful factors acting on object
11. Tension, pressure	31. Harmful side effects
12. Shape	32. Manufacturability
13. Stability of object	33. Convenience of use
14. Strength	34. Repairability
15. Durability of moving object	35. Adaptability
16. Durability of non-moving object	36. Complexity of device
17. Temperature	37. Complexity of control
18. Brightness	38. Level of automation
19. Energy spent by moving object	39. Productivity
20. Energy spent by non-moving object	

Table 2.11 -Invention Principles of TRIZ (Navas, 2013)

1. Segmentation	21. Rushing through
2. Extraction	22. Convert harm into benefit
3. Local quality	23. Feedback
4. Asymmetry	24. Mediator
5. Combining	25. Self-service
6. Universality	26. Copying
7. Nesting	27. Inexpensive, short-lived object for expensive, durable one
8. Counterweight	28. Replacement of a mechanical system
9. Prior counteraction	29. Pneumatic or hydraulic construction
10. Prior action	30. Flexible membranes or thin film
11. Cushion in advance	31. Use of porous material
12. Equipotentiality	32. Changing the color
13. Inversion	33. Homogeneity
14. Spheroidicity	34. Rejecting and regenerating parts
15. Dynamicity	35. Transformation of the physical and chemical states of an object
16. Partial or overdone action	36. Phase transformation
17. Moving to a new dimension	37. Thermal expansion
18. Mechanical vibration	38. Use strong oxidizers
19. Periodic action	39. Inert environment
20. Continuity of a useful action	40. Composite materials

These 39 characteristics are plotted to a table in rows and columns, the rows being the characteristic which is improved and the columns being the characteristic in deterioration due to the improvement of the former. The table, as seen in Figure 2.9, suggests up to 4 different principles of invention for each conflict.

Which properties of the system change for the worse? / Properties of the system to be modified or improved		1	…	27	28	…	39
		Mass of the moving object	…	Reliability	Accuracy of measurement	…	Produktivity
1	Mass of the moving object			3, 11 1, 27	28,27 35,26		35, 3 24,37
…	…						
9	Speed	2, 28 13,38		**11,35 27,28**	28,32 1, 24		
10	Force	8, 1 37,18		3, 35 13,21	35,10 23,24		3, 28 35,37
…	…						
39	Productivity	35,26 24,37		1, 35 10,38	1, 10 34,28		

Figure 2.9 - Search for Solution Principles using the Contradiction Table (Livotov, 2008)

For a situation in which the speed needs to be improved (more or less speed) but the reliability of the system decreases there are two principal solutions: principle 11 (Cushion in advance) and 35 (Transformation of the physical and chemical states of an object). There are also two secondary solutions: principle 27 (Inexpensive, short-lived object for expensive, durable one) and 28 (Replacement of a mechanical system)(Livotov, 2008).

S-curve lifeline of a product or technology

There are three stages of development of any technology (Royzen,1993):

First Stage:

The first stage is the early stage of the technology. In this stage it is necessary to put a lot of effort, time and money in order to achieve meaningful progress, therefore research moves slowly across time as the engineering system needs many high-level solutions to be workable.

Second Stage:

The second stage is reached as soon as there are enough high-level solutions that let the system be workable. Then, progress is quicker as there is no need for deep research as in the first level.

Third Stage:

In the third stage the engineering system reaches its development limit where the solutions become increasing low level and the improvements in the technology do not lead to a significant improvement in the performance of the engineering system.

3

CRITICAL ANALYSIS OF EXISTING METHODOLOGIES

In this chapter a critical analysis of the existing methodologies is carried out. There are several aspects to point out, namely the relative vagueness of some methodologies and the technicality of others. While the former can only provide vague answers the latter's technicality can hinder its use.

Business Model Canvas

As cited in Ching & Fauvel, 2013 the model is complex and not self-explanatory. For example, the authors refer that the students needed to be introduced to it and had difficulty distinguishing between Customer Relationships and Channels or to understand what a Value Proposition is exactly. Two additional problems mentioned by the authors are that the BMC does not mention competitors to the business and there is an apparent lack of detail on cost/revenue structures. The authors refer that this model is useful for early entrepreneurs because of its generality. However, to more experienced entrepreneurs a variation of the BMC that fits their business better is recommended.

Another author (Coes, 2014) cites the BMC as a methodology in which the goal is to create value with revenue in return, excluding non-profit organizations and governmental organizations. Moreover, it is a methodology that does not consider competitors, market factors and other external forces(Coes, 2014).

Design Thinking (Stanford)

Design thinking is a framework for developing a product that solves a specific problem. It is a general tool that can be applied to any situation. However, this generality hides processes

that are dependent on the practitioner ability and creativity to harness. It is a vague framework that does not refer specifically issues related to market or to technology.

Value Creation Wheel

The Value Creation Wheel is a framework that is complex and flexible. However, this flexibility implies generality and dependence on the user's ability to brainstorm solutions and to wage an effective discussion on how to rank these solutions and filter them. The Value Creation Wheel method is too general to apply in a context of entrepreneurship as does not offer concrete views on technology and market, being only a framework for more concrete methodologies to be applied. These other more concrete methodologies need to be known by the practitioners and may not add anything relevant to the discussion of the problem.

Kano Model

The Kano model is a tool that allows a diagnostic of customer needs into categories that represent different levels of product quality as viewed by the customer. However, this tool does not consider the intricacies of the development process, nor the technology involved to meet customer needs. Moreover, it does not distinguish between product characteristics that are in the same category of quality, leaving the designer of the product alone in the decisions to make (Shahin et al., 2013).

TRIZ Methodology

A review on TRIZ to study its benefits and challenges in practice concluded that there are 6 main challenges in applying TRIZ. Those challenges are mainly concentrated on its learning and application. TRIZ is a complex tool rather difficult to apply and to learn. Also, this methodology contains many methods and multiple approaches to solving a problem, resulting in bottlenecks related to choosing the best method and applying it. It also requires a lot of time to get to know the methodology and apply it well (Ilevbare et al., 2013).

Moreover, this methodology is too centered on the technology, having no space for business related topics as customer needs and wants and market penetration of the technology are not discussed.

SWOT Analysis used in case-studies:

A study using SWOT analysis and the resource-based view of the firm was conducted in Italy to evaluate micro and small wine businesses. The findings suggest that a SWOT analysis "helped complement the usefulness of the resource-based view of the firm and extended the

findings to identify clear gaps or needs"(Alonso & Bressan, 2016). The SWOT analysis is therefore less general and more precise when coupled to the resource view of the firm.

Another study was made to 20 UK manufacturing companies in 1993-1994 regarding the use of SWOT analysis (Hill & Westbrook, 1997). This study suggests that SWOT Analysis when used solely tends to produce low quality results, with overlaps in content, general phrases with no description and non-explained contradictions i.e., a phrase appearing both in strengths and weaknesses. However, SWOT remains popular because it is very straightforward and requires little preparation on anyone's part also because it is the easiest entry analysis to perform and can trigger debate over contradictions appearing in its process. This debate however relies heavily on the performers ability to stir it and produce deeper and meaningful findings (Hill & Westbrook, 1997).

Overall SWOT analysis is very business centered without any reference to technology. Moreover, it is a general methodology, and it depends on the ability of its practitioners to find any meaningful result.

4

Interviews with Small Business Owners

In this chapter a collection of interviews will be analysed to inquire about how and if the described methodologies in chapter 2 are used by the interviewed entrepreneurs. The main objective is to understand if the interviewed subjects could have used a methodological approach to transform an idea into a business. From there conclusions about the viability of a methodological approach are derived.

4.1 Interview Guideline

In this section the interview guideline is presented. The interview is divided into four parts:

- Contextualization:
  Where general questions about the interviewed are asked.
- Product/Market fit:
  Where it is asked about the technology view/market view dichotomy.
- Evaluation of the utility of Methodologies for an entrepreneur:
  Where the entrepreneur is asked directly about methodologies that he may have used in the conception of the business and about blockers encountered during the said conception of the business.
- Lessons Learned:
  Where the interviewed expresses what he learned during the process of conception of a business.

4.2 Interviews Results

In this section the interview results are shown (Table 4.1) and discussed. A sample of an interview can be consulted in the Appendix 1:

Table 4.1 - Interview findings

	Entrepreneur A	Entrepreneur B	Entrepreneur C
Education	MSc. Mechanical Engineer	MSc. Mechanical Engineer	MSc. Mechanical Engineer
Tech/Market Trigger	Fragmented supply (Market trigger)	Networking and legislation opportunity (Market trigger)	Problem solving of family need (Market trigger)
Idea/Prototype	Conveyor Systems Development	Renewable Energy Services	Hardware Development and Prototyping
Vision/Mission	Defined in the beginning, slightly changed	Defined in the beginning	Defined in the beginning
Technological Innovation (tech risk)	Incremental Innovation	Not Innovative	Innovative (Patent Possibility)
New market prospection (market risk)	Customization Market Experience	Market Experience	No Market experience. Niche market identification
Product-Market fit	Technology pull	Market pull	Market pull
Known Methodologies/Frameworks	SWOT and Business Plan	SWOT and Business Plan	TRIZ, BMC, SWOT, Design thinking
Use of Methodologies/Frameworks	SWOT and Business Plan	Only Business Plan	Uses TRIZ on technology development and SWOT analysis
Funding	Own capital. Avoidance of venture capital	Own capital	Own capital and public investment
Bottlenecks	Lack of technicians with enough expertise (market)	Adaptation to legislation changes (market)	Lack of funds (market)

4.3 Discussion of Results

All three entrepreneurs are in very distinct areas of business, A and B are small businesses related to technology that are already in market for many years and C is a start-up that is not yet in market. The trigger was always on the market side, being never an existing technology that was then adapted to market. Instead, the entrepreneurs always started with a market need inserted in a story that was different for each entrepreneur and which led them to obtain the technology adequate to fill the need. Entrepreneurs A and B devised their market need and subsequently developed their business idea due to experience in the respective field. In the case of entrepreneur C, the market need was brought to him through a family member's health condition, and not by any kind of experience in the field.

The vision of the three entrepreneurs was very clear since the beginning and seldomly changed over the course of the company's life. For entrepreneur A the vision initially was to maintain conveyor systems and then expanded to design and maintenance of custom conveyor systems. Entrepreneur B had a vision (deliver and assembly of solar panels) for the company that was maintained despite the market he was operating being affected by legislation. Entrepreneur C had a vision which is to develop and license new hardware to solve existing problems, one product at the time. This vision is changing over time to developing and small-scale production to obtain the desired funding for projects.

On product development it is noted that both entrepreneurs A and B have a sales strategy focused on customization of the service (A and B) and of the product (A) while C focuses on the development of a product for an identified niche market. Entrepreneur C is the one where the product has higher market risk, due to the niche market it is inserted in and technology risk due to the product involving patents.

It is observed that from the methodologies described in chapter 2 entrepreneurs A and B solely used SWOT analysis and Business Model Plan while C has knowledge of SWOT, TRIZ, Kano Model and Design Thinking and applied SWOT, TRIZ and Design Thinking to its project. This difference can be justified by C being a younger entrepreneur and therefore having contact with these methodologies through academia, attended courses and mentoring. Entrepreneur C's business also deals with innovation directly and was founded specifically to trade innovation while entrepreneur A and B founded their business after having worked in the field as employees of other companies.

Interestingly all entrepreneurs used SWOT analysis, albeit for different reasons. Entrepreneurs A and B used SWOT to define the best strategy of operation for their businesses. Entrepreneur C used SWOT to obtain funding.

Entrepreneurs A and B used their own capital when founding the company and entrepreneur A avoided using venture capital as the company in his vision should have a sustained growth. The bottlenecks cited by A were lack of technicians with sufficient autonomy to perform certain duties in the shop floor. B cited adaptation to legislation changes while C stated that there was a lack of institutional funding for small companies focused on hardware innovation.

5

A New Methodology Proposal

In this chapter an approach to transforming an idea into a business is presented. This approach was thought upon the realization that the current methodologies and frameworks did not explicitly discuss market risk and technology risk.

The BMC describes the situation of the business discussing mostly matters related to market risk in an indirect way. The VCW includes the vision of the stakeholders but does not explicitly mark the difference between the two risks. Design Thinking, Kano Model and SWOT analysis discuss the market risks in an indirect way while TRIZ focuses solely on technology risks.

This led to thoughts of creating a framework that would incorporate explicitly both the market and technology risks. This framework is more appropriate for businesses involving technology, being start-ups or small companies that work with a technology.

This new methodology starts with a technological or market trigger, meaning the entrepreneur looks at either the market or the technology and finds a market need or discovers a new marketable aspect of the technology. Hence, an idea is generated in a synergy with the vision of the company.

It then divides the risk into two dimensions: a market dimension and a technology dimension. It is considered that the financing risks result from the two primary risks, being itself a secondary risk, meaning that a company with no market or technology risks has an increased probability of obtaining funding. A good example is a newly formed construction company, which operates in an existing market selling a service that already exists and is being sold. This company will easily raise large sums of capital from institutional lenders. In the case of a start-up that risks in commercializing a new product for a new market the odds of raising enough

capital from institutional lenders are low. This start-up will have to bet on risk capital and business angels, therefore splitting the risk between the stakeholders.

The market dimension is where everything associated with market issues i.e., potential customers and value proposition come into play while in the technology dimension what is valuable to consider is the technical feasibility of the idea and the technological hurdles to overcome to implement the idea on the market. Inside each dimension there is the option to use methodologies to reach the findings. In the technology dimension, one can use the TRIZ methodology, Kano Model or SCAMPER methodology to infer what technologies will contribute to making the product. In the market dimension one can use the Kano Model, the 5 C's, the SWOT analysis and the PESTEL to infer the market size of such a technical solution and the type of customers that the idea can appeal to. Figure 5.1 details the approach describing the above-mentioned steps.

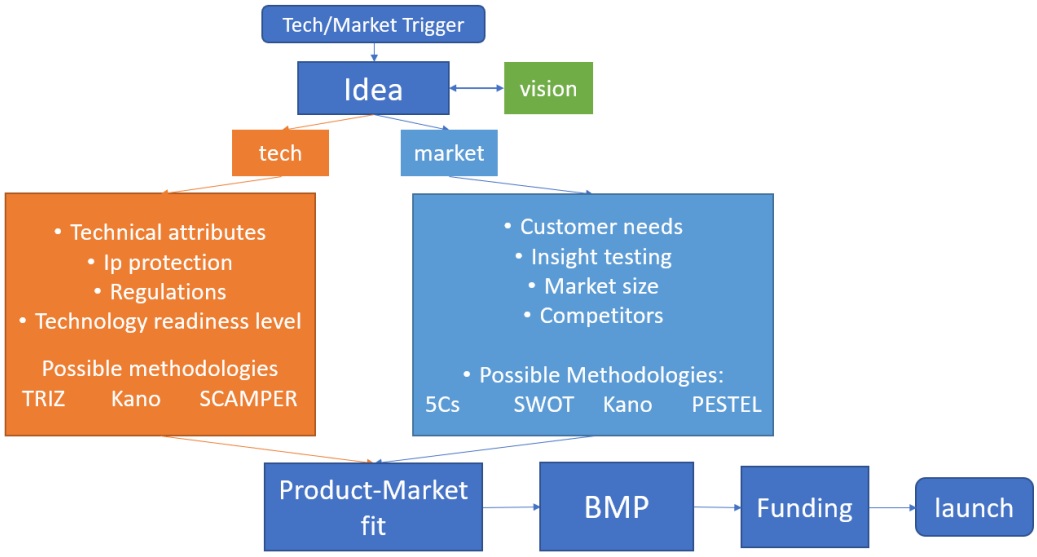

Figure 5.1 - Methodology for market launch of small business projects

It is expected that after all the steps from the technology dimension (in orange) and the market dimension (in light blue) a Product-market fit (the degree which market needs are answered by the product's features) is defined with ease, recurring if needed to the possible methodologies to help with the definition of the market (see the Possible Methodologies in the light blue box) and to help with the definition of the product (see the Possible Methodologies in the orange box). In the end there is the development of a Business Model Plan (BMP) to obtain funding from venture capital and then finally, the launch of the company.

5.1 Defining Technology View

The technology view encompasses the products technical attributes, its intellectual property, the regulations that the product might be subjected and the Technology Readiness Level. The purpose of defining a technology view is to investigate the technological challenges that might emerge within the implementation process, to address them upfront. Defining a technology view can be approached after an idea is already generated, together with defining the market view. After the technology view is defined, the identified technological challenges can be addressed with TRIZ.

5.1.1 Technical Attributes

Technical Attributes are intended as the specifications of the product. From there it is inferred the technology the product must have to meet those specifications. In example one smartphone technical attribute is the internet connectivity. Then it requires both software and hardware to perform its function. The technology behind a technical attribute can be eligible for a patent.

5.1.2 Intellectual Property Protection

Intellectual Property Protection is where it is verified if the technology behind a technical attribute can be eligible for a patent. A patent is a contract between a company or a person and the state or an international organization stating that the product or feature in the product is protected meaning only the person or company can extract benefits from the product or feature for usually 20 years. A patent is, in its broad sense, something that is inventive and novel over what already exists. The method to determine if a product is eligible from a patent is to take the most similar looking product and the most similar functioning product and compare to the new invented product to assess its novelty and inventive value. An interview to a patent examiner was performed and is available at Appendix 2.

5.1.3 Regulations

Regulations are important to ensure the product is sold according to the laws of the country where it is being sold. In the EU market, all products must obey to a set of rules imposed by the European Commission. Table 5.1 details the scope of industrial products that

need regulation and their corresponding directive. If the product belongs to one of those categories, legislation is needed to be considered during the design of the product.

Table 5.1 - List of products subjected to EU product rules (European Commission, 2016)

This guide primarily relates to the Union legislation on:

- The restriction of the use of certain hazardous substances in electrical and electronic equipment (Directive 2011/65/EU)
- Appliances burning gaseous fuels (Directive 2009/142/EC)
- Ecodesign requirements for energy-related products (Directive 2009/125/EC)
- Simple pressure vessels (Directive 2009/105/EC and Directive 2014/29/EU)
- Toys' safety (Directive 2009/48/EC)
- Electrical equipment designed for use within certain voltage limits (Directive 2006/95/EC and Directive 2014/35/EU)
- Machinery (Directive 2006/42/EC)
- Electromagnetic compatibility (Directive 2004/108/EC and Directive 2014/30/EU)
- Measuring instruments (Directive 2004/22/EC and Directive 2014/32/EU)
- Non-automatic weighing instruments (Directive 2009/23/EC and Directive 2014/31/EU)
- Cableway installations designed to carry persons (Directive 2000/9/EC)
- Radio equipment and telecommunications terminal equipment (Directive 1999/5/EC and Directive 2014/53/EU)
- Active implantable medical devices (Directive 90/385/EEC)
- Medical devices (Directive 93/42/EEC)
- *In vitro* diagnostic medical devices (Directive 98/79/EC)
- Pressure equipment (Directive 97/23/EC and Directive 2014/68/EU)
- Transportable Pressure equipment (Directive 2010/35/EU)
- Aerosol Dispensers (Directive 75/324/EEC as amended)
- Lifts (Directive 95/16/EC and 2014/33/EU)
- Recreational craft (Directive 94/25/EC and Directive 2013/53/EU)
- Equipment and protective systems intended for use in potentially explosive atmospheres (Directive 94/9/EC and Directive 2014/34/EU)
- Explosives for civil uses (Directive 93/15/EEC and Directive 2014/28/EU)
- Pyrotechnics (Directive 2013/29/EU)
- Regulation on the Labelling of Tyres (Regulation (EC) No 1222/2009)
- Personal protective equipment (Directive 89/686/EEC)
- Marine equipment (Directive 96/98/EC and Directive 2014/90/EU)
- Noise emission in the environment by equipment for use outdoors (Directive 2000/14/EC)
- Emissions from non-road mobile machinery (Directive 97/68/EC as amended)
- Energy labelling (Directive 2010/30/EU)

If the product is to be sold in the European Economic Area and it belongs to any of the categories in it needs the CE marking, obtained after the manufacturer issues a declaration stating that the product meets the specifications on the legislation. The letters 'CE' appear in this shape (Figure 5.2):

Figure 5.2 - CE mark (European Commission, 2016)

5.1.4 Technology Readiness level

Technology readiness level is a set of stages used to measure technologies in development. It has nine stages ordered from one to nine. The less developed the technology is the lower it scores on the scale, scoring the highest score the technology successfully used on the real world. In Figure 5.3 it is shown the definition of each stage: ~

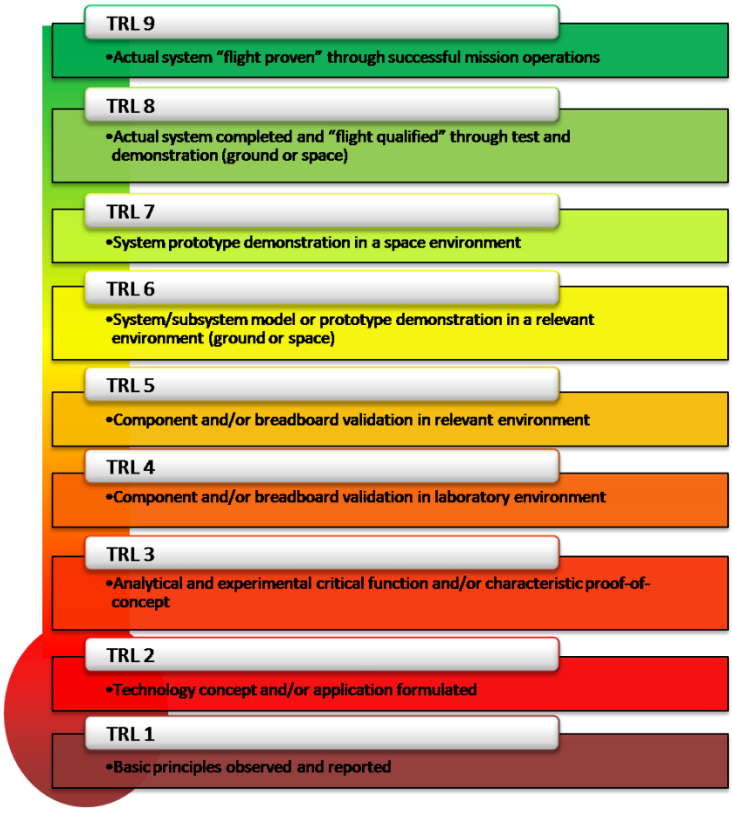

Figure 5.3 - Technology Readiness Level (Dunbar, 2021)

5.2 Defining Market View

The market view encompasses customer needs, insight testing, market dimension and competitors. The purpose of defining a market view is to understand how the market for the product looks like and if there is a market need. Defining a market view can be approached after an idea is already generated, together with defining the technology view.

5.2.1 Customer needs

Modern customer needs theory (Bayus, 2008) can be summarized in Figure 5.4 :

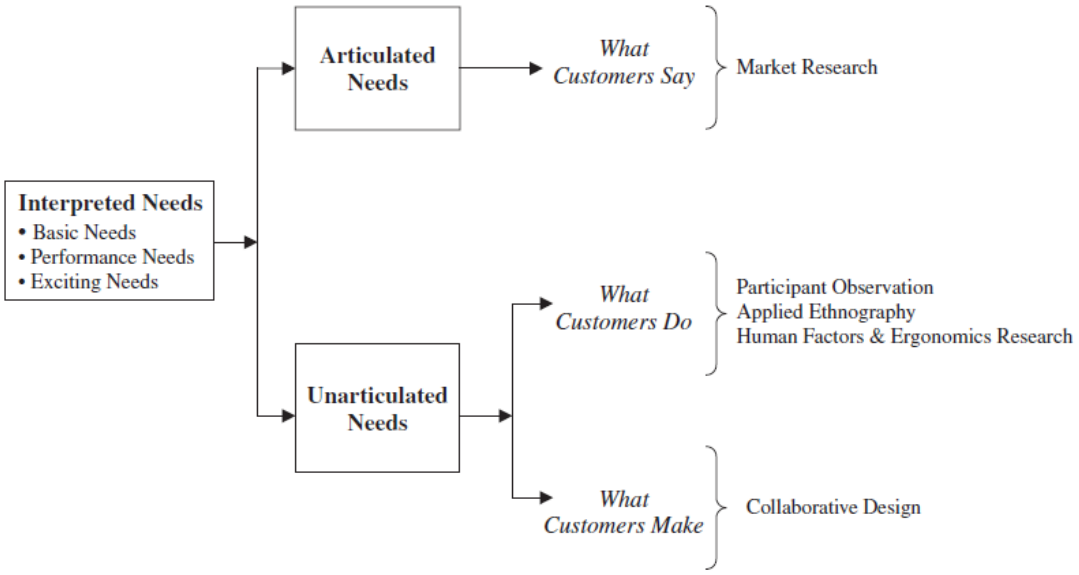

Figure 5.4 - Types of customer needs (Bayus, 2008)

Customer needs, following the Kano Model approach in which basic needs represent must-be quality, performance needs stand for unidimensional quality and exciting needs stand for attractive quality. The Customer might or might not be able to articulate its needs so observation techniques and participation in product development are employed.

5.2.2 Insight testing

Normally insight testing is done with a simple inquiry to the targeted customer segment and should be short and concise. It consists of two steps:

1. Collect customer information such as:

- Gender,
- Age group,
- Has job/is student
- Current Studies
- Responsibility for bills (who usually pays the bills / does the shopping)

2. Collect data relevant to the product
    - What if you could solve this problem with this product?
    - How much are you willing to pay for a product that solves you this problem?
    - Would you recommend this product to a friend?

This questionnaire shall provide insights into the customer perspective and shall give an initial view of the acceptance of the product in the market as well of its perceived value for the customer.

5.2.3 Market Size

Market size can be measured with inquiries and government statistics institute data. It consists of how many buyers can the product appeal to and of the characteristics that define those buyers.

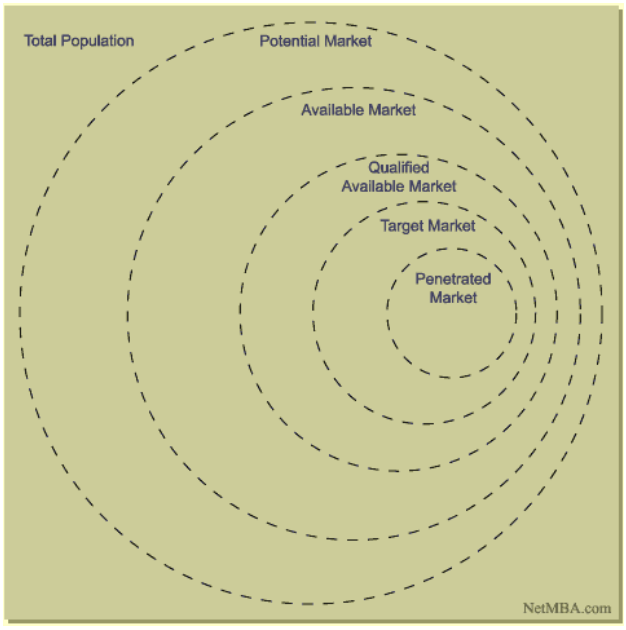

Figure 5.5 - Market Definition Diagram (Internet Center for Management and Business Administration, 2010)

Figure 5.5 summarizes the types of market existing for a given product (Internet Center for Management and Business Administration, 2010):

- Potential Market:
  Those who are interested in the product
- Available Market:
  Those that have money available to buy the product
- Qualified Available Market:
  Those that are legally allowed to buy the product
- Target Market:
  The segment of market that the firm decided to serve
- Penetrated Market:
  Those that have purchased the product

Customers can also be divided into segments according to when they purchase a product or service:

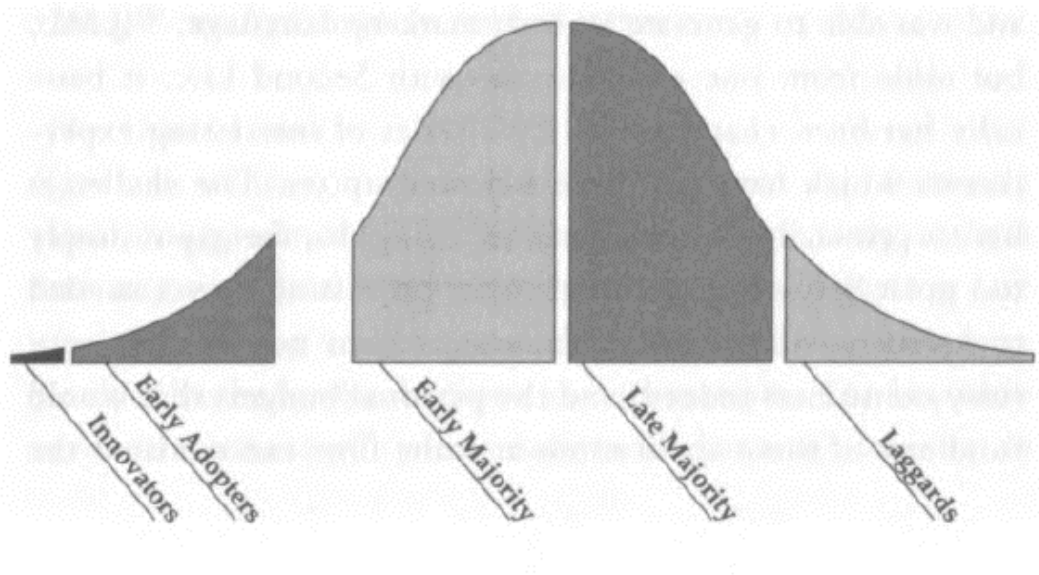

Figure 5.6 - The Revised Technology Adoption Lifecycle (Moore, 2014)

Those segments are Innovators, Early Adopters, Early Majority, Late Majority and *Laggards*. Each segment has an attributed market size according to Figure 5.6 and are defined as (Moore, 2014):

- Innovators (Techies):
  Those who are the first to purchase the product and are looking to spend the money on something innovative.

- Early Adopters (Visionaries):
  Those who are not technologists and that are looking to solve a problem spending their money on new technology. They just need a proof of concept to buy the new technology, relying on intuition and vision to purchase it. Early adopters are essential to open any high-tech market segment.
- Early Majority (Pragmatists):
  Those who are driven by a sense of practicality while sharing some traits with the early adopters but need to wait until they decide to purchase the product. Normally they buy technology when the same technology has enough well-established references (for example peer recommendation) for them to justify the purchase. This group comprises one-third of the total market segment.
- Late Majority:
  Those who wait until the technology becomes a standard and tend to buy from large well-established companies. Like the early majority this group comprises one-third of the total market segment.
- *Laggards*:
  Those who don't want to buy the technology because they show no interest. From market perspective, laggards are not worth pursuing.

For a product to progress through these customer categories it needs to overcome hiatus, the bigger of them being between early adopters and the early majority. This transition typically goes unrecognized. The early adopters are buying a business advantage by being the first to buy the technology while the early majority wants to buy a productivity improvement for existing operations. The early adopters are looking for a fundamental breakthrough, and technology is important only to match their vision. They are the least price sensitive and are the drivers of progress because they invest large sums of money on the technology required to implement their vision. The early majority on the other hand like measurable and predictable progress. They buy quality, supporting infrastructure and reliability of service, as they plan on living with the product for the years that may come.(Moore, 2014)

A contradiction is identified as the early majority (pragmatists) will not buy the product unless they know someone who has bought the product. This sparks as a contradiction because the pragmatists tend to communicate only with themselves while the early adopters tend to do it across types. To communicate the product to the pragmatists, one has to be patient and

slowly build their trust through partnerships with other older firms and through appearance in the usual sales channels' pragmatists use (Moore, 2014).

5.2.4 Competitors

Competitors are companies that rival each other targeting the same market.

If two companies directly compete with each other it means they sell the same product to the same type of customers i.e., Coca-Cola and PepsiCo, and if they compete indirectly with each other then they sell different products to the same type of customer i.e., Pizza-Hut and McDonalds.

When making a new product a company must ask what alternatives people have to the product being developed. These alternatives need to be evaluated and its Customer Value compared with the product CV.

5.3 Product-Market fit

Product-Market fit is the product development process and adaptations after testing with customers to attend their needs and wants the best way as possible and is a continuous process. According to Andy Rachleff, a good product-market fit is the key to the success of a start-up, as nothing can replace a product that sells. The term product/market fit was developed by Andy Rachleff inspired in the investing style of Don Valentine. A good product-market fit is developed on top of a solid value hypothesis. According to Andy Rachleff, a value hypothesis is

"… an attempt to articulate the key assumption that underlies why a customer is likely to use your product. Identifying a compelling value hypothesis is what I call finding product/market fit. A value hypothesis identifies the features you need to build, the audience that's likely to care, and the business model required to entice a customer to buy your product."

To reach this value hypothesis one can use the methodologies mentioned in Figure 5.1. One of the objectives will be to verify if the idea triggered by the market or the technology is valuable for the customer. This is done recurring to customer inquiries like those explained in insight testing and can be also done through Kano inquiries if the objective is to better an existing product. To identify the features that need building, besides the Kano Model, one can apply the TRIZ methodology to devise the direction in which technology is moving and to solve

problems related to the implementation of the technology. To help devise a business model one can employ a SWOT analysis to the environment the company will be operating in.

One common mistake the entrepreneurs incur is to develop their first products thinking about the early majority (see Figure 5.6) instead of finding the early adopters of the technology to whom they should be tapping into (Maples & Rachleff, 2019). Once the value hypothesis is proven through word of mouth one starts to wonder about a growth hypothesis. A growth hypothesis is the mechanisms through which you can increase the number of your customers and should only be though about when one already has a solid value hypothesis (Rachleff, 2013).

5.4 Discussion

There were some matters that were impossible to cover due to time constraints, namely the role of market and technology triggers and how they happen. Also, the number of interviews would be enlarged provided there was enough time.

Along this thesis it was thought that some methodologies related to technology and market ought to be used inside the framework being worked on, namely TRIZ, Kano Model and SWOT analysis. The initial idea was to develop a path of methodology application for the entrepreneur to apply one after the other and reach a meaningful conclusion after the application of such methodologies in order (TRIZ —> Kano Model —> SWOT).

It was quickly realized after the interviews that the whole approach should place more decision power in the hands of the entrepreneur instead of demanding he or she to apply these methodologies in order. By reflecting upon the interviews, it was realized that entrepreneurs would not use a methodology that wasn't simple, practical, and straightforward, as two of the three entrepreneurs interviewed didn't had knowledge about methodologies such as TRIZ or Kano Model, let alone Design Thinking or VCW. The only methodology known commonly between them was the SWOT analysis. Therefore, it was impossible for them to effectively use a framework that mixed unknown methodologies.

The approach was then changed. It included the methodologies mentioned but the entrepreneur had the freedom to use or not use them.

Instead, the focus was turn to the market and technology dimensions. From the strategic management tools that were studied in this thesis there was no clear reference to market and technology risks. Some methodologies dealt with market risks and TRIZ alone dealt with

technology risks. So, there was the idea of separating the idea into its technology dimension (dealing with the technology risks) and into its market dimension (dealing with its market risks). Some topics inside each dimension (market/technology dimension) were introduced as food for thought for the entrepreneur. The aim of these topics is to provide a foundation of thought about each dimension, and to prepare the entrepreneur for a successful product-market fit and an insightful business model plan.

Since the beginning of this dissertation, it was understood that what makes companies fail is mainly the fact that there is no market for the product being sold. This framework allows an entrepreneur to really think about the two major bottlenecks that can hinder the development of a product from an idea: market, and technology. Moreover, it allows the entrepreneur to reflect upon the idea of product-market fit and to find a business model plan suitable for the business.

From the model it is expected to be simple and accessible to all entrepreneurs that want to make use of it. The entrepreneurs that make use of it should gain the notion of both risks (market and technology) that exist when launching a business and act accordingly to mitigate those risks, with or without methodologies to apply inside the framework.

The limitation of this study is the reduced number of interviews, with only one nascent start-up and two small well established businesses. Therefore, the conclusions are not very robust and further studies are required. The limited timeframe was a blocker to conducting more interviews and analysing the results.

6

Conclusion

The objectives of this study were to reflect upon the process of developing a business idea since its trigger towards its business model plan and to discover the main success factors of companies. From those reflections a framework destined to model the idea development into a business was created and subsequently validated based on qualitative interviews to founders of companies. The result was a methodology of the process that spams from the trigger of the idea to the start-up launch. This new methodology encompasses a division of the idea into two dimensions, a market dimension and a technology dimension with both dimensions being analysed and relevant methodologies employed in both dimensions. A product market fit is then performed, and a business plan is carried out for the project to obtain the necessary funding for launch.

This methodology serves to help the person trying to found a start-up, as it sets guidelines and offers other methodologies to effectively solve problems that one may encounter during the development phase of its start-up.

Moreover, it divides the risks incurred when founding a start-up or running a small business into two main dimensions of risk: market risk and technology risk, respectively associated with their dimensions. The main task of this new methodology is then to help the entrepreneur in mitigating those risks to make sure a there is a successful product-market fit and the entrepreneur is successful in raising capital for the enterprise.

Further work can be done related to inquiring if such theoretical frameworks are useful for an entrepreneur who is beginning is activity as an entrepreneur or for a small business owner wanting to expand the business. Further work can also be carried out enlarging the sample of interviewed subjects to collect more data.

Overall, the main objectives of this thesis were accomplished with special emphasis on the comprehension of the market and technology risks a start-up must face and how to mitigate those risks.

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APPENDIXES

Appendix 1 - Interview with Entrepreneur A:

Foreword:

This interview was conducted on 12th February 2021, 6:00 – 06:32 pm GMT with Entrepreneur A who works as Chief of Operations at Mime in the field of Industrial Maintenance, Assemblies and Engineering Services. This interview serves to clarify the aspects related to the role of patents in the innovation process and aims to give a more comprehensive view on the world of patents.

Francisco: Good afternoon, first, I want to ask some questions about your background and after that some questions about the company itself and the story behind it, is that okay?

A: Good afternoon, Francisco, it is okay, we can start.

F: So, what is your education?

A: I have a master's degree in Mechanical Engineering and an ongoing PhD in Mechanical Engineering, all pre-Bologna

F: And what is your working experience?

A: Well, I … beforehand let me ask you your age.

F: I am 24 years old

A: Quite young I see … Well Francisco I first worked for Jorge de Mello group, more specifically at a factory at Almada, Tagol. I was in the group for 11 years, meanwhile the group started its internationalization process, which I remember perfectly. I went to the group's factory in Spain at the start of the internationalization process, I was six years in Spain, then I was working for other worldwide factory projects and in America. At 34 years old I founded Mime together with two other colleagues and after that I've been working in Mime ever since.

F: What about the mission of your company, was it always the same or it changed over the years?

A: There was a small change on the mission of the company at 2/3 years of operation. Initially we started with maintenance contracts in various factories across the country (Portugal), but we started to understand that our customers wanted a more integrated solution such as customer support and engineering solutions, so we started to manufacture the equipment ourselves to sell to our customers, and thus the manufacturing side of the business is born.

F: How did you had the idea of creating the company?

A: Mime was born out of a challenge. My superior challenged me because he saw that I was a person that could work autonomously, with the right profile. Together we concluded that in the factories of the group there were many machines of the type we now manufacture. And we verified that in the market the supply of these machines was completely fragmented. Years ago, there were structured and experienced companies supplying these products but along the years, since the year 2000 these companies began to close due to various reasons. The small companies that were left didn't have a very strong engineering component and we know that in regular or small companies there is not the will or the availability to form an engineering department, only in big, structured companies such as EDP. If there is no engineering department then the engineering must be bought somewhere. And that was our vantage point available to our customers and one of the reasons of our company success.

F: So, you started to think first on the market dimension of the problem and then on the technological dimension, right? (7:45)

A: It was quite the opposite. First, we thought about what we were able to do and about the equipment we would sell. The two things must come up almost at the same time and must be developed in parallel. In one hand we must have the know-how but in the other hand we must understand if there is a market need for what we are able to do. And that is what we did, it was almost simultaneously that we developed both dimensions. Along the years, when the company is established on the market, we can think first about what the market wants and after that about the machines we will develop to fit the market need.

F: In an initial phase both dimensions must come in parallel but as you establish yourself there is a tendency to adopt a market first approach.

A: Exactly yes. The first idea is having the know-how and the customer ready to buy the product. Then, having the know-how we can develop new competences and we can search the market finding the gaps that are not served and try to adapt ourselves to those gaps.

F: What if you could start again, would there be something that you would do different?

A: First, my head aches when I think about starting it all over again. You need a lot of energy and determination, and the path is hard and difficult. Either you do it young or you don't do it at all. I don't have any major regrets. We could have accelerated the process a bit more. I know I am an entrepreneur, but I don't like to require funding from venture capital or other sources because I am a reserved person, it is part of my personality. So, the growth of the company has been slow and organic. And that takes longer than leveraged growth. As I said I prefer to employ my capital to create something that is in my responsibility. Maybe if I had leveraged the company more maybe we would be more international now and probably with more customers and cashflow. (12:05)

F: And what kind of methodologies do you know, for example SWOT, Business Model Canvas, Business Model Plan, TRIZ, Kano Model, Design Thinking…

A: From all of those we apply on the Business Model Plan the SWOT analysis for example, but you must know that everything is very practical and must be tested on the field. I would say in the beginning we did a lot of simulations and employed a lot of strategic thinking because we had no background, nothing to base ourselves on. Without a background is more difficult to plan and to do certain things.

F: This means these methodologies are only used in the beginning?

A: These methodologies can be used anytime; the issue is that experience is also a good methodology and as we 'feel' the market the market tells us where we should go with our products. That is what has been happening, the growth of the company is due to word of mouth from the customer side.

Professor Fernanda: Excuse me for the interruption, I am the co-adviser of this thesis, and I would like to ask a question: You talked about BMP and SWOT. Do you think that, as an entrepreneur, there would be other methodologies that you find to be practical and useful?

A: In our case we use SWOT a lot and what we learn from experience. We haven't been using other methodologies to the moment.

Francisco: And what about product development, do you use any methodology to develop new products?

A: As I said, what we do is keeping an eye on the market to find the 'gaps' and then fill those 'gaps' with a machine that we develop specifically for the purpose. In our company we have a rule which is to develop a new machine per year. Then the machine goes to our portfolio. Our strategic vision is to grow on this condition of systematically finding the needs and filling them with our products. For example, last year we developed a machine to assemble into another machine that we developed earlier. As I said we develop one machine per year but

without deviating from the path that we established for the company, which has three branches of operation and what we offer must relate to those three branches of business.

F: And what kind of technical/technological hurdles did you encounter during the development of such machines?

A: Well, in Portugal we have this problem of not having technical personnel in quantity. We have very good technicians but not as many as we would like. And this is a general problem affecting many areas. That is our biggest problem. Finding people that autonomously can manufacture our equipment. (17:59)

F: But for example, you don't have problems with specific things during manufacturing like part assembly?

A: Normally what we do is a lot of work in the blueprints. We work a lot to draw every part. If later we encounter something that we are not sure how it works, before launching the machine to the market we build a prototype and test the specific feature. And that is our methodology. We are developing vibration transporters for the food industry and there are certain components that we are not sure that work and we will have to build and test prototypes.

F: And what challenges do you face in selling your products?

A: The Portuguese market is a bit 'cold'. There is no confidence from companies to invest and this has to do with the political instability of the country that arises sometimes. A company like ours goes after the investment other companies make and in times of little investment, we have our maintenance branch that provides us with cashflow.

F: And don't you think that a theoretical background to identify your customer needs or the most adequate market segments would be of use to the company, feedback forms included?

A: That is a very relevant question. We haven't implemented that due to the structure of the company not being big enough to have available time to do such things, but I am aware that written feedback from clients would be very welcomed to implement the continuous improvement of the processes, products, and services. However, the structure we have does not allow us to reach everything we want to reach. For example, for this year we have an ongoing certification of our processes to value them and to better them. But of course, this company has a squeezed structure and has 11 years so in the future we will think about that. In terms of feedback forms I think it would be very important to have them. I also don't know if the clients would be available to fill that kind of forms.

F: And don't you think that forms prior to the development of the product would be interesting to know what the customer wants/needs?

A: It is quite interesting. Again, we don't do that because our resources are very scarce.

F: I understand. And from your experience what makes a start-up successful?

A: First, the know-how. You absolutely need to know how to do something of value. From my experience, we were at DNA Cascais, a start-up incubator in Tagus Park. There were several cases of companies developing a wonderful product for 2 years but failing because the product does not sell. And well with no sales there is no company, there is no governance. Everything starts with market need and know-how.

Professor Fernanda: Those companies you talked about, these companies developing these products failed because little to no attention was paid to the market risks and the whole market dimension and instead all the work was focused in developing the technology, the product, do you agree?

A: Exactly. Sometimes the technology is something pleasuring to develop, and one might get lost developing it. If you don't have a market vision the whole process becomes just a futile entrepreneurship exercise.

Francisco: How did you knew that there was a market?

A: Because I was on the client side when I started this endeavour. I knew perfectly that the group had factories with these machines and that those machines needed service. Meanwhile one of our founders had already a big portfolio of clients and had a clear notion of what the market was like. And that's how we started. We didn't do market studies because of this founder's prior knowledge of the market. What he didn't have was people to bring the idea to life, to structure the business.

F: Ok Luís, thank you for your time I have no more questions, I appreciate your answers very much and your statements will be very helpful.

A: Thank you Francisco, Thank you Professor Fernanda and Professor Helena.

Appendix 2 - Interview with Subject P, Patent Examiner:

Foreword:

This interview was conducted on 8th December 2021, 4:00 - 04:28 pm CET with subject P who works as a Patent Examiner at Company Y in the field of Medical Injection Patents. This

interview serves to clarify the aspects related to the role of patents in the innovation process and aims to give a more comprehensive view on the world of patents.

Francisco (F): How do you define a patent?

Subject P (P): So, a patent is a contract between a company or person and the state or international organization. This contract entails that the company will share information on a product they have, on an invention they have, they will share it to the public and in return they will get protection from the state to be able to exploit this product for usually 20 years, and so it's kind of an exchange so that the company gives information to the public so that the public knowledge can progress, but in return they get protection, and so the idea is that after 20 years the company has received enough return on its research investment and the society as a whole can benefit from the company's research. So, a patent is this exchange between the state and the company to give protection to a product of the company

F: And how do you define innovation?

P: In terms of the patent world, innovation is defined as something that is novel and inventive over what already exists. For it to be novel is quite easy is just needs to not exist anywhere, and for it to be inventive is a bit more complicated. In the patenting world, the IP industry came up with a process, a method to determine whether a product is inventive or not. In this method you take the most similar looking product, or the most similar functioning product and you see what the differences are. Usually, it takes just one difference and from that difference you determine what the effect of the difference is. Let's say I have a bowl and a mug, a coffee mug. The only real difference is the handle. The effect of this difference is that I can more easily hold it, from that effect I can determine the problem that the inventor tried to solve when he designed the mug. This problem is then how to create a more ergonomic bowl for example. Then you compare your invention to what already exists, and you see if what already exist has tried to solve this problem. So, you got the bowl and now I'm going to try and see if anything else in the world uses a handle to improve ergonomics. So, I might find …

F: A bucket for example?

P: A bucket, yes. Does this bucket have a handle? And if it has a handle does the handle serve the purpose to improve the ergonomics. And if it does, I can say "look, if I combine my bowl with my bucket, I get something similar to your mug so your mug isn't inventive because

I can use two products, combine them and get to your product so it is not inventive over these two combine products". A product to be innovative must be completely new so it cannot exist as it is in the world but it also must be inventive so it needs to solve a problem which could not be solved by combining two other products.

F: And now onto the patent process section, which aims to know how the process of getting a patent works. So where can you apply for a patent?

P: Every country should have a national patent office and you can obviously apply there if you are resident in that country or if your company is in that country. But there is also international organization such as world intellectual property which is in Geneva there is the EPO which is the European Patent Organization and there are a few other regional organizations. You can also apply to them either online or thru your national office that can get to them for you. Mostly though everything is done online, it used to be done on paper but now it has evolved.

F: Why would you apply for a patent?

P: So, if you apply for a patent, it would be to get these 20 years of protection in which you exploit your product and get the return on investment of your product. That is theoretically why you would apply for a patent. There are also different patent strategies for example in the automotive industry what is done is companies apply for dozens and dozens of patents, even patents companies' thing they are not going to use, just so they can build a big patent portfolio which is impressive, and then they can go see competitors and it gives them a big negotiating power when negotiating with competitors. Often in the automotive industry they just use technologies from competitors, a car comes out, they reverse engineer everything and they got all the technology, but a lot of that technology is patented so theoretically they are not allowed to use but there are always agreements between companies for sharing technology because in any case it can be easily reversed engineered, and it is beneficial for everyone. But for the negotiations to occur every player must have this big portfolio of patents, because if for example I'm Renault and I go to BMW to enact an agreement, meaning nobody sues anyone and we just share what we've got, if I'm Renault only has 3 patents and BMW has 5000, BMW can say that is not a fair exchange it is not interesting for us. So that is why every company in the

automotive industry files a lot of patents, I have 10 000 you have 11 000 let's make a deal. That is one strategy and there are loads of strategies to deal with patents.

F: But this strategy applies only to big companies?

Well, you can as a startup, if you want to get investment, and if you have many patents, it is easier to get more investment because you have something solid. A patent is property, is intellectual property much like real property like land. It is something valued that can be evaluated. So, it is easier to get investments, you know, either from a bank or so, patents are worth a lot. So, for startup it can also be good. So, if you are an innovative startup, and your technology is unbelievable, then you patent it, because you're not using it for an investment, but you're using it to make sure that you're the only one who can use it. There is lots of different strategies. (10:30)

F: Yes, to manage the patents, how to survive in the world.

P: Exactly, yes.

F: I have another question. Why wouldn't you apply for a patent?

P: Yes. So, the patent strategy is just part of a larger innovation strategy, or research strategy, yes. But for some companies, they are research, and they have their research strategy, but patents aren't part of it. Because they do not feel they get enough return on the investment on the research of patents. For example, Coca Cola, let us say. They have a recipe, and nobody knows it, and they do not have a patent on it. And that is why nobody knows it. Because if they had a patent on it, they must publish their recipe, and they would give that recipe to everyone. So, they would have had a 20-year protection on the recipe, which sure they could have made money on it. But they were thinking more long-term, and they thought okay, we are not going to file a patent, we're going to keep the secret to ourselves, and then nobody will ever know except for us. And yes. So, if you want to keep something secret, an innovation secret, then do not file for a patent. It all depends on how much you think you can get in return from the patent. (11:57)

F: That is brilliant. That is honestly brilliant.

P: Yes.

F: If something is easily, if an innovation is easily, if an invention is easily scavenged and reverse engineered, for sure you will apply for a patent…

P: For sure, yes.

F: But if for example, is a, it cannot be, it does not have the possibility to be reverse engineered, like for example a formular for a drink, you can only make similar things, you cannot make the think. I understand.

P: Yes.

F: That is why, that's why companies like, for example, processes to fabricate things. Those are the real things, I think. Those are the secret things. That is why Apple is so secret about its installations and how it manufactures, I think.

P: Yes, yeah. And I mean, so, yes, when you get a patent, you get 20 years of protection. For some industries, that is a lot, and it's worth it, you know. But for other industries that is nothing. And they are thinking more long-term than 20 years. So, it is, a patent isn't, it doesn't have the same worth depending in which industry you are, depending on what size your company is. Yes, it depends on lots of things. But the patent is not adaptable, to, to the industry. The situation. (13:25)

F: This, this, this question of the years. Do you think that it would benefit the patent world, let us call it like that, would benefit from, from a shorter in a length thing from the span, of the protection that they offer?

P: Who would profit?

F: Ah, who would profit. I do not know.

P: Just would people profit?

F: Would people profit? Or for example, if you want Coca Cola to patent its formular, would it benefit, if for example you would say, oh you have one hundred years of protection of the formular?

P: Yes, yeah.

F: You think that is…

P: Yes, so they have done it. Just for medical products. You can, you can get 25 years of protection for medical products. Because the investment you put in a medical product is so big, you know, to develop a medicine, it is, you know, ten years of research minimum. You know 10 years of getting it approved by the regulators. And by the time that is all done, you have two, three years when you can exploit your patent. So, they have added 5 years that

medical companies can, can exploit their patent for a bit longer and get a big, bigger return on their investment. Because what would the national, what the state wants to do with patents is push people to invest in research. And so, if, if the return on investment is not big enough to push people into invest in research, you must make it bigger. Yes. (15:09)

F: So, what are the costs of applying for a patent?

P: So, it varies a lot from country to country. But let's say in Europe, if you want a European patent at the European Patent Organization, it costs on average five to six thousand pounds, euros, sorry, to get your patent. But that's not including costs for attorneys or anything on that, so it depends, but that's the minimum let's say. And if you apply to a national organization, so to the French patent office, German patent office, you know whichever you want. A usually their patents are heavily subsidized, and it usually only costs between, I think in France it's maybe 300 euros, and in Germany 500.

F: And who can apply for a patent?

P: Anyone. Anyone can apply for a patent.

F: But for example, me, myself, a Portuguese citizen. Can I go to a French, to the French office?

P: If you have a French address, yeah. Probably. But you need a French address.

F: You need a French address. And let's move on to the final part. I will condense the two last parts because it's a bit long the interview already.

P: No, it's alright.

F: I think. Okay. So then. How do you measure the value of a patent?

P: So, once again, it depends on the industry, you know. As I said, for the automotive industry you don't really assign a value to a specific patent. Just for the overall portfolio. And then for more innovative industries, like, yeah, let's say medical industries, every patent is important. And every patent has a different value. But there's no defined way of assigning a value. It's through negotiations, no, you might think at the start that this patent is amazing, you know, it's an incredible invention. And then when you bring the product to market, nobody wants it anymore. So, you patent, at the start you might have thought it was valuable, but in the end it's not very valuable because nobody wants your product. So, it's hard to determine in advance the value of a patent. You can determine with hindsight's, you know, 20 years afterwards you

can say okay, that patent was worth this much, because I made this much money from the product in 20 years' time. But it's impossible to say in advance really, it's just guessing and through negotiations that its determined. (18:05)

F: And how do patents contribute to innovation?

P: Yeas, so as I said, you know, it's about the exchange of knowledge. That you get in return for protection. So first, the companies are more motivated to research and to invest in research, because they know they're going to get a return of investment later on. They know that they can get a protection on their research. So, it gives them this kind of insurance that what's they're doing is worth it. And then also, it helps, because not only companies who research, but they will then share this research, share the product of this research to the world.

F: Cautiously. With a patent.

P: Year. Yeah, yeah. But when they apply for a patent, they, they publish the, the information and the whole world can see. So, not only are they producing research, but they are also sharing it?

F: How do you see the relationship between universities and the patent world? Because, because in my scope universities, for example if I have a thesis, ah, and the thesis has a new idea, in the thesis. Will I be able to patent the idea, and apply for a patent, still?

P: It really depends on if you shared this information with anyone else, and when you apply for the patent. So, if you have kept the invention and the information related to the invention secret, then you can apply for a patent, because it hasn't been published yet. It's not, it's not part of the worldwide information you say. But as soon as you've shared your information with anyone, you disclosed, you know, what the invention is, you've published your thesis maybe, then you can't get a patent for it, because a patent needs to be new. And, because you've published your thesis, it's not new. It already exists. The thesis is already part of the worldwide information. So, it's not new over your thesis, even though it's our thesis. You can't get a patent. So, you need to be careful if you have an invention, or you think you have an invention, to either keep it secret, either make people, make people, you know, make people sign non-disclosure agreements. Or just file a patent straight away. (20:42)

F: And about, about what will happen in the future with patents. How, how is the, how is, how, wait, let's start again. About what happened in the past first. How was the development of patents over the past few years? The past years let's say the past years.

P: How recently do you mean?

F: How recently. And the, how did the system become what it is today?

P: From the start, you mean?

F: From the start of patents, how did patenting started to, when did patenting stuff started to be a thing?

P: I'd have to check again for the exact date, but it was a long time ago. Basically, it started in, in Venice I think, the first patent, let me just check for a date. (Pause) In 1474. So, quite a while ago. It started in Venice, but I mean, it was all for the reasons we have already discussed. You know, how to promote research and all that. And then bit by bit, just every, every started doing it, because it worked well, and once every country started doing it, then, you know, organizations, international organizations started, and then, there's a lot more interaction between the offices, the patent offices around the world. To make it more efficient basically.

F: And how is your institute's position, relating to this, to the patenting world. Because I, I, I believe there are some institutions that are more powerful than others.

P: More powerful not really. Because every institution has power over the, the jurisdiction. The country that they', they're from. You know, it's the same power, the German patent office has the same power over German patents than, as the French patent office has power over the French patents. So, it is not more power. But some institutions get more patent applications than others. I think in China they get something like a million a year, or something. Or as here, I think we get maybe, I think it's something like 150,000 or 200,00 a year in Europe. So, it's a lot less. In China they have loads and loads and loads of patent applications. (23:38)

F: What about the US?

P: I don't know their numbers. It's probably, probably, somewhere between Europe and China. China is definitely the place with the most patent applications. , yeah, some offices are more important, just because there's more patents going there, and , yeah, then there's also, you know, the quality of the work that every office does. For example, if you apply for a patent,

I don't know, in, I don't know, I can't say a country really, but in some, in a country where patent, where the patent office isn't well developed.

F: Portugal.

P: I don't know about Portugal, yeah, no I think, I don't know, I can give an example I don't know really. Let's, if you apply for a patent there, then they will try and find something that's similar, try and see if it already exists, it might, you know, they're going to examine your patent. But they might not examinate as well as the European Patent Office. And so, once you get your patent, you're not sure what it's worth really, because you're not even sure if you should have had your patent. Maybe your product already exists somewhere else. And then, when your competitor finds out, he's going to say ah, your patent is worthless, I already had it. And then your patent's worthless. So, when you apply for a patent, you want it, you want a good patent, a solid patent, and you want to be confident in the fact that, yes okay, I've got a patent now, my invention is innovative. Is inventive and is worth something. You don't want to be doubting yourself every single time, so that also influences where you're going to apply. Because, for example, a lot of people want to apply in Europe, at the European Patent Office, because they know that the work and the patent they're going to get, is a solid patent at the end. They can be confident in the quality of the patent. And in other offices it is not necessarily the case. (25:44)

F: And the last question. How do you see the future of patent analyzing a submission? At your institution?

P: Well, I can see what we've already been inquiring a bit, is that a lot more, a lot more of the examination is automated. So, 20, 30 years ago, when you, when an examiner was looking examining a patent, he would go, everything was on paper. So, there would be these big libraries of patents, and you'd have to go and search one by one, on the paper, see if it's what you were looking for. And now everything it's on the computer, and everything's automated. So, it's a lot easier for us. But then there's also, we get more and more AI coming in. For example, now a big subject is whoever an AI computer can be named as the inventor of a patent. And it's a big debate. I mean, depending on the country, they've got different rules. And in some countries, AI can be an inventor, and in some it can't be an inventor. So that's, yeah, one way it's going to go. Yeah.

F: Are there any further relevant aspects to you? Of this patenting world? Do you have anything that you want to talk about that was not mentioned in this interview?

P: No, no, I don't think so. I don't think so.

F: You really examinate.

P: Yeah.

F: I think we're done here.

P: Alright.

F: Cool. It was a very good interview.

P: Quite alright. (28:02)