Design of a Business Model for an Internet of Things based university spin-off

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Master's Dissertation

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Mestrado Integrado em Engenharia e Gestão Industrial

2020-06-29

Abstract

Research centres around the world are the birthplace of many inventions that end up disrupting people's lives. University research centres, in particular, are proficient in using the scientific method to prove their hypotheses. However, turning a scientific breakthrough into a product is not trivial, and requires skills, business skills, scientist may not possess. The current work is business oriented and aims to help a university spin-off, WeSENSS, introducing their product, currently at prototype stage, into the market.

The solution offered by WeSENSS is the result of previous projects at INESC TEC, more specifically, from its research centre C-BER. The value proposition of the solution is divided in two parts. On the one hand, it intends to help people that perform harsh jobs, for instance, firefighters, by constantly monitoring physiological and environmental data, making it possible to detect when an operational is not fit to continue working, whether due to strain, fatigue, gas intoxication or another reason. This feature allows better team management and to avoid accidents. On the other hand, WeSENSS intends to address a pressing problem of the modern society, stress, more particularly, stress in the workplace. The focus of this part of the value proposition is mostly psychologic and environmental variables are not so relevant. The company aims to help perform stressful jobs, such as air traffic control (ATC), that due to stress may harm professional's health and, at the same time, help ensure that professionals perform their job at the most appropriate conditions.

In order to deliver such value, the spin-off has developed a platform based on two wearable IoT devices, which allow for constant monitorization of an individual and the environment that surrounds him/her. In order to do so, the venture benefited from advances in electronics and telecommunications. These advances allow for small but powerful devices that can be comfortably be used, commonly called wearables, and for devices that can be always connected, making IoT devices a reality. Besides, sensing technology also plays a vital part in WeSENSS's product, this tech has been thoroughly studied at INESC TEC.

The main goal of the work was to develop a new business model (BM) for the company. Moreover, the company needed a new operating plan once previous ones were outdated, which was also addressed in this work. Other aspect included was the dynamic nature of BMs, as the evolution of several components could be foreseen. In order to achieve such goals, several interviews were conducted with relevant stakeholders, following a qualitative method, the Lean Startup method. This method advocates that business development should be performed in close relationship with relevant stakeholders, such as customers, manufacturers and distributors. These stakeholders play a key role in shaping how a company positions and behaves in a market. It is a very practice-oriented method, although based in the scientific method. The entrepreneur must create hypotheses for the business and test them based on insights collected from the previously mentioned stakeholders, and act accordingly, i.e., reinforcing, changing, or dropping hypotheses according to the feedback obtained.

The outcomes of the current work were a new BM. It analyses which market segments the spin-off should focus on, proposes a renting revenue model and different price-points depending on the volume of sales. It also includes a new operational plan and costs estimates, these were developed closely with WeSENSS's members, in order to be as realistic as possible. Several aspects on how the company may evolve and shape itself in the future were also analysed, for instance, to which countries the spin-off may expand and which new use cases it can explore to grow its business.

In the future, it is expected that the *spin-off* continues to apply the Lean Startup method, i.e., goes to the field to test the new hypotheses raised in this work.

Definição de um modelo de negócios de uma *spin-off* universitária baseada em Internet das Coisas

Resumo

Os centros de investigação de todo o mundo são responsáveis por muitas descobertas que acabam por revolucionar a forma como as pessoas vivem. Os centros de investigação universitários, em particular, são especialistas em verificar as suas hipóteses usando o método científico. No entanto, transformar uma descoberta num produto não é uma tarefa trivial, requer conhecimentos de gestão que nem todos os cientistas possuem. Esta dissertação foca-se na componente de gestão de negócios e procura ajudar uma *spin-off* universitária, a WeSENSS, a introduzir o seu produto, que se encontra na fase de protótipo, no mercado.

A solução oferecida pela WeSENSS é o resultado de projetos do INESC TEC, mais especificamente, do seu centro de pesquisa C-BER. A proposta de valor da solução WeSENSS divide-se em dois principais aspetos. Por um lado, pretende ajudar pessoas que desempenham trabalhos hostis como bombeiros, por exemplo, através de monitorização constante de variáveis fisiológicas e ambientais. Será possível detetar se um operacional não se encontra em condições de desempenhar as suas funções, quer seja devido a de desgaste, fadiga, inalação de gases tóxicos, entre outros. A solução permite gerir equipas mais eficazmente e a prevenção de acidentes. Por outro lado, a WeSENSS pretende responder a um problema premente da sociedade moderna, o stress, mais especificamente, o stress no local de trabalho. Este segundo aspeto da proposta de valor foca-se na parte psicológica em detrimento da componente de envolvimento ambiental da solução. A empresa pretende ajudar trabalhadores que desempenham profissões stressantes, como controladores de tráfego aéreo, o que lhes pode afetar a saúde e, ao mesmo tempo, impedir que façam o seu trabalho no máximo das suas capacidades.

De forma a atingir os seus objetivos, a empresa desenvolveu uma plataforma baseada em aparelhos IoT vestíveis, que permite uma constante monitorização de um indivíduo e do ambiente que o rodeia. Para o efeito, a WeSENSS beneficiou dos avanços na eletrónica e nas telecomunicações. Estes avanços tornaram possíveis aparelhos pequenos, mas potentes, que podem ser confortavelmente "vestidos" pelos utilizadores, comummente chamados de *Wearables* e tornaram realidade aparelhos que estão sempre conectados, os aparelhos IoT. Para além disso, a tecnologia associada aos sensores é também uma componente vital da tecnologia WeSENSS, mas é um aspeto extensivamente estudado pelo INESC TEC.

O objetivo principal deste trabalho foi desenvolver um novo modelo de negócios para a empresa. Para além disso, a empresa necessita de um novo plano operacional, pois os anteriores encontram-se desatualizados, o que também se tornou um objetivo para este trabalho. Outro aspeto abordado na dissertação foi o aspeto dinâmico dos modelos de negócio, o que na prática, se traduziu na previsão da forma como os diversos componentes do modelo de negócio vão evoluir. De forma a atingir este objetivo, várias entrevistas foram conduzidas com *stakeholders* relevantes, fazendo jus à metodologia *Lean Startup*. Este método advoga que o desenvolvimento de um negócio deve ser feito em proximidade com *stakeholders* relevantes, por exemplo, clientes, fabricantes, distribuidores…Estes representam um papel importante na definição de como uma empresa se comporta num mercado. O empreendedor deve contrapor as suas hipóteses para o seu negócio com as informações obtidas nas interações com o mercado e deve tomar as devidas elações, isto é, reforçar as suas posições, alterar as suas hipóteses ou até abandoná-las se o *feedback* for nesse sentido.

Como resultado do presente trabalho, um novo modelo de negócios foi desenvolvido. Este analisa os segmentos que a *spin-off* deve dar mais atenção, propõe *renting* como *revenue model* e apresenta diferentes preços de acordo com o volume de vendas previsto. Inclui um plano operacional e uma estimação de custos, que foram desenvolvidos junto dos membros da

WeSENSS, de forma a serem o mais realistas possíveis. Foram também analisados diferentes aspetos que a empresa precisa de ter em consideração ao longo do seu crescimento, como por exemplo, quais os países para os quais se pode expandir e que novos casos de uso deve explorar para crescer.

No futuro, é expectável que a *spin-off* continue a aplicar o método *Lean Startup*, i.e., que vá para o terreno testar estas novas hipóteses apresentadas neste documento.

Acknowledgements

To start, I would like to thank INESC TEC for such a warm welcoming and for posing me such a thrilling challenge. Designing a business model for WeSENSS was a true test to my skills, hard at times, but, in the end, I ended up learning many new things.

I must also mention Professor José Rodrigues and Duarte Dias, WeSENSS' CEO, for their continuous support in this journey, always available to help me to best of their abilities.

Also like to think every interviewee, their insights were essential to this project.

To finish, a special thanks to my family and friends.

Nuno

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Abbreviations

API	Application programming interface
ATC	Air traffic controller
ATEX	Appareils destinés à être utilisés en ATmosphères Explosives (Devices destined to be used in explosive atmospheres, free translation)
AU	Ambi Unit
B2B	Business to business
B2C	Business to consumer
BM	Business Model
BMC	Business Model Canvas
BMCh	Business Model Change
BMI	Business Model Innovation
C-BER	Centre for Biomedical Engineering Research
CE	Conformité Européenne (Compliant with european regulations, free translation)
CEO	Chief Executive Officer
CISM	Critical incident stress management
CMU	Carnegie Melon University
ECG	Electrocardiogram
FCT	Fundação para a Ciência e Tecnologia (Foundation for Science and Technology, free translation)
FDA	Food and Drug Administration
FEAST	First European Air Traffic Controller Selection Test
FF	Firefighters
HaaS	Hardware as a Service
HRV	Heart Rate Variability
HW	Hardware
INESC TEC	Institute for Systems and Computer Engineering, Technology and Science
IEETA	Institute of Electronics and Informatics Engineering of Aveiro
IoT	Internet of Things
IP	Intellectual Property
M&A	Mergers and Acquisitions
MVP	Minimal Viable Product
NAV	Navegação Aérea de Portugal (Portuguese Air Navigation, free translation)
NICE	Novelty, Lock-In, Complementarities and Efficiency
PPE	Personal protective equipment

R&D	Research and Development
SaaS	Software as a Service
SWD	Smart Wearable Device
TT	Technology Transfer
TTO	Technology Transfer Office
VP	Vice-President
VR2Market	Virtual Responder to Market
VS	Vital Sticker

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1 Introduction

University based related research institutes are important hubs for innovations and scientific breakthroughs. The aim of these institutes is primarily to develop science and design innovative concepts with impact to the society. These institutes do not focus on the commercialization of these new technologies, they rather sell or license the technologies to third-party companies (existing companies or creation of startups) to exploit the solutions. They have people with high degrees of education (PhDs), that apply their talent, in their respective research fields, in pursue of the unknown, to enlighten humankind about the world that surrounds us. Many real-world products, that affect millions of lives, come from discoveries made in these institutions. Research centres have deep expertise on the scientific area, but sometimes there is a lack of understanding on how to take research from the laboratory to the market. These centres are making an effort to overcome this issue, creating specialized departments focused on technology transfer, such as the Centro para a Inovação, Tecnologia e Empreendedorismo (CITE, Centre for Innovation, Technology and Entrepreneurship) of the Institute for Systems and Computer Engineering, Technology and Science (INESC TEC) where this work is inserted and which objective is to develop internal processes and tools to manage INESC TEC R&D results, organizing the resulting knowledge and competences.

The main general topic of the current thesis is exactly on how to leverage technologies and devices developed upon scientific research projects and lead them to commercial success. More precisely, technology developed by the C-BER (Centre for Biomedical Engineering Research) research centre of INESC TEC and other research partners, over the past 5 years, have culminated in advanced knowledge about Occupational Health tools using innovative signal acquisition data processing techniques concerning psychophysiological variables.

What is the relevance of all this knowledge for the broad public? Stress is considered the 21st century epidemic (Fink 2016). It is responsible for health degradation, loss of productivity, accidents, loss of lives, among other negative consequences for society (Dias 2020). The globally connected life has created a stressed society. Therefore, having tools to assess if a person is stressed, even if the person feels it or not, can have a huge relevance for one's future health (Matrix 2013). Moreover, accurately measuring vital signs can be of huge importance, especially for people whose life is threatened every day, whether due to a disease, or due to the job they perform, if it requires facing harsh situations continuously. For example, firefighters fit in this description, a job which is going to be extensively approached throughout this work. Portugal is one of the most affected countries in the world by fires, due to its clime, topology, cultural habits, among other factors (Beighley and Hyde 2018). Fires have a deep impact in the country, as lives are lost, public and natural heritage, as well as private properties are lost, and firefighting professionals and volunteers expose themselves to a great risk to save other people's lives and possessions (WWF 2019). Unfortunately, they do not always enjoy good working conditions, due to lack of equipment and funds. These professionals and volunteers are an example of a class that can benefit from strain and stress monitorisation.

Vital sign measurements exist since a long time ago, and the current challenge is to bring accurate physiological variables measurements to everyday life in the most comfortable way without interfering with the normal daily life and working routines, and particularly to the field of work of professionals that can benefit from it. This is possible due to electronics advances that enable to develop smaller devices that are more powerful, and more efficient. This technology advance is allowing for the creation of ergonomic small wearable devices, that have gradually been introduced into people's lives with several functions. Furthermore, connectivity and network developments allow for large amounts of data to be exchanged virtually anywhere. Ubiquitous connectivity paved the way for IoT devices. The combination of data acquisition, compact wearable devices, and connectivity make IoT devices an exciting new opportunity for the society.

1.1 The VR2Market Project, WeSENSS predecessor

Virtual Responder to Market (VR2Market) was a five-year project (began in 2014) funded by Carnegie Melon University (CMU) Portugal (INESC TEC 2019).

The main scope of the project was to develop a real time monitoring platform for First Responders[1]. In particular, by using wearables devices to measure physiological variables, such as heart electrical activity via an electrocardiogram (ECG) performed with a small wearable device, and environmental variables such as temperature, toxic gas exposure, it is possible to assess if a first responder life was at immediate risk. This capability enables decision makers to quickly trigger rescue measures whenever necessary. Furthermore, such devices also enable assessing the levels of both physical and mental stress of the professional, which allows for better human resources management (VR2Market 2019).

The VR2Market solution is quite a comprehensive one. To achieve all the desired goals, it was necessary to develop sensor technology. The INESC TEC was responsible for it. The development of the communications from the sensors to the cloud, via a transponder, were entrusted to Instituto de Telecomunicações (Institute of Telecommunications, free translation) and the Institute of Electronics and Informatics Engineering of Aveiro (IEETA). The funding was provided by the Fundação para a Ciência e Tecnologia (FCT, Foundation for Science and Technology, free translation) through a programme based on the collaboration with CMU. The team also resorted to help to produce the devices from a textile company, Petratex and from a biotech engineering company called Biodevices. (INESC TEC 2019)

The main outcomes of this project were: intellectual property; hardware; an app; server software (data analysis, data storage and an application programming interface (API)) to fulfil its goal; and, ultimately, the market needs were identified in pilot projects (VR2Market 2019).

Concerning intellectual property, this project was responsible for three main innovations. One patent awards the ability of identifying a person by their heart's electrical activity. A second patent was awarded due to the ability to measure the level of stress of a person using the recorded heart's electrical activity. A third patent is related to the position of the electrodes in the body, i.e., the design that the team developed to enable the electrodes to move in solidarity with the user's body, allowing to continuously measure the user heart rate, even if the person is moving (VR2Market 2019).

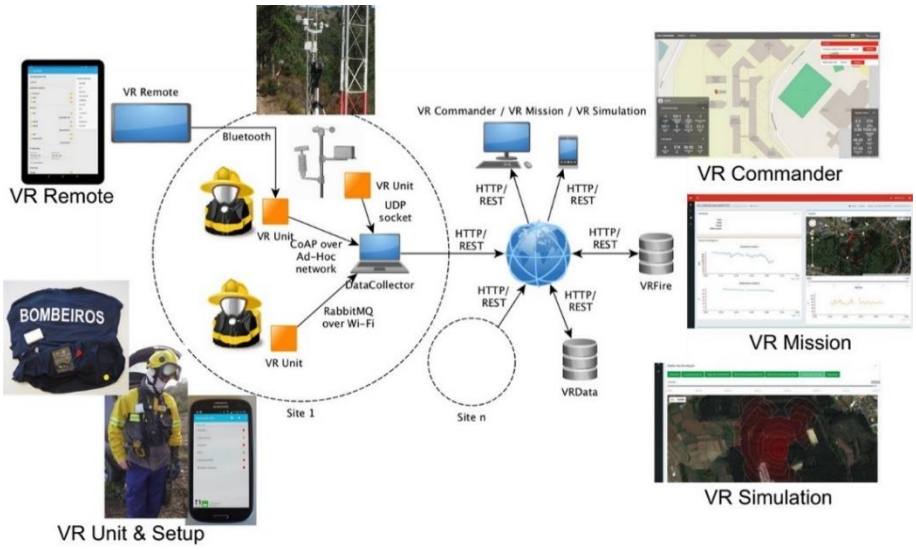

Figure 1 – VR2Market platform architecture (VR2Market 2019).

[1] A First Responder is "someone who is one of the first people to arrive to deal with an emergency, especially a paramedic, police officer, or firefighter." (Cambridge Advanced Learner's Dictionary & Thesaurus n.d.)

In respect to the hardware, during the four years of the project it evolved. At first it was a shirt with physiological sensors embedded and an external device to measure external variables. On the last iteration, these devices were simpler and more advanced: a small wearable ECG patch device to put over the user chest, which may be stranded by a textile ribbon; and a box for measuring the environmental variables. These devices needed to be connected to the app to send the readings, so the user needs to carry a smartphone. The app uses the communication capabilities of the phone to upload the data to the server (as Figure 1 depicts). Once in the server, data is stored and processed and becomes available to be used via the available API. Even though some interfaces were developed, the team focus is on delivering data processed, i.e., knowledge, and then clients decide how they want to use that information, for instance they may develop live dashboards or monthly reports (Tedim 2016).

Besides scientific and technological contributions, during the VR2Market project valuable market insights were acquired. As previously mentioned, the focus of the project was to develop a solution to aid first responders, however, with time, new applications for the technologies developed emerged. More specifically, it was found that the VR2market, due to its ability to track stress, was valuable for professionals that worked on stressful settings such as air traffic controllers (ATCs) and Oil & Gas workers. Overall, over 1500 hours of tests were conducted in real life settings. These tests were made with police officers, firefighters, militaries and ATC. The feedback, according to official statements was quite positive, mainly in the area of firefighters, with several international testimonials stating that such solution is of tremendous value for their profession. The difficulty to enter in this market at a national level, led research to look also for other use cases where such solutions could be of high value. For this, it was created a generic architecture of the system with the most recent technological achievements, allowing to have a solid infra-structure that could be easily used to demonstrate the potential of this system in different scenarios (see Figure 2), creating a appellative brand named WeSENSS. One of the areas where this system raised interest was on the Oil & Gas industry where some contacts have been established. EQS (which is a services provider and consulting company that works with petrochemical companies) is one of these industry players who has showed interest to use the VR2Market solution, embedding it in their systems using the available API. The project ended in 2019 and currently, if a sound business opportunity is identified, there is a possibility to bring these technologies to market by creating a spin-off, WeSENSS (Lusa 2017, INESC TEC 2019).

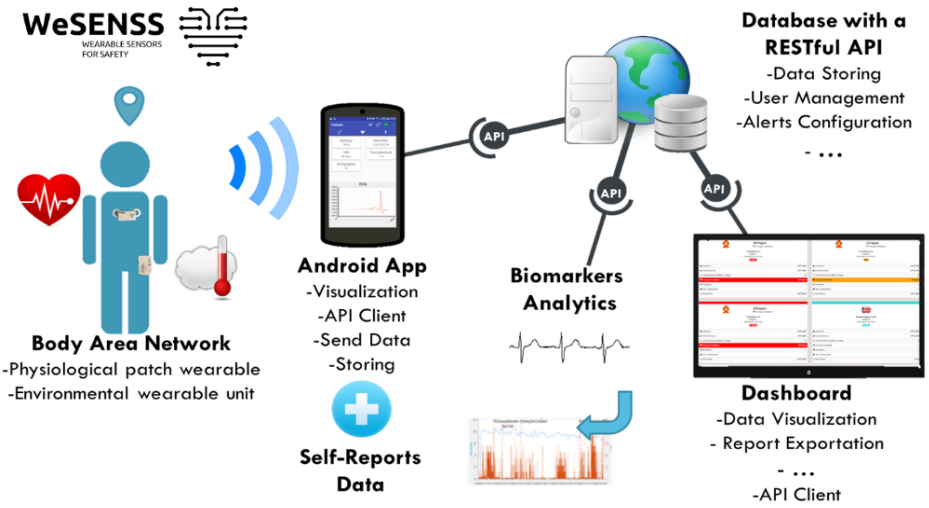

Figure 2 - WeSENSS platform architecture.

1.2 INESC TEC presentation

VR2Market was led by INESC TEC, in partnership with other institutions. Moreover, INESC TEC is also the institution where the current thesis was developed, so a brief overview on the institution presented in following paragraphs, based on information presented on its official website (https://www.inesctec.pt/en/institution).

INESC TEC is a private non-profit research institution. It is an interface between institute, academia and industry, it aims not only to develop scientific research and technological development projects, but also to bring the resulting technologies from the lab to the people's and businesses' lives via technology transfer projects, creating value for the society.

It counts with more than 700 researchers and holds 13 R&D centers. It is present in the cities of Porto, Braga and Vila Real, and also abroad, in Brazil. The research is focused in four main clusters: Computer Science, Industrial and Systems Engineering, Networked Intelligent Systems, and Power and Energy.

INESC TEC was created in 1985 and it is currently celebrating its 35th anniversary.

1.3 Problem definition and objectives

After the development of the technology and initial market contacts, the company wants to determine the best way to introduce its solution to the market. Questions like which segments to prioritize, how to sell the solution to each segment will be addressed, among others.

One of the objectives of this work is determining the business model (BM) that the spin-off should adopt, in order to meet success. To do so it is important to state the current BM, this way is easier to identify improvement possibilities and possible solutions.

Moreover, the company had defined previous operational plans, but these ones are outdated, therefore a new operational plan was developed in order to meet the company goals, while respecting external factors that affect the company.

The company has already ongoing relationships with some potential clients, nonetheless, it is desired to explore new use cases for the solution, after all, the solution is quite generic and addressing new markets may be relevant for the growth of the company.

Considering the dynamic nature of a BM, it will be studied how the company could adapt its business in the future, whether as a response to external factor or as a change related to the natural evolution of the company.

1.4 Methodology

The methodology followed in this work is the Lean Startup, which was introduced by Blank (2013). Briefly, this methodology advocates that entrepreneurs must clearly state their hypotheses concerning their business and then they should seek relevant stakeholders to test their hypotheses. After approaching those stakeholders, the entrepreneur should update his hypotheses for his business, reinforcing them, altering them or drop them altogether.

WeSENSS is already focused on some segments: firefighters, ATC and Oil & Gas. However, as the solution is quite generic several new possible use cases were explored. These aimed at overcame some obstacles WeSENSS faces, more particularly, low volume and segments with low available budgets. The analysis was performed resorting to websites, newspapers and scientific papers found online.

Before developing a new BM, it was necessary to set an initial BM, using internal documents, as well as holding informal talks with WeSENSS's members. Then, several people were interviewed: firefighters; ATCs; an Oil & Gas consultant; two entrepreneurs; a health products

retailer. Prior to the interviews, guides were made. These were an important tool to assess if relevant subjects were addressed during the interviews. After the interviews, a report was written for each interview containing the main insights from each interviewee. These were the base of the proposed BM for the spin-off.

In order to develop the new BM, the initial hypotheses were contrasted with the insights from the interviews, component by component. Some aspects of the new BM required further analysis, for instance, concerning the revenue streams three scenarios were proposed.

1.5 Document structure

The current thesis is composed by a literature review, on Chapter 2. The chapter presents a deep review on all terms related with the BM concept. More precisely, it tries to shed a light on the current accepted definition of BM. Moreover, a special emphasis is given to the dynamic nature of a BM and to common characteristics of BMs adopted by IoT based ventures. Taking in consideration that WeSENSS comes from a university context, literature concerning the impact of being a university spin-off is also reviewed.

Afterwards, on Chapter 3, a current state of the project is presented, including its initial BM. Then the goals of this thesis are clearly defined, as well as the method used to address it.

Chapter 4 and Chapter 5 present all the information (findings of the work) related with how the company should move forward. A new BM is proposed, based on the data collection. A special focus is given to the monetization of the solution, more particularly, price and payment options. The new BM is presented together with a new operational plan. As there is a high uncertainty involved in this kind of projects, alternative value propositions and customer segments are explored on Chapter 4, and their possible evolution and how they should be addressed by the company are presented throughout Chapter 5.

Finally, on Chapter 6, the main conclusions of this project are presented, focusing on the challenges WeSENSS might have to endure on the future, and what should be done from now on.

2 Literature Review

2.1 Business Model

2.1.1 The Inception of Business Models

Business Model was first used in 1957 in Bellman et al. (1957) article regarding the construction of business games for training purposes (Nielsen, et al. 2018). Then, during several decades (from the 1960s to the late 1990s), it was used to refer to business process modelling with the goal of creating information systems which is a rather functional view of the purpose of a business model (Wirtz, et al. 2016).

The term became popular in the late 1990s with the dawn of the personal computer and the spreadsheet (Ovans 2015). These tools allowed managers and entrepreneurs to test different aspects of their businesses and, therefore, build models of them. Another aspect that led to the widespread of this term was the rise of the Internet (Gleeson 2010), which allowed to the creation of new ways to do business, for instance making online content free, but monetizing it via ads existing in the web page or subscription based streaming services of music, movies, games... During this period, the term "business model" lost the functional meaning people gave to it during decades and became a broader term, as it was used to refer to a depiction of the entire organization of a firm and how that particular organisation would impact on the company success (Wirtz, et al. 2016).

In the early 2000s, there was a hype on internet-based businesses, as these promised very high returns. Consequently, BM started to be commonly used in non-scientific circles, such as the media. Unfortunately, that increased use resulted in a perversion of the term, as it was perceived as a simple and unsubstantiated explanation about how the company generated revenues (Wirtz, et al. 2016). Porter (2001) further warned that believing in "these" BMs was counterproductive. Most of these miracle businesses failed in what is known as the *dot.com* bubble (Thompson 2019).

Although BMs only started to be subject of great attention in the late 1990s (Geissdoerfer, Vladimirova and Evans 2018). It is important to clarify that, prior to that, enterprises had BMs, but they designed and applied their BMs without realized they were doing so (Ovans 2015, Teece 2010, Lubik and Garnsey 2016). In fact, one of the most basic BM is selling goods to customers directly, which goes back to centuries ago and even before *selling* existed, bartering was already a way of doing business (Gleeson 2010, Teece 2010).

2.1.2 The Concept of *Business Model*

Despite the attention it has received over the last twenty years, the term itself lacks an objective definition (Ovans 2015, Gleeson 2010, Casadesus-Masanell and Ricart 2010). Teece (2010), argues that as the term has not found ground on any area of knowledge, it has been hard to converge to *one* definition of the term. The author further adds that the term has little relevance in social sciences realm because in economics it is usual to work with theoretical constructs that assume "fully developed spot and forward markets, strong property rights, the costless transfer of information, perfect arbitrage, and no innovation", where customers evaluate products according to an utility function and investors do business as long as the return of capital is respected. Describing the real business environment like that is, in the author's opinion, a "caricature". In fact, BMs are built for real situations, where the value of a product is what the customer perceives, based on his needs and sometimes buyers don't even base their decisions on their reasoning but rather on their emotions (Teece 2010).

Authors, over the years, provided different definitions to the term, according to the use they intended from it. Cosenz and Noto (2018) presents three types of perspectives for the term. Some authors define BM as intrinsic to a company and, thus, a manifestation, something one can analyse and observe externally. This perspective allows to classify companies' BMs according to the way they capture value (where razor-and-blade, freemium and pay-as-you-go are a few examples, see Table 11 in Appendix A for further examples). A second perspective about the BM term is a cognitive/linguistic one, that is, managers build on their minds a model or a pattern on how they perceive the structure of the business. Building such mental model helps managers to summarize on their mind how the business works and thus better explain it to other people (investors or employees). The third perspective is a formal conceptual representation. They differ from the mental presented before because they are explicit (document or graphic representation). Writing down a BM is relevant for entrepreneurs in the sense it obliges them to think, analyse and improve their business and is also a great tool to communicate the BM to other people or even discussing it as a team (Cosenz and Noto 2018).

Besides different perspectives on the term, BM definitions have been quite diverse because authors define the term according to their background. Wirtz et al (2016), in their review of decades of scientific works on business models, have identified three main research fields: organisation theory-oriented, strategy-oriented and technology-oriented (see Figure 20 in Appendix B for more details). These have worked as research silos, aiding to the heterogeneity of the concept and the formulation of partial definitions. Another aspect that negatively affects the convergence on a single perspective is the fact that, even on recent papers, some authors base themselves on previous studies, which no longer reflect the more recent understanding of the term and only partially define the term.

Over the last two decades, there has been an effort to find a converging definition of the term and in some respects it has occurred. For instance, recent publications all use the BM term in a broader depth, in the sense they use it to depict the entire company, while some older studies argue that BM is much more specific of a smaller part of the business. Another aspect that shows convergence in the scientific community is the role of a BM. Currently, authors agree that the role of a BM goes from operation management to strategy of the business. Additionally, recent work has focused on the dynamic nature of BMs, while older literature approached the concept on a static way (Wirtz, et al. 2016).

The BM concept has received great attention from the strategy field, but it is important to distinguish the term from Strategy itself. An essential concept for strategy, which is not part of the BM concept, is competition (Vossler 2015, Wirtz, et al. 2016). Built upon the competitive environment analysis, strategy is about developing a contingent plan of action, comprising a set of high-order decisions, that will meet the defined objectives and vision of the company (Casadesus-Masanell and Ricart 2010, Wirtz, et al. 2016). The temporal scope of a strategic plan is medium to long term, so strategy is tightly linked with how to guide the company in the future (Wirtz, et al. 2016). Depending on the unravelling of events, contingencies may or may not be verified, and the BM chosen accordingly, as Casadesus-Masanell and Ricart (2011) argue, "strategy refers to the contingent plan about which business model to use". Consequently, BMs "are reflections of the realized strategy" and basically consist of a depiction of how the entire company is organized to capture value (Casadesus-Masanell and Ricart 2010, Wirtz, et al. 2016). Based on the developed BM, business processes and information systems are defined and built (Vossler 2015). Therefore, business models are a link between business strategy and business process (see Figure 3).

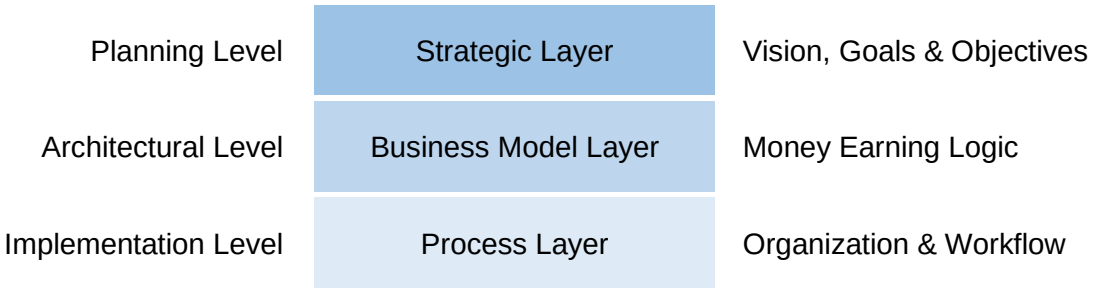

Figure 3 – Business layers (Vossler 2015).

Based on their literature review and aligned with the effort for convergence they conducted, Wirtz et al. (2016) propose what they consider to be a complete, in the sense that it tries to aggregate the three main approaches of the term identified, and dynamic view about the BM concept:

> A business model is a simplified and aggregated representation of the relevant activities of a company. It describes how marketable information, products and/or services are generated by means of a company's value-added component. In addition to the architecture of value creation, strategic as well as customer and market components are taken into consideration, in order to achieve the superordinate goal of generating, or rather, securing the competitive advantage. To fulfil this latter purpose, a current business model should always be critically regarded from a dynamic perspective, thus within the consciousness that there may be the need for business model evolution or business model innovation, due to internal or external changes over time. (41)

2.1.3 Business Model Components

As mentioned, a BM comprehends several elements of a company, so it is common for authors to present a definition of the term and then break it down into components. Wirtz et al. (2016) present a very complete list of common BM components proposed in the literature. They point out that there are three main groups of components: strategy oriented, customer & market oriented and value creation oriented (see Figure 4 for more details).

It is not surprising that a BM comprises strategy related components, once strategy is often recognised as the baseline that guides the creation of the other aspects of a BM. Some authors argue that a BM should include the vision, mission statement and different strategic paths envisioned for the business. Furthermore, it is important to consider the entities with whom the company is willing to strategically partner. Networking has been found to be an important factor for enterprises success (Wirtz, et al. 2016).

Another consensual component is the value proposition, i.e., what benefit will the customer have by using the product or service provided. This element cannot be properly stated without a thorough analysis of the competition and the market where the company is operating in and, of course, the segments of the market the offered product is intended to reach. It is common to present different value propositions for different customer segments.

The customer segment component highlights how interdependent the components are, in the sense that each segment may require different channels and may be charged differently (one-time purchase or subscription based are examples of different methods companies can charge their customers). The charging method concerns the revenue streams component.

In order to deliver the value-added services or products, a venture must be aware of the necessary assets and capabilities and identify core ones. These resources (assets and

capabilities) then must be properly managed to deliver the desired outcomes, so it is necessary to list the activities/process of the company. Regarding the inputs necessary for producing the value proposition, and often a dismissed component in BM structures proposed, it is the procurement component. This aspect has gained more and more relevance, especially in the global economy.

Another financial component (besides revenue streams), is a component that lists the inevitable costs of running the business. The acknowledged costs will then be part of the financial plan, which, on its turn, also includes the financing sources and planned revenues.

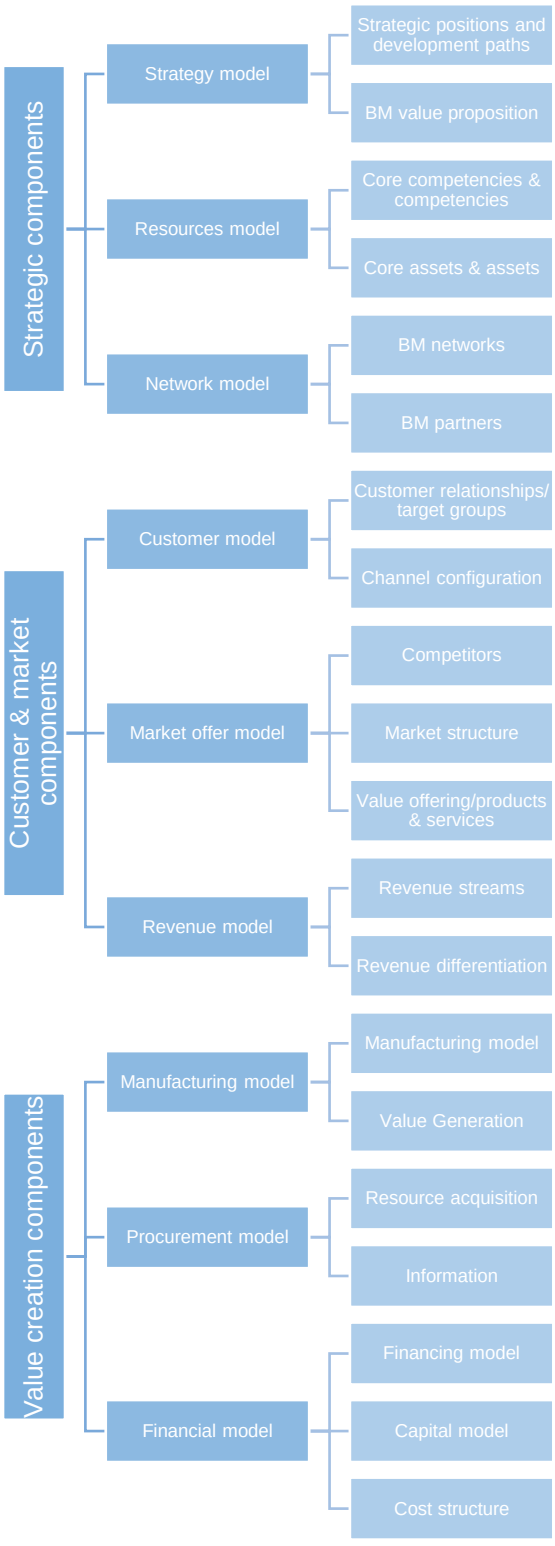

Figure 4 - Components and partial models of an integrated business model (Wirtz, et al. 2016).

2.1.4 Guidelines on Business Model generation

A BM, independently of how successful it may be in the present, to ensure its continuity of success and pave the way for competitive advantages, it must be the most differentiated (from competition), non-imitable and self-reinforcing as possible (Teece 2010, Casadesus-Masanell and Ricart 2011).

Regarding non-imitability, Teece (2010) stressed that BMs (or some of its components) are often subject of imitation by competitors within months of revealing some degree of success, as BMs as a whole or its components are not patentable. Therefore, the author presents some measures to make business models hard to imitate. The first is to base the BM on hard to replicate processes, assets or systems. The author used Walmart as an example to prove his point. When Walmart decided to build large supermarkets on small towns, competitors did not want to go to those locations due to the low number of potential clients. When the competition eventually realized it was profitable to open supermarkets on not so populated locations, Walmart had already "conquered" the customers that lived on those small-towns and there was no market left for other supermarkets. A second measure is to develop BMs that include some level of opacity. Competitors may understand how the BM work on general terms, but if they were to implement a similar one, they would have a hard time doing so. For instance, when Apple started selling individual songs on its music player, iTunes, it was unfeasible to charge each song individually, as the credit card company fees would make the transaction unprofitable. Therefore, the solution adopted was to periodically send to the credit card companies a set of each customer's transactions, this way Apple avoided losing its margin in transaction fees (Schlender and Tetzeli 2015, 286). The third aspect is to design a BM that competitors cannot replicate once it will "disturb relationships with existing customers, suppliers, or important alliance partners" or even within the competitor itself (cannibalization).

Casadesus-Masanell and Ricart (2011) argue that self-reinforcement is key for BMs, but often neglected. A BM is self-reinforcing when it creates virtuous cycles, i.e., when an element of a BM creates a link that reinforces itself. For example, Ryanair by selling cheap tickets attracted higher volumes of customers, which allowed the company to save money from economies of scale and, consequently, sell even cheaper tickets. Besides creating virtuous cycles, an entrepreneur or a manager must focus on setting up a BM that destroys competitors' virtuous cycles or one that works alongside competitors BM. The author suggest that these cycles have the same impact as tribal strategies, used for example by mobile operators that offer cheaper phone calls when calling numbers of the same operator. Tribal effects and virtuous cycles are two ways to create winner-takes-all effects.

2.1.5 Business Model Benefits

It has been found that the active use and development of BMs has many upsides. For Chesbrough (2010) and Costa (2014) designing an innovative BM is as valuable as an innovative technology and further adds that an ill business model is unlikely to bring success, no matter how good the technology or the management team is (Mateu e March-Chorda 2016, Costa 2014).

Almeida (2015) lists those benefits and clusters them in five main types. The first is the fact that BMs allow for an easy comprehension of a very complex system that is a company, by professionals of different backgrounds.

The second is that BMs can be used as an analysis tool. The competitive environment requires regular change in a company BM. So, having a clear and well structure BM is relevant to identify what is wrong and what are opportunities of improvement. Then using such tool makes it easy to benchmark different BMs and comparing them to new ones or other companies' BMs. Comparing BMs can be quite useful in the case of underperforming companies, because they

can compare their underperforming BM with the BM of more successful companies (Vossler 2015).

Almeida (2015) also identifies managerial advantages of using BMs. The author states that after defining one, it is easier for managers to define what actions they need to implement. Or in a BM change perspective, it is easier for the manager to know what must be done to make those changes a reality. Besides, BMs help managers to clearly communicate the business logic to any element of the company.

The fourth benefit identified is the fact that BMs promote innovation, specially do to the fact that BMs are usually broken down into components, making it easy for decision makers to identify particular aspects of the business that can be improved.

The fifth group of benefits is the legal protection of the firm, Almeida (2015), argues that companies can patent the technologies that underpin their BM, which disables/discourages other companies to copy a winning business model, leaving then in an inferior competitive position. Intellectual Property (IP) is also a way to increase the company value.

2.1.6 From Business Model to Business Plan

According to Kenton (2019), "A business plan is a written document describing how businesses—both new and established—plan to achieve their goals." Such document has three main roles: forces the entrepreneur or manager to think, in detail, about his business and to come up with feasible goals; investors (banks and venture capital firms) often require a business plan of a project when they are contemplating investing in it; and, a business plan also works as a tool to control the performance of the company (companies should revisit and update their business plans frequently).

Regarding the content of a business plan, usually, it includes a description of the product or service the company intends to provide, a market analysis (competition, forces and weaknesses), financial planning/projections and a budget. The usual length of the document its between 15-20 pages (Kenton 2019).

Therefore, the differences between a business plan and a BM are very clear. A business plan is a detailed document explaining the goals of a firm and how it plans to meet them while a BM is the rationale, i.e., the logic that underlies on how an enterprise works and profits (Teece 2010). The latter is not a document, some companies' managers do not even think about BMs even though their business have one, according to Casadesus-Masanell and Ricart (2010), all enterprises have a business model.

The confusion that may arise between these two concepts, is that in some moments entrepreneurs or managers use documents to explain the BMs of their projects. But these are short documents (one page), visually suggestive, rather than long detailed documents. Some tools are often used to visually present BMs, such as, the Business Model Innovation (BMI) pattern cards, the 4-Dimension Concept, and the Business Model Canvas (BMC) (Emprechtinger 2018).

One can find contesting voices about the utility of a business plan in the case of new businesses. According to Blank (2013), a business plan is not fit for a startup because it "is essentially a research exercise written in isolation at a desk before an entrepreneur has even begun to build a product". Doing so, an entrepreneur makes the dangerous assumption, in the view of Blank (2013), that he can, from his desk, figure every single aspect of his future business. The author further adds that a startup should focus on finding a "scalable and feasible" BM, instead of writing a business plan.

Even though Blank (2013) reveals a drastic position against business plans for startups, as previously mentioned, business plans are frequently required by investors to decide whether to

invest in a business. As startups usually need investors, they might need to develop a business plan. The view in this work is that BMs are certainly the best tool to start building and test a business idea, but as the BM is validated, it is a very good basis to dive deeper in the business and develop a business plan. As it is possible to conclude from the components of the BM and the content of a business plan, it is clear that they are both very well aligned, as would be expected since they are both focused on describing a business.

Similar to business plans, BMs should also be frequently revisited by managers, as the business adapts to its growth and to the changes in the market and the industry. Therefore, it is also important to consider BM evolution, which deals with designing and updating a business model and belongs to the concept of Business Model Change (BMCh).

2.2 The Dynamic Nature of Business Models

2.2.1 Business model change terminology

Several authors have addressed the dynamic aspect of BMs but, similarly to what happens in the business model definition, there is not a common view and perspective on the subject. This can be assessed by the broad list of terms used in the business model dynamics realm: innovation, change, evolution, reinvention, adaptation, renewal (Costa 2014). Then, each author frames these concepts in his own way. For instance, some authors see business model change as incremental change and business model innovation as disruptive change (Wirtz, et al. 2016). Cavalcante et al. (2011) view on those terms is different, they argue that when there is a change it might reach different levels of innovation, incremental or radical. Vossler (2015) presents a similar understanding about these concepts, arguing that BMCh may lead to incremental change (which he calls of evolution), to an intermediate level of change (adaptation) or to radical change (innovation), see Table 1 for more details.

Table 1 – Business model evolution, adaptation and innovation (Vossler 2015).

	Business model evolution	**Business model adaptation**	**Business model innovation**
Planned outcome	Natural, minor adjustments	Align with the environment	Disrupt market conditions
Scope of change (areas affected)	Narrow	Narrow – wide	Wide
Degree of Radicalness	Incremental	Incremental – radical	Radical
Frequency of change	Continuous, gradual change	Periodically	Infrequently
Degree of novelty	Not applicable	Novelty is not a requirement	Must be novel to the industry

Costa (2014), on his turn, distinguishes the terms stating that BMCh is used more broadly (applies to early stage ventures and mature ventures), while business model innovation is used to refer to innovation in mature ventures.

In this work, it will be followed the Cavalcante , Kesting and Ulhøi (2011) view, which separates change from innovation concept, stating that a change in a business model may introduce incremental or radical change, or might not bring no innovation at all.

2.2.2 Business model change drivers & obstacles

According to Giesen et al. (2007), companies that financially outperformed competitors, put twice the emphasis on BMCh. Besides the financial benefits, there are studies that argue that

changing the BM is essential for companies' long-term survival. Companies that are run under a static BM experience higher growth in the short-term but are unable to cope with external changes and so end up disappearing (Terra, Rodrigues and Maia 2019).

Entrepreneurs/managers are pushed to introduce change in their current business due to technological innovation (van Putten and Schief 2012). Technological innovations can be brought to market by competitors or a company may need to change its BM due to a new technology developed in their own R&D centres. Another reason that forces change, is a shift on the competitive landscape. In a global world, competitors appear at a fast pace and some market structures are very volatile, due to Mergers & Acquisitions (M&A) and alliances (Costa 2014). Fending off low-end competition is also listed as reason for BMCh (Vossler 2015). In an information driven era, customers are more educated and demanding (Almeida 2015), and therefore, shifting customer preferences or the acknowledgment of unmet customer needs may lead to BMCh. Law changes are also a recognized driver of BMCh (Almeida 2015). Finally, Casadesus-Masanell and Ricart (2011) present macro-economic shifts, more precisely the slowdown in developed countries, contrasting with the business opportunities in developing countries as a driver of BMCh.

As evidenced, business model changes may be driven by a multitude of factors. However, companies and their managers must sometimes fight internal obstacles in order to implement the necessary change. Christensen (1997) argues that mature companies are unwilling to dive into new market segments in order to keep focusing on segments in which they are already established. Managers fear abandoning a "ground" they extensively know, their comfort zone, to start exploring uncharted waters, i.e., the unknown. Tongur and Engwall (2014) argue that companies are unable to cope with technological innovation due to business model inertia, thus its paramount for companies to have systematic ways to review and update their current BMs.

2.2.3 Business model change types

Geissdoerfer, Vladimirova and Evans (2018) present four different ways a company can change its BM (see Figure 5): in a new venture, the creation and implementation of the new BM is considered BMCh process in itself; transformation; implementing new BMs to work in conjunction with current BMs; the acquisition of a new BM. Geissdoerfer, Vladimirova and Evans (2018) theory is partially confirmed by Cavalcante , Kesting e Ulhøi (2011) view on this subject who argue that BMCh can be achieved by BM creation in the case of a new venture, corresponding to the first type of BMCh of Geissdoerfer, Vladimirova and Evans (2018). Then, while Geissdoerfer, Vladimirova and Evans identify transformation, Cavalcante, Kesting e Ulhøi (2011) go a step further and argues that this transformation can be achieved by extension (adding elements to the incumbent business model), revision (some elements of the business model are dropped and replace by a revised version of those elements) or termination (entrepreneurs/managers identify elements that should be removed).

Startup

In the case of a startup, the venture does not have a business model, so it must go through the process of creating the initial BM. According to Terra, Rodrigues and Maia (2019), change is more frequent in the early stages of a firm.

There are several methods to create this initial BM, a recent approach to this subject is the Lean Startup, introduced by Blank (2013). This author created this approach due to the gaps he observed in the most common method used before. According to Blank (2013), the mainstream way companies are launched is by writing a business plan. This first step is basically a research exercise in which the entrepreneur assumes he can figure out every unknown of his company from his desk. A business plan is usually made in isolation. It also includes, typically, five years financial projections, which are, in Steve Blank's opinion, "mere fiction". Then, after getting

the investment, startups start developing the product. This process is often made with little or no input from customers or partners, secrecy is desired, and involves thousands of man hours and respecting pre-established product development timeframes. After the product development, companies introduce the product into the market. This is the moment when customer feedback is finally received, and many times, companies face backlash from customers, as they do not value the specifications of the product. Blank (2013) argues that "business plans rarely survive first contact with customers", which lines up with the statistics that 75% of startups fail (Blank 2013). After realising these issues, the author came up with its Lean Startup approach. Under this approach, entrepreneurs should not start their enterprises by writing a long and detailed business plan, but by stating their hypotheses (guesses) about their business using the BMC (Osterwalder and Pigneur 2010). Then they should start the customer development process. During this phase, entrepreneurs must talk to customer and partners about the business they are creating, and then update their business models according to the feedback obtained. The updates can be subtle, or substantial updates (pivots). The goal is to quickly build a minimal viable product (MVP), which is a prototype (that can be far from a final product), and then start the agile development process (for product development). This process goes hand in hand with customer development and consists in introducing incremental updates to the MVP, after receiving feedback about the prototype and watching how customers interact with it. The process ends when the company finds its scalable and repeatable BM.

The Lean Startup method is an agile approach, which recognises that startups "don't knows", right from the start, which is their business model and, so, must look for one, going from failure to failure until they reach success. It is based on an iterative development process which strongly relies on the stakeholders' feedback, thus ensuring, in the end of the process, the alignment between customer needs and the product offered.

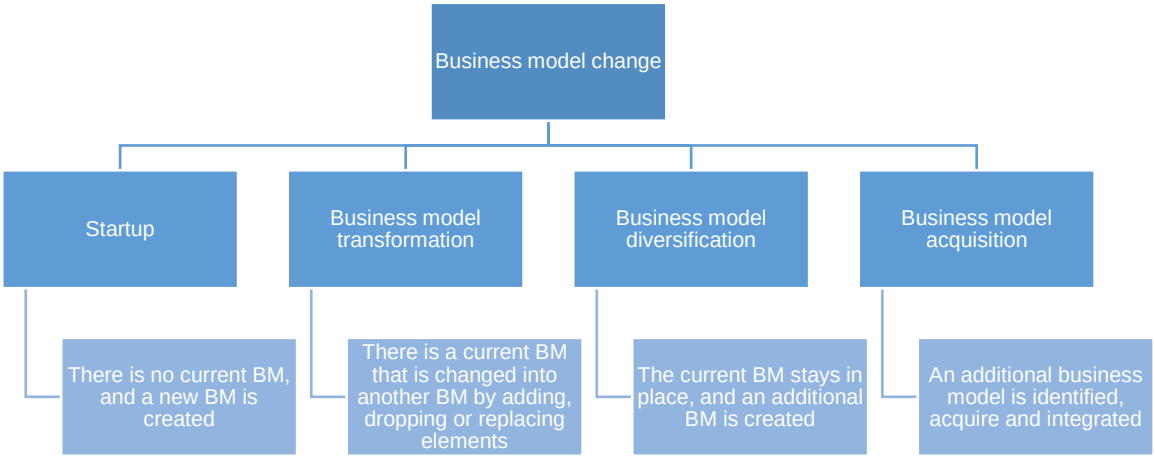

Figure 5 – Business model change types (Cavalcante, Kesting e Ulhøi 2011, Geissdoerfer, Vladimirova and Evans 2018).

Business Model Transformation

Another type of BMCh is transformation, this occurs when a company has a current BM that is going to be changed. This change can consist in adding elements to the current BM, revising them or dropping them altogether and can affect one, several or all components of the current BM (Cavalcante, Kesting and Ulhøi 2011). One relevant matter is detecting the need for a change in the BM. According to McGrath (2011), the signs of BM stagnation are churning clients, growing struggle in finding improvements to the current BM, and changes starting to have minor impact, i.e., minor impact in the business performance. About designing a new BMs Ovans (2015) presents the framework introduced by Casadesus-Masanell and Ricart (2011), whose process to a new business model is to make decisions regarding three aspects, policy

choices, asset choices, and governance choices. Ovans (2015) also presents the framework invented by Girotra and Netessine (2014), which consist of changing the current BM on four categories: changing the products, postponing decisions, changing the people who take decisions, and changing the incentives in the value chain.

Business Model Diversification and Acquisition

The third way businesses can innovate their business model is to implement, in conjunction with the current business model, a new one, applying both in parallel, i.e., BM diversification. The last type is to acquire an organisation with a different BM, leading to BM acquisition (Geissdoerfer, Vladimirova and Evans 2018).

2.3 Business Model assessment

Some authors stress that BMs can only be assessed ex-post, i.e., their performance can only be measured after its implementation (Vossler 2015). In fact, Cosenz and Noto (2018) argue that experimentation is key for BM assessment. Such ex-post assessment includes measuring the increase in profits or in other relevant financial, operational or economic metrics of the company (Mateu e March-Chorda 2016). Osterwalder (2010) suggests a two-step evaluation method: first companies should do a macro analysis of the BM; and then, analysing strengths and weakness, threats and opportunities of each component of the BM.

Unfortunately, ex-post assessment can only be performed in well-implemented BM and can only be obtained quite some time after that implementation (Mateu e March-Chorda 2016).

Therefore, some authors have proposed designs for ex-ante ways of assessing BM. Amit and Zott (2001) have developed the NICE tool (**N**ovelty, Lock-**I**n, **C**omplementarities and **E**fficiency), see Figure 6, which the authors argue that comprise the four main drivers for value creation in e-business. Briefly, companies should aim for efficiency, i.e., reducing the cost per transaction. The lock-in driver refers to the goal of having higher retention rates. E-businesses should try to bundle their products/services, according to Amit and Zott (2001), that is a proven success strategy. Finally, the service/product offered should be innovative.

Mateu and March-Chorda (2016) proposed another tool for assessing a BM. This tool is based on a set of questions, presented below, regarding value proposition, market size, substitute products, among others listed below, which Amit and Zott (2001) use as guidelines for a BM assessment. Mateu and March-Chorda (2016) suggest that, after some adaptation, each question should be evaluated resorting to a Likert scale.

- *How does the product or service bring utility to the consumer? How is it likely to be used? Are all the necessary complements available?*
- *What do customers really value and how will the firm value proposal satisfy their needs? How much may the customer pay for receiving this value?*
- *How large is the market? Is the product/service honed to support a mass market?*
- *Are there alternative offers in the market? How is our offer in comparison to theirs?*
- *Has the business model got the contractual structures required for executing value-creating activities?*
- *What will be the cost of providing the product/service? How will these costs behave as volume and other factors change?*
- *What is the nature of the appropriability regime? How can imitators be held at bay?*

In the case of early-stage ventures, the inability of assessing business models prior to implementation poses a pressing problem, once these ventures have very limited resources and operate under great uncertainty, so there is little room for error (Vossler 2015). Vossler (2015) points out that early-stage ventures should operate under constant BM reassessment, which goes in line with the Lean Startup model proposed by Blank (2013). Blank (2013) argues that during the startup stage of a company, customer development and agile development methodologies should be applied, which consists basically in presenting the product/ideas to stakeholders of interest and use the feedback to further improve the BM. Following this methodology, entrepreneurs are left with the knowledge gained from contact with stakeholders and from market research they might perform. Entrepreneurs can only hope the information they gather during the Lean Startup process improves in quality as Teece (2010) argues, "Pioneers, in particular, are often forced to make only educated guesses…", so the success of the venture is highly dependent on the reliability of the information obtained.

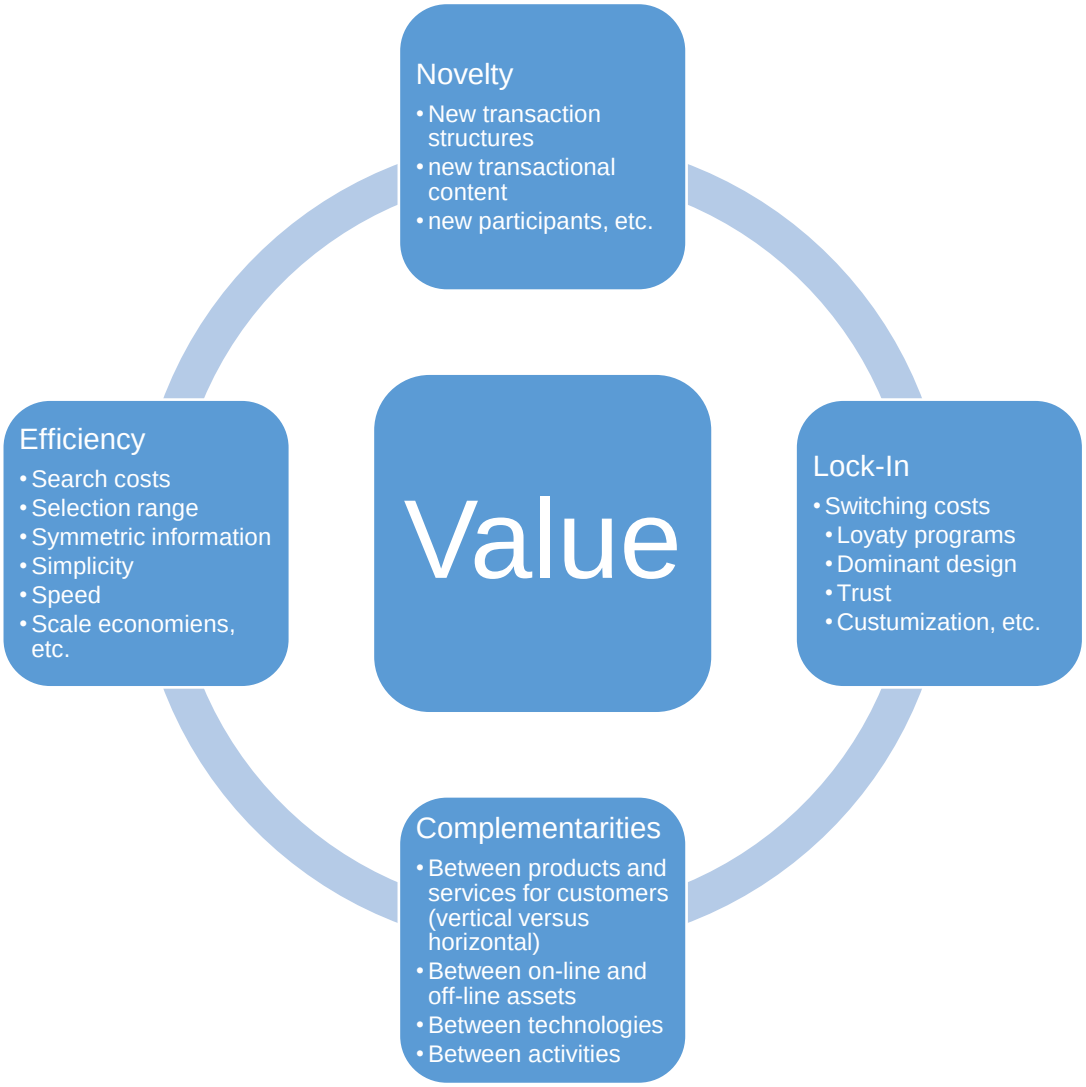

Figure 6 – The NICE tool for BM assessment (Amit and Zott 2001).

2.4 Business Models for IoT-based ventures

The term Internet of Thing (IoT) refers to the vision that every physical object, irrespective of the level of sophistication, can, one day, be connected to the internet. An IoT offering can be strip down to five layers, the physical object, to which sensors and/or actuators are added. Moreover, some kind of connectivity is necessary. Then, on digital grounds, it is necessary to

process the acquired data, which usually occurs in servers and, finally, there is an associated digital service (Elgar, et al. 2016). IoT devices have an intrinsic feature that comprises a big opportunity to create impactful and novel ways of capturing value as they are always connected. Ventures offering IoT-based solutions must define their value proposition carefully, since the technology and the devices themselves are not relevant *per se*, but their value relies is in the platforms that support their use and new augmented functionalities they enable, due to the fact they are always online. Elizalde (2018) stress that IoT-based solutions enable an active relationship between the clients and the company that sells the solution, contrasting with the one time sell that is most common in hardware deals.

Jamieson (2017) further argues that frequent use cases of the IoT technologies consist of B2B. The first use case presented is compliance monitoring, more precisely, IoT-based solutions can inexpensively monitor continuously places that are hard to access and are hostile to humans. The same IoT-based capabilities can be used by companies to monitor the state of their expensive assets, allowing for a more effective and cheaper preventive maintenance, enabling clients to experience significantly improved service levels. Another function where IoT-based solutions have brought value is on remote diagnostics. The solution can alert and act if one or more variables present undesired values. Finally, Jamieson (2017) presents two use cases related to logistics and supply chain management, one is asset tracking and the other is automatic fulfilment. The data provided by the devices help to reduce inefficiencies and unpredictability, pleasing both the customer (company providing logistics or supply chain management services) as well as its client. Besides finding its path in B2B context, consumer products are also interesting for this type of solution. Elgar et al. (2016) list, for instance, home automation, home surveillance systems, health monitoring devices, fitness trackers, and connected cars.

Despite all the potential for business disruption, IoT implementation is falling short of expectations, especially in the B2B context. Blanding (2019) stresses that companies are unable to harness the value of data that comes from IoT-based solutions, and suggests that they should run trials and implement novel BMs. Regarding the inability by companies to generate value from IoT-based solutions, Jamieson (2017) argues that IoT ventures are only viable when they "can deliver recurring, continuous value for the customer". Westerlund, Leminen and Rajahonk (2014) point out technology immaturity and the fact that IoT can be applied to a plethora of use cases have hindered standardization and modularity and consequently, IoT adoption. The authors further argue that the data provided by an IoT-based solution is useful and brings value to many actors in a business environment, and, therefore, entrepreneurs need to leave the closed-firm mindset and embrace an ecosystem business model, in order to exploit the maximum value from using IoT devices. Unfortunately, another factor that is hurting IoT adoption is the fact that business ecosystems are hard to set. The partnerships that enable such exploitation by an ecosystem have revealed to be difficult to establish, since they require considerable time to come to fruition and, moreover, defining the roles of each actor in the ecosystem is also hard.

Elizalde (2018) argues that companies should find innovative and differentiated ways to capture value from clients, applying novel revenue models. In what concerns revenue models for IoT-based solutions, Elgar et al. (2016) state that these have two major components. One is the locus of the value creation, i.e., which part of the hybrid value proposition should be charged, the physical, the digital or both. The second is the delivery and payment component, i.e., how to charge the offerings, one-time payment, or recurrent payments. For instance, a Digital Product refers to an offer in which the physical component (the device) of the value proposition is free (the locus of the value creation are the digital services), and the client pays a one-time fee for the digital services, see Figure 7 for other cases. This terminology presents itself as systematic way to name revenue models, for example, Software as a Service (SaaS) can be named Digital Service, and Hardware as a Service (HaaS) can be named Physical Service.

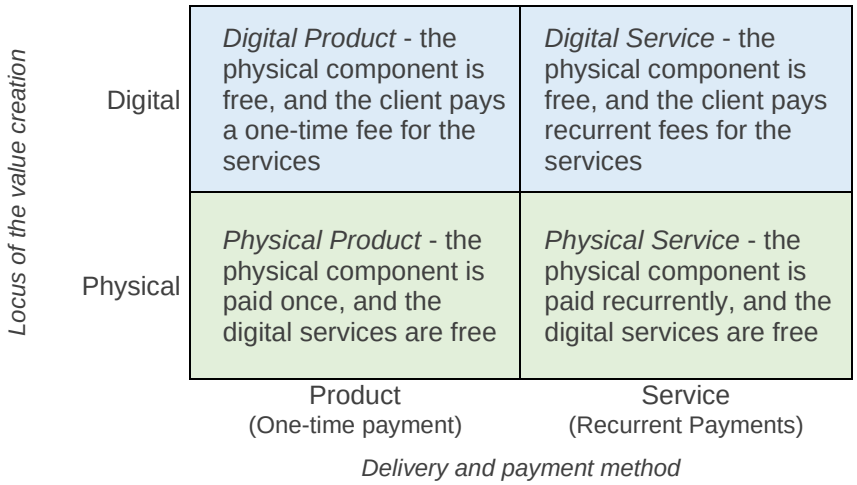

Figure 7 – IoT revenue model frame work (Elgar, et al. 2016).

In their study, Elgar et al. (2016) analysed over thirty companies. In what regards IoT revenue models that only charge one of the components of the offering (the physical or digital component), called pure play, Physical Product (see Figure 7) was the most common revenue model (it was present in 56% of the cases, see Figure 8). Other pure play models were present in only 3% of the cases.

Focusing on IoT revenue models that charge both components (physical and digital), called dual play, the most common is the digital add-on model, i.e., after selling the physical component the customer can purchase certain digital services, this revenue model was present in 25% of the cases. Another model is the physical freemium, which is similar to the digital add-on, the difference is that the digital services are payed recurrently, which was identified in 9% of the cases.

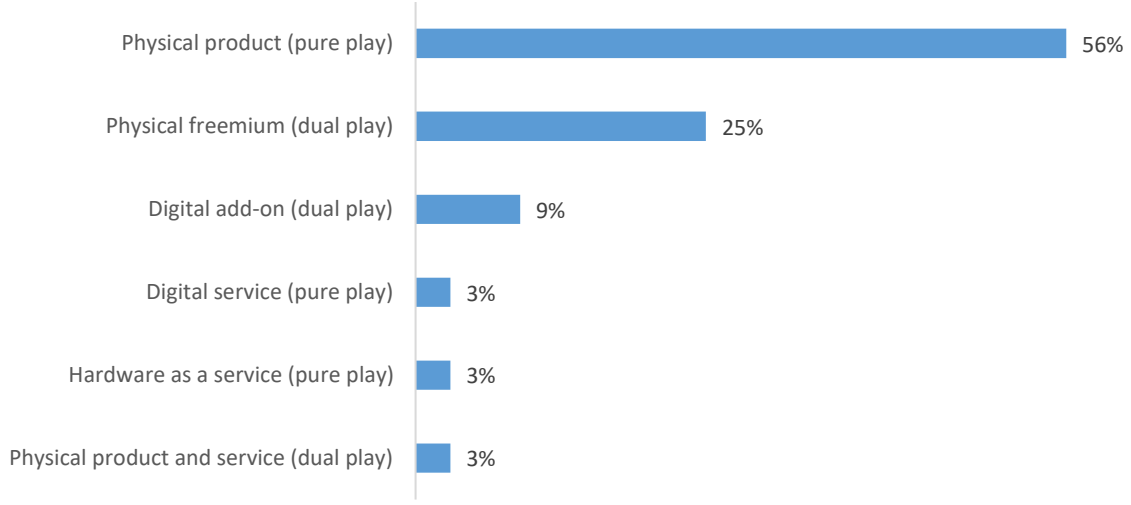

Figure 8 – Frequency of IoT revenue model patterns, pure play and dual play options (N=32) (Elgar, et al. 2016).

The previous revenue models presented focused on offerings that involved two stakeholders (seller and client) but, as mentioned previously, the data acquired by the IoT-based solutions may be valuable to many actors in a business ecosystem. Elgar et al. (2016) also addressed these revenue models in their study. The most common revenue type they identified, present in 81% of the cases, was the Complementary Offer, see Figure 9, more precisely, a company opens the platform to other parties (using an API, for instance). Other dual play revenue models were present in less than 10% of the cases. Complementary Bargain, i.e., the purchase of an IoT-based devices grants the customer discounts on third parties, for instance, a smart thermostat

purchase makes the client enable to receive a discount on the client's energy bill. A third revenue model is IoT for free, in this model, the third party buys the device and offers it to the customer, for instance, insurance companies may offer home monitorisation devices to its customers, once they diminish the risk of house damage. Elizalde (2018) adds more ecosystem-oriented revenue models. For instance, designing an IoT-solution in a way the user can share the device with other users, charging a fee to them. Another monetization technic is selling the data acquired by the devices to third partners.

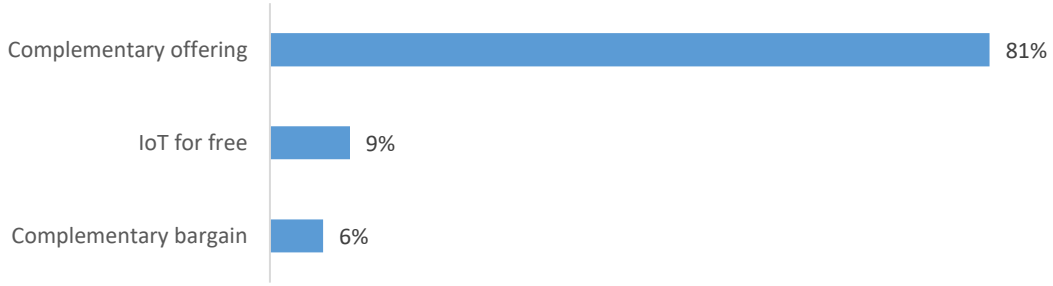

Figure 9 - Frequency of IoT ecosystem based revenue model patterns options (N=32) (Elgar, et al. 2016).

Regardless of which component the company decides to monetize, defining the price is an additional problem. Elizalde (2018) argues that IoT-based solutions allow to charge according to the utilization rate. This rate can be of the IoT devices or the variables the IoT devices are monitoring. Such pricing method is common in B2B markets (Langkamp, et al. 2017). Langkamp, et al. (2017) complement these pricing models with the value sharing type, i.e., the company is rewarded every time the client gets a benefit from using its IoT-based solution, and the reward should be proportional to the benefit the client gets.

To finish, a venture can apply different revenue models to different customer segments. In order to determine the best model to use the company should seek customer engagement since an early on stage, performing interviews with potential clients, experts and other relevant stakeholders (Langkamp, et al. 2017).

2.5 Smart Wearable Devices

According to the European Commission (2016) a smart wearable device (SWD) is one that can sense the person who wears such device or the environment that surrounds her. Additionally, these devices possess computational power which allows them not only to collect data, but also to store the data locally or to send it to and external device (smartphone or a server) for further processing. After data treatment, the information is retrieved to a person of interest, the user or other.

The European Commission (2016) further stresses the need for technology categorization. According to the International Electrotechnical Commission (IEC) current efforts, SWDs can be: on-body electronics, i.e., devices that contact directly with the external surface of the user, smartwatches for example; near-body devices, which do not contact directly with the external surface of the user; in-body devices, which function in the interior of the user.

These devices are only feasible due to the smaller, yet more powerful, electronics. Moreover, ever better sensor, communication and battery technology are also important factors. Furthermore, as in the past, as new technologies, such as 5G, become mainstream, SWDs are only going to become more powerful and relevant. SWDs existence is in line with the IoT trend. Internet of Things is the term used to describe a world where Internet is ubiquitous, i.e., not only to be accessed by computers, but also, by gadgets, machines, everyday products. All these

devices would share data between each other, which, ultimately, would result in great benefits for the users (Minerva, Biru and Rotondi 2015).

The ability to track the user movement, environmental variables and physiological ones, can comprise a benefit in several markets (see Figure 10). As an example, in the medical sector, if people start using such devices, disease prevention may be achieved. There are already devices monitoring glucose and devices that predict epilepsy. Other example is the Oil & Gas sector and firefighters, who are exposed to dangerous gases, so using a monitor device may be lifesaving.

Despite all the potential benefits, statistical studies show that SWDs record a high rate of abandonment after a few months of use (Minerva, Biru and Rotondi 2015). In fact, there are still challenges to overcome, as to find stronger business cases, enhance functionality, and improve battery life, data security and interoperability.

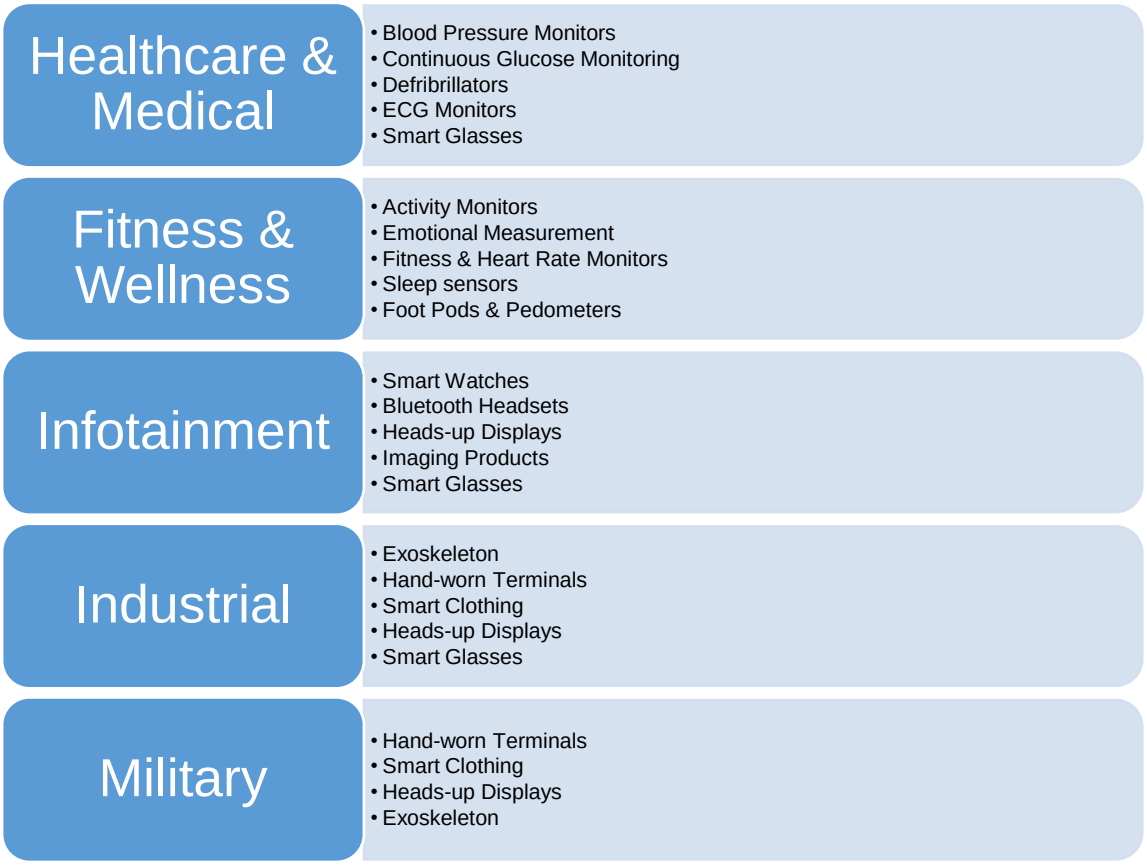

Figure 10 – Types of wearables and application examples (European Commission 2016).

2.6 Technology Transfer & University Spin-offs

Technology Transfer (TT) refers to the process of introducing into the marketplace and to the wider society knowledge obtained in research centres, whether they are public or private ones (European Commission n.d.). The most basic way to do so is via education and scientific publications. However, some research institutes have preferred to use more direct ways to push a technology into the market. Their technology transfer offices (TTOs), which are the entities responsible for managing the technology transfer in an institution, often choose to use between the following strategies: patent sale, patent licensing and spin-off ventures (De Cleyn and Festel 2016). It has been found that having equity in spin-off ventures can yield better returns than patent licensing (De Cleyn and Festel 2016).

Focusing on university research labs, the technologies invented there are usually generic, i.e., do not have a well-defined application, so it is necessary to identify and choose proper markets and applications for the technology. This is where problems emerge, since the people involved in these ventures have strong scientific backgrounds, but lack market, sales and management knowledge (Costa 2014, Lubik and Garnsey 2016), as, for instance, it's important to know how to draw attention to a product and to make people desire it (European Commission n.d.). Moreover, in Europe, academia members are not impelled to engage in commercial activities, unlike the U.S. counterparts (De Cleyn and Festel 2016). And business related skills are paramount for the success of the venture, for instance, in the process of defining an application for a new technology, one must be able to effectively interact with a wide network of different stakeholders (investors, suppliers, partners) and it will be necessary to identify the right moment to commit to a given market (Lubik and Garnsey 2016). Lubik and Garnsey (2016) further add that the process of the technology development for market deployment is long, so these ventures go through long development times (5 to 10 years) and demand large sums of financing (up to hundreds of millions). Finally, internal conflicts are also listed as an obstacle for university spin-offs success. These concern the conflicting objectives between the university, that values knowledge share via publications, and the other stakeholders that cherish secrecy and profit orientation.

Despite all the challenges that a university spin-off must overcome, they also benefit from their lineage and academic connection. According to Costa (2014), investors appreciate the link to the university itself, the network that surrounds university research labs and the university connection automatically boosts the credibility of the venture. However, investors may be disappointed if they feel the team has a total lack of venture development experience, so it is important to work on convincing them otherwise (De Cleyn and Festel 2016).

2.7 Life Stages of startups

According to Dibner (2018), who is a seasoned investor, in spite of all the lingo and jargon that has been used by investors and entrepreneurs, there are only three stages in a startup life: pre series A; series A (transitional phase); post series A.

The pre series A phase is a period in which the entrepreneurs are still fine tuning their product and value proposition to the market and, at the same time, trying to realize if there is actually a market or segments in the market for their services or products. During this period, several seeding rounds may occur.

Then, when the startup is confident it has found a scalable and repeatable business model, it may go for a series A round. These investments are aimed for growing the company, by reaching as many customers as possible. This is a transitional moment, prior the company was still working on their product, market identification, but after a series A round, it changes its focus to grow the business. If such investment is awarded it is because investors think the startup is ready to commit to the business model presented and can now enter a less riskier growth stage.

The third stage is post series A, during this period, several rounds may occur with the goal of raising money to accelerate the growth of the company. As soon as the startup has confirmed that its business model is working, i.e., he customer segments are responding well to the product, the product itself is being well reviewed, the revenues and cost are the expected and, therefore, the sole focus of the company is to grow, according to Balaji Viswanathan (2018), CEO of Invento Robotics, the venture leaves the startup phase and becomes an enterprise, entering what is called the scale-up phase (RocketSpace 2018).

Blank (2013) definition of a startup aligns with the one presented by Dibner (2018). According to Blank (2013), a startup is looking for a repeatable and scalable BM, while a established

company already as a business model in place. Dibner (2018) uses seed rounds as reference points to determine a venture stage, in fact, the relation between available funds and venture phase is well studied (see Figure 11). It was found that startups struggle with lack of available funds when they are trying to begin the commercialization of a product and also, after finding business success, when they are expanding their operations to enter the scale-up phase (Tedim 2016).

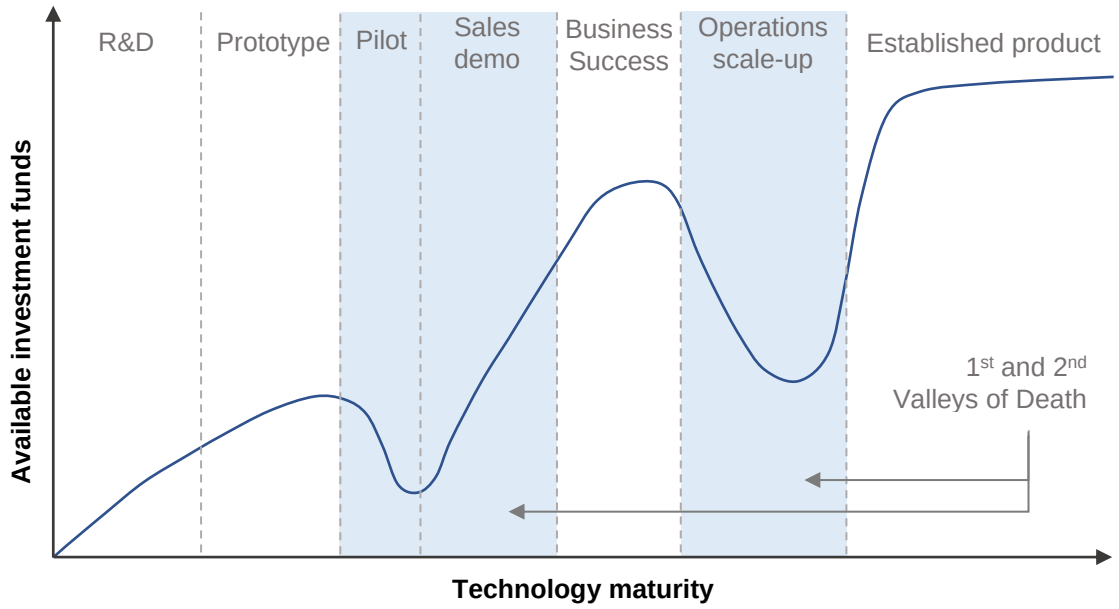

Figure 11 – Valleys of death (Tedim 2016).

3 WeSENSS: Project's initial state

Even though WeSENSS is a new company, it is the culmination of several years of scientific research projects. It is the vehicle built to leverage breakthroughs from previous projects developed by INESC TEC and partners, which focused on building feasible engineering solutions and proving their relevance scientifically. Besides, by conducting pilots as well as market analysis, and directly contacting with end users, as was performed during previous projects, relevant market knowledge was accumulated along the way.

In the following paragraphs, all insights and preconceptions developed so far about how the company should be structured and operate, and how the initial BM should look like, are presented. These are based on internal, confidential documents as well as informal talks with members of the VR2Market project and of the novel venture WeSENSS. This information was used to make an initial BMC (see Figure 12).

Value Proposition

Thus far, WeSENSS has developed on two main value propositions. Real time monitoring for individual workers and teams that perform hazardous jobs, a second proposition that is stress evaluation in the workplace. Furthermore, there is too a third one, that is using the devices to identify a person. This third value proposition is useful in situations where other accurate identification methods are not convenient or even possible at all (Cunha, et al. 2018).

Looking a little more closely to the platform, its first layer is composed by devices with built-in sensors. One device is used on the abdomen, the VitalSticker. The aim of using such device is acquiring physiological variables, it can track the user's cardiac electrical activity, the respiration rate, the body temperature, among other relevant variables. The second device, used to acquire environmental variables, is the AmbiUnit. It senses the concentration of certain gases in the air, the presence of some particles, the environmental temperature, among other variables. The platform also needs a third device, an aggregator, that can be an Android phone. The aggregator device assures that the acquired data is sent to the server via cellular connection. Then the data can be analysed, stored and access by the platform users when deemed necessary. Moreover, the aggregator is also responsible to feed the platform with the localisation of the users and allows the user to see the current and past figures of the recorded variables, using the WeSENSS app (Cunha, et al. 2018).

Concerning the back-end side, the server is responsible to process the raw signals into relevant information for all stakeholders. The information is made available not only via dashboards for real time control, accessible through the app or through other apps (business/operations control dashboards), but also via reports for a more planning oriented purpose. All data exchanges with the server are performed using an API. Having an API ensures that customers can easily integrate the functionalities WeSENSS offers they deem interesting to them with the current systems they use (Cunha, et al. 2018).

After detailing how the platform works, it is now easier to understand how the venture leverages the technologies developed to bring value to its target customers. Regarding the real time monitoring for individual workers and teams that perform hazardous jobs, these workers are exposed to harsh environments that can threaten their lives. The team found they had two times more stress related diseases and over two times the probability of developing cancer, moreover, stress and fatigue are linked to more than have of the fatalities in the first responders context (Dias, Rosas, et al. 2017). With both vital signs monitoring and environmental variables monitoring, it is possible to effectively alert the worker to go to a safer place or seek help whenever any anomaly is detected in his/her health state or in the environment surrounding him/her. If the worker is unable to do so, help can reach him using the geographic localisation of the worker. From an organisation point of view, by having real time data at their disposal, managers can take better, more informed, and more effective decisions. Moreover, they can

quickly detect a dangerous situation and take action to solve it. Both the organization and the individuals can access automatic reports, they can use them to analyse the decisions they made and to understand how to mitigate the health impact of their harsh work conditions, respectively (Dias, Rosas, et al. 2017).

In what concerns the second value proposition, for stress evaluation in the workplace context, the environmental variables as well as the geographic data lose importance. The focus here is to understand the degree to what degree workers are challenged, on a constant basis, with decisions involving major complications creating stress. The team found that stress is responsible for a loss of over 600 billion a year in Europe, due to public systems expenses, loss of productivity, and absenteeism (Dias 2020). Managers can determine, using the dashboards and the reports, if the stress level of a worker is compatible with the functions s/he is performing. Then, the manager can track the root causes of the stress displayed and take decisions to promote the worker wellbeing, for instance, award an extra day off. Furthermore, the users (professionals) can use the data to seek ways to improve their health (Cunha, et al. 2018).

Customer Segments

The technologies developed during the projects before WeSENSS inception are quite generic, and several use cases were developed during those projects. Some of them include data acquisition in the sports context, teams monitoring and safety (which can be used by first responders, Oil and Gas workers, and military staff), stress assessment (which can be useful pretty much to all companies with mentally challenging positions), and personnel identification (which can be useful pretty much to all companies and public institutions, such as hospitals) (Tedim 2016, Ranito 2018).

The spin-off focused on the teams monitoring and safety use case and the stress assessment use cases. Moreover, the spin-off focused on the following segments: ATC in stress assessment; and, Oil & Gas in the real time monitoring and safety. The main reason for this choice was that these were the segments that showed more interest in the technology resulting in the availability to conduct pilot tests in their premises, and good acceptability was recorded.

Pilots were also conducted with firefighters, the technology was praised, but no follow-up conversation existed, so recently, the company has focused on the ATC and Oil & Gas segment. In the military segment, the high security standards made the adoption of WeSENSS technology very unlikely, which led to its disregard (Tedim 2016).

Competition

WeSENSS sees that the market is divided into two types of companies, those that focus on physiological data and those that focus on environmental data (Ranito 2018).

Regarding companies in the physiological sphere, some focus on the medical sector and others focus on products for the consumer. The first is a market with very few competitors, where incumbents deploy several strategies to block the emergence of new entrants, and certifications are hard to obtain and maintain. The later includes companies such as Apple, Fitbit, Garmin, among others, that use sensors with lower quality and less relevant data. Consumer devices can be as cheap as eighty dollars, although the most sophisticated can cost around one thousand dollars. In the middle, there are companies with medical grade devices, science based, that operate in several markets, first responders included. Some identified companies are FirstBeat, Zephyr, Equivital, Bittium, and Empatica. These are the most direct competitors of WeSENSS, as, in some use cases, the environmental unit is not relevant at all, for instance, ATC stress assessment (Ranito 2018).

In what concerns environmental data acquisition companies, the market is much more mature and already sell products to the first responders. Identified companies include Industrial

Scientific, Sperian Protect, MSA Security, and Universal Site Monitoring. Solution prices start at around one thousand dollars and include periodic fees (Ranito 2018).

A player that offers a product combining both aspects, physiological and environmental variables, called Human Systems Integration was identified (Dias, Rosas, et al. 2017). This player works on several markets, such as the military, mining industry, Oil & Gas, first responders, and fitness (Human Systems Integration 2020). The company is involved in several governmental programs, more specifically, with the Department of Defence (DoD) and the Department of the Homeland Security (DHS) of the United States (SBIR 2020). Unfortunately, the company does not disclose in full detail its technology, making it impossible to compare with WeSENSS's.

WeSENSS's solution is unique in the market, it is the only one that records physiological, environmental, geo-linked variables. Moreover, the spin-off developed patented algorithms that allow it to estimate complex indices in short periods of time, less than 30 seconds, these algorithms use heart rate morphology, instead of the standard Heart Rate Variability (HRV) competitors rely on. The spin-off's solution was design to work with protective equipment and to cope with movement, obtaining high resolution, noise-free readings despite the harsh conditions. Finally, WeSENSS offers an open API, allowing customers to easily integrate the solution with their systems (Ranito 2018).

Channels and Customer Relationships

Up until this point, WeSENSS has contacted the potential customer directly. The company focuses on B2B segments, customization level is high, so this seems to be the most appropriate way to reach customers and manage relations with them. In the case of the Oil & Gas segment, the spin-off was able to build a relationship with a services provider and consulting for refineries, which already has well established relationships with refineries.

Nonetheless, the creation of a website to promote the venture is recognized as an important asset for these relations.

The platform was designed in way to be highly automatized, that is, customers should be able to use the platform without requiring the presence of WeSENSS personnel. However, so far, the company has made initial presentations of the platform and, in the end, a group and individual meeting explained the obtained results.

Partners

The members that were involved in this project are all very well connected to several university or university-related institutions. This network is being quite helpful to source talented people, knowledge exchange, special entrepreneurial programs that help the creating of the startup. The connection with INESC TEC is quite important, as it is the institution that is keeping the venture alive, through several initiatives (usually with other players) and is the holder of the IP.

In terms of getting the products sold, WeSENSS found in consultancy companies a strong ally. These companies already know the customers interested in this type of technology, so letting consultancy companies reselling WeSENSS's solution becomes a win-win-win situation: WeSENSS moves the product and services, consultancy companies have more data and a tool to better support their own services provided, and customers benefit from all the features that the solution provides.

The spin-off has already made an extensive work on listing all the available manufacturers and their conditions (price and quantities) (Valente 2019). These are also key elements with whom WeSENSS must closely work to build a good product.

Key Activities

Even though the platform has been developed for some years, there are still features and improvements to be made both from hardware and software perspective, so research and development is a key activity now and in the future.

Since the company is focusing on enterprise customers, finding them, establishing contacts, and conducting demonstrations of the products, are key activities for the business. Each customer will have different needs, and the company will have to embed the technology relevant for the customer pushing to the limits the modularity of the platform. In fact, the team is currently negotiating multiple pilots to test those limits and the operations needed to adjust the solution to the customer. The outcomes of these efforts are going to be crucial for the future of the company.

Roadmaps for the company have been designed, but targets were not met, once these were plans contingent of a certain level of funding that ended up not being awarded. If those plans were financed, the company would be mass producing and internationalising, by now, which unfortunately had to be postponed (Dias, Rosas, et al. 2017).

Resources

One of the greatest resources WeSENSS has is the INESC TEC's partnership. It has allowed the venture to access talented people and investment funds to continue its growth. Besides, it allows the company to access IP at favourable conditions.

Moreover, team members are quite experienced and skilled people, these are the base of the company. All the know-how they have acquired over the years in the projects that preceded this startup is key for the success of the company.

Costs and Revenue Streams

This is the most underdeveloped aspect of the initial WeSENSS BM. Several efforts have been made to understand the cost to manufacture the devices, but many relevant costs are still to be evaluated, for instance, the workforce cost. Furthermore, the spin-off is still undecisive on how to offer the solution, particularly, whether it should offer a one-time purchase, a subscription, a license… Therefore, this is the main focus of the current work, and the most adequate revenue model will be proposed in the final BM.

<table>
<tr><th>Partners</th><th>Activities / Manufacturing</th><th>Value Proposition</th><th>Customer Relationships</th><th>Customer Segments</th></tr>
<tr><td rowspan="3">Consulting companies
Manufacturing companies
University connection</td><td>R&D
Pilots
Sales demos</td><td rowspan="3">Incident prevention
Automatic reporting
Better team management
Health record</td><td>Demonstrations
Feedback
Customer support</td><td rowspan="3">Fire Departments
ATC organisations
Oil & Gas companies</td></tr>
<tr><th>Resources</th><th>Channels</th></tr>
<tr><td>Skilled team
Privileged access to IP</td><td>Sales pitch
Partners
Website</td></tr>
<tr><th colspan="3">Costs</th><th colspan="2">Revenue Sources</th></tr>
<tr><td colspan="3">Hardware
IP fees
?</td><td colspan="2">Partner sales
Turn-key or as a Service?
?</td></tr>
</table>

Figure 12 – Initial business model canvas

3.1 Goals

On the previous section, it was presented how WeSENSS intended to make business previous to this work. The focus of this section is to present what this work is intended to add to what has been previously done, i.e., what are its main goals.

To start, the first goal is to clearly state the current BM of WeSENSS, because several studies, talks and initiatives have occurred but there was not a concise BM of the company that could be used to analyse, test and evolve upon. Defining a business model is beneficial from a managerial standpoint, since it is a key tool for managers to evolve their business towards better and more innovative BM (Tedim 2016). An initial BM and BMC were already presented in the previous section.

It is important to notice that not all BM components will have the same relevance for this work. As previously mentioned, WeSENSS team is most concerned about the revenue model, and, therefore, that is a component of main relevance and focus for this work. This component deserves special attention, since IoT-based solutions enable novel revenue models and, at the same time, IoT-based ventures have had difficulty in harnessing the value of their solution, so properly defining the revenue models is utter important (Elizalde 2018, Blanding 2019). This study will investigate which is the preferred revenue model of WeSENSS target market, Moreover, developing an understanding about price sensibility for each market segment is also going to be a key goal.

Operational plans have been made in the past but are now outdated. Therefore, a new operational plan will also be developed. One of the requests of WeSENSS for this work was to define market entry strategy. For that purpose, it is important carefully set priorities, which is something that this new operational plan will lead to.

On another hand, there are some aspects of the spin-off that were expansively discussed developed by the team, such as the value proposition and customer segments, so these components will not be the focus of the current work, in the sense that this work is not focused on validating those components as that has been previously accomplished. However, even though the spin-off has a clear idea about the market segments to address, based on the use cases performed in previous projects, it was also requested to understand whether there were use cases that were previously disregarded that are worth considering again (due to changes in the context, for instance). Based on the dynamic nature of the BM, more specifically, the fact that the business model must evolve in line with external factors evolution, for each BM component there this work also provides remarks about how the business model may evolve with time, based on the analysis of data collected (Terra, Rodrigues and Maia 2019).

3.2 Method

The method followed in the current work will be the one advised in the literature review, based on Blank (2013) Lean Startup. Briefly it proposes that entrepreneurs must state initially their ideas, i.e. hypotheses for their BM, and then go and talk with key stakeholders, such as, people with extensive expertise on the field (product development, market structure…), potential customers, suppliers, among other important stakeholders for their business, to validate those hypotheses. The reasoning for this recommendation is that those stakeholders are the ones that are going to use the product, certify it, deliver it, compete with it, and so on, so the company must learn from them, in order to make a product that is not only market ready, but ready for market success. During the process, entrepreneurs may reinforce their hypotheses, modify them, or drop them.

WeSENSS has already explored some use cases, but since its technology is quite generic, the company wanted to understand if there were other segments it could approach. In order to meet this goal, a market search was developed. It was made a selection of business opportunities to be analysed, the selection intended to overcome some of the hurdles WeSENSS had faced, low volume, segments with low available budgets and an additional segment that became more relevant during pandemic times. The information was retrieved from several websites, newspapers and scientific papers found on the internet. It was showed what would be the impact of following a new segment in the way WeSENSS makes its business and its relevance for the spin-off.

To start, using several internal documents from previous and future projects involving WeSENSS and insights from informal talks with the team it was possible to design an initial BM, which includes the initial hypotheses for the company. These hypotheses were organized according with the components of the BMC.

Then, interviews were conducted with relevant stakeholders of each segment to assess the hypotheses included in the initial BM. More particularly, for the Oil & Gas segment, interviews were conducted with the responsible for digital solutions of a consulting and services provider of Oil & Gas companies; for the firefighters segment, an interview was conducted with a coordinator of a private fire station (Firefighter 1) and with a firefighter of a public fire station (Firefighter 2). In what concerns the ATC segment, insights were provided by NAV safety coordinator and a NAV psychologist and manager of the Critical Incident Stress Management (CISM) program. NAV is the entity that manages the Portuguese air traffic. Moreover, further interviews with entrepreneurs were performed to learn from their experience of developing startups and entering the market: Entrepreneur 1, former CEO of a wearable startup, and Entrepreneur 2, CEO of company that sells energy systems for the truck industry.

Prior to the interviews, it was necessary to develop guides, one for each of the segments and other for the entrepreneurs. In the case of the interviews from stakeholders of the firefighters, ATC and Oil & Gas segments, the focus was understanding the right revenue model, but insights about other components of the BM that inevitably emerged during the interviews, see an example of a guide in Appendix E. Regarding the interviews with the entrepreneurs, these did not focus so much on revenue streams, they were wider in their scope, covering the whole components of the BM, a second example can be found on Appendix E.

After the interviews, a report was written for each interview summarizing the insights collected, which can be found on Appendix F. The data collected was contrasted with the initial hypotheses. The analysis was performed in the same way as when the initial BM was developed, component by component. Starting by the Value Proposition and Customer segments components. A section regarding competition was also developed, resorting not only to data from WeSENSS's internal documents, but also with other sources. The Key Activities and Cost were developed based on insights from WeSENSS's team members, so that the Operational plan and estimated costs were as realistic as possible. In the Revenue Streams section, scenarios were made to study the balance between price and estimated sales, besides a tool to help determine the price was developed. Finally, for each component, several remarks were made regarding how the company may organising itself to face future contexts. In the end of Chapter 5, a BMC is presented to summarize the new BM.

4 Market Search

Different use cases are explored and presented in this chapter, in line with the goal of understanding whether there are use cases that were previously disregarded but are worth considering again. The last section of this chapter explains the impact that the new use cases, presented in the following sections, might have for WeSENSS' present and future.

The use cases were chosen with the goal of overcoming some of WeSENSS' current challenges. After exploring the firefighters' segment, the company felt compelled to travel to the U. S., due to the larger market size of that country (Lusa 2017). Therefore, it was explored a use case, presented in the section 4.1, that would benefit a larger number of people, while using WeSENSS current solution with little adaptation and with a strong value proposition, save a life. A second use case was explored, since it uses IP developed in the VR2Market that is not being used by WeSENSS's current solution, the identification of a person using its vital signs (VR2Market 2019) and that would gain new emphasis during the pandemic, since touchless solutions became more relevant. Finally, during test pilots with firefighters, the solution was much praised, but the low budgets of that segment hindered the solution adoption, therefore a use case was explored that is less financially restricted, performance enhancement for athletes and sports teams.

4.1 Real time risk assessment for chronic patients

As mentioned, the use case presented in this section aims to address a larger market than other use cases (remarks about that will follow), its value proposition is help saving lives and WeSENSS current solution can be used with little adaptation.

Regarding possible adaptations, the monitoring device should have a cell connection in order to be always connected to the Internet and thus the user avoids having to carry a device to provide the connection (a cell phone, for example). Moreover, specific software would need to be developed, as this use case dishes the need for an environmental unit and would be used standalone.

In previous market analysis, it was considered that consumer devices, like smartwatches, or fitness bands gave limited insights to the user about the acquired data (Ranito 2018). So why not build a consumer device with WeSENSS superior, medical-graded, technology. It would be advancement to current consumer cardiac activity monitors, a solution that the customers could comfortably use and be monitored constantly. The device would be targeted to people that, due to some health condition, may suffer from sudden life-threatening events, for instance a cardiac arrest, an epileptic attack, or a fall. If the user senses s/he is not feeling so well, s/he could push a "panic" button in the device or, alternatively, if the user is unable to call for help, the device would be able to detect if the user is going through some harmful event and trigger those alarms by itself. Getting help quickly is very important for the survival rates and for lowering the risk of permanent damage (Verissimo 2020). Furthermore, if such device preserves the data collection function, there is the possibility to even foresee such events.

Recent data shows that cardiac diseases are the main cause of death in Portugal (35 thousand people in 2017, a third of the annual total death figure (Agência Lusa 2017) in the country. About 500 million people, between the ages of 40 and 65 years, face a very high risk of suffering from a fatal cardiac event (Instituto Nacional de Saúde Doutor Ricardo Jorge 2015), which is an increasing trend due to the ageing of population. This age group could benefit from a solution such as WeSENSS. Death by cardiac event is a serious problem in almost every country around the globe, especially those with an ageing population.

A downside of this B2C strategy would be the existence of substitutes and similar products, like such as regular phones or smartwatches. However, the majority of them does not call for

help autonomously, which would be an important advantage for WeSENSS. Bittium is a Finish company with an extensive product line that ranges from robust network solutions (VoIP, LTE…), to cell phones and medical devices (mainly to brain and heart activity monitorization). Bittium sells a compact device, Faros, that can detect several cardiac diseases (Bittium 2020). AliveCor KardiaMobile also has a device with which users can conveniently and regularly monitor cardiac activity, is a six lead ECG device, cleared by FDA (AliveCor 2020). The major threat would be iBeat Life Monitor, which is a smartwatch that monitors several physiological variables and can call for help autonomously (iBeat 2019).

Pursuing a B2C strategy requires a whole new set of activities, which, in turn, require considerable resources to be effectively performed. One of those activities is reaching the customer, knowing where the customer is, how the customer finds the product. For instance, spending resources informing doctors, so that they can advise their patients about the benefits of using this device, contacting former cardiac arrest people to tell them about this device, that can make them feel more safe in their daily life. Making the company more active in social networks, have a compelling website and advertisement bits. As previously mentioned, saving a life is a very compelling feature, and, therefore, emotional advertisement might have interesting results to appeal for its purchase. For instance, the Apple Watch often appears on the news in stories about how the watch helped saving a life. There's a piece on The Boston Globe stating that the Apple Watch saved a woman paddle boarding in Massachusetts, thus making a strong point regarding Apple's smartwatch relevance (Sweeney 2019).

Other important activity WeSENSS would need to focus would be converting the current device so that it can perform the desired functions. Selling directly to customers may also require specific certifications, that can become expensive.

4.2 Biometric key

The current work was developed amid the COVID-19 pandemic. The transmission of many diseases, such as strains from the corona virus family, is eased by touch (World Health Organization 2020). This global pandemic really shows the need for authentication methods that do not rely on touch, i.e., are touchless methods. For instance, Santa Maria hospital, in Portugal, suspended biometric authentication during the pandemic, to prevent disease dissemination, because a fingerprint based authentication method was in place (Bento 2020). Moreover, the project that preceded WeSENSS, the VR2Market, resulted in three patents, but one is not being explored by the company, therefore, this use case was selected to showcase the potential of that unused IP. The patent grants WeSENSS the ability to identify a user by the waveform of its heart electrical activity (J. P. Cunha 2016a).

WeSENSS can follow several strategies. It can sell or license the patented algorithm to incumbents in the wearable market or build a new device, based on the current ones, for this specific purpose and then sell it to organisations that require tight security, such as, hospitals and factories, or even consumers that may desire to use it to open the doors of their own houses, for example.

Implementing authentication via heart electrical activity analysis comes with many benefits: it is a very secure system, it was obtaining similar results as other biometric state-of-the-art methods; it is very quick, it needs 1,020 heartbeats, on average; it is touchless, which prevents disease contamination, moreover is a very fluid method from a user experience perspective; and it is fit to be used in devices with low computational power, such as wearables (Paiva, Dias and Cunha 2017).

There are already players in this market and many similar products. For instance, Nymi sells a wrist band equipped with sensors that enable heart activity sensing, besides, the company also offers a Software Development Kit (SDK), a software package that enables people and

organisations to conveniently integrate Nymi solutions in their own systems (Nymi 2020). There is also a rumour saying that the next Apple Watch will use its heart rate sensor to enable user authentication (Keith 2020). Many wearable device makers can introduce this feature. Moreover, there are substitute methods present in the market, such as iris or face scan and recognition.

If WeSENSS considers this market segment and chooses to license its solution, it needs people with experience in such establishing such deals. If developing proprietary hardware and software is the chosen strategy, the venture will need specialists in building secure apps. For instance a problem posed by these devices is that the authentication must be solicited, in other words, a malicious person can connect to a WeSENSS device and use the reading to log into services or open secure doors, without the user ever realizing s/he is being targeted, therefore further R&D would be necessary to build a device for this segment.

4.3 Performance enhancer

During the VR2Market project, the team worked closely with firefighters. Although the solution was appreciated, this segment was unable to pay for that solution. Therefore, the present use case was chosen, since in the sports market there are significant funds available for solutions that help athletes and teams improve their performance, for instance, British Premier League teams, such as, Leicester City Football Club and Southampton Football Club, invest in such solutions (Smith 2016). No matter how minor the improvement is, it is highly valued (Shah 2018). Due to the value added of the potential gains of using wearable technology to boost performance, there are many products developed for all types of sports (team sports, individual sports, motorsports…) and all types of athletes (casual, fitness, amateur, professional,…).

The VR2Market project was not focused on sport, and, besides, the wearable device offerings for sports space is already crowded. So, why should the sports market be considered, why is it consider in this section, and how could WeSENSS leverage its know-how to bring value to the sports market? According to Sanyal (2018), next-gen sports wearable technology will be a combination of the existing features “with additional movement and biometric tracking such as blood oxygen saturation and bioimpedance, to give an even better prediction about performance outcomes”. Acquiring the data is only part of the problem, it is necessary to complement the data acquired with tactical insights of the opponents for meeting the optimal training (Smith 2016). Soper (2016) additionally states that success is met when teams go beyond data description and use data to predict events and to prescribe measures. Moreover, WeSENSS hardware is modular, i.e., they can be adapted to house difference sensors, furthermore, their design assures the device can acquire data with little noise, due to the patented electrode design (J. P. Cunha 2016b). WeSENSS team, and INESC TEC are also proficient in data analysis, they have the necessary skill to not only accurately acquiring body signals, but also to transform that data in knowledge and help give athletes and teams insights to improve their performance.

WeSENSS was not built with the sports market as a target, so WeSENSS needs to spend many resources if it intends to implement any novel feature in this market. For instance, in cycling, lactic acid is of tremendous importance (Burke 2002). It allows to determine how far an athlete is from his limit, so it would be very important for teams to have such information in hands (Lomas 2015). If any breakthrough is achieved, the solution may help athletes prevent injuries (Hellmerichs 2019), improve scouting (Soper 2016), plan their training sessions better and, ultimately, perform better (Sanyal 2018).

As previously mentioned, the wearable devices for sports market is crowded. The following paragraphs provide an overview on the current technology offered, focusing particularly on football (soccer) as it is the most popular sport worldwide (Brown n.d.).

Johnson (2019) provides a comprehensive list of solutions. Some of them consist of devices attached to the players socks (such as Player Soccer from Zepp or Trace devices), others offer devices that require a vest to be used with (such as Playertek from Catapult Sports or FieldWiz from Advance Sport Instruments). Belly bands are used by some companies such as Omegawave, this company's device includes ECG, a feature that previously mentioned devices did not feature. The device measures the brain electrical activity to better assess the player readiness to play. First11, provides a solution consisting in two similar devices that should be used one in each foot. The solutions presented above are similar, although differ on the level of sophistication, and they consist of wearable devices equipped with sensors (GNSS, ECG, accelerometer, gyroscope, magnetometer). Those sensors send physiological, motion and position information to an external device or to the cloud. Then the information is analysed, sometimes complemented with other information (such as videos from motion-tracking cameras). The focus of these companies is not to sell hardware but to deliver insights/knowledge that can provide an edge to the user, so often the product is a platform, and not the device.

The benefits that come from using this kind of devices is invaluable. So much, that in 2015, FIFA launched a committee for analysing how technologies could improve the sport. This committee was responsible for the Goal Line technology, the VAR system and the introduction of wearables in the sport, the so called Electronic Performance and Tracking Systems (EPTS) (E. Alvarez 2017). In the British Premier League these devices are extensively used in training and can now be used in matches as well (Smith 2016). Wearables are ubiquitous on American professional leagues and are now becoming mainstream on amateur ones (Slinger 2018).

Some of the devices presented previously are, multisport, i.e., can also be used in other sports such as skiing, snowboarding, mountain biking, surfing, kiteboarding, basketball, American football, among others. Therefore, the potential income is far bigger for WeSENSS.

If WeSENSS decides to address this segment, a key activity is the development of ground-breaking technologies, which the venture must be prepared to support. Moreover, marketing skills are also necessary, advertising in sports events and using brand ambassadors are possible ways to communicate with potential customers in this market.

4.4 Impact of new use cases on WeSENSS

WeSENSS vision is to be an occupational health company. On one side, it aims to help workers that perform harsh jobs and their employers, by monitoring, in real time, the impact that the conditions workers are subject to have in their health (in the short and long term). On the other side, it aims to help workers whose jobs are psychologically demanding and therefore are prone to suffer from stress. For the later, WeSENSS plans to include mindfulness techniques to ease the stress of the workforce. However, WeSENSS aims to be a health consultant for companies and institutions, and not a medical monitorization equipment provider.

Some sensors used by WeSENSS' devices are graded as medical devices, but the product is not medically certified, because certifying a product to be used in the medical sector, brings heavy costs, which are not easily accepted by the current venture governing institution. For instance, in order to introduce a real-time monitor for patients with life threatening conditions would require such certifications.

For this reason, there is a settled desire among the company's top managers to be a B2B venture and some reluctance for adopting a B2C orientation. This tendency is also due to the fact that the platform was built from the start to be implemented in a B2B context and not to be used by single users.

Furthermore, meeting new use case needs will, for sure, demand further product development, which is undesirable at this stage, since WeSENSS is very limited in terms of resources available.

Summarizing, due to the reasons mentioned above, i.e., misalignment with the company's vision and need of further development or certifications, WeSENSS team feels the company should focus, for now, on the current use cases and customer segments, the firefighters, the ATC, and the Oil & Gas industries. Nonetheless, the presented use cases may be important in a later phase of WeSENSS, as a new feature, such as the user identification technology, or as a new market to explore once the venture becomes more mature. Further remarks on this matter will be made in the following chapters.

5 New Business Model Proposal

Based on information retrieved from WeSENSS's team, from research performed on external sources, such as the Internet, and from the interviews conducted, a new BM proposed on the following pages with the purpose of preparing WeSENSS to enter the market with a BM that enables to successful in the present and in the future, since the proposed BM was made having in consideration insights from relevant stakeholders, includes an operational plan and evaluates how each component of the BM may evolve in the future. In the end of the chapter there is a BMC that summarizes all the information (see Figure 19). The idea is to correct previous hypotheses developed during research projects that were incorrect and proposing a feasible, realistic BM that might guide the company towards success. The data that supports the new BM is presented side-by-side with the proposal of the respective BM component.

Customer segments

Customer segments that have been a priority for the company have already been mentioned: firefighters, ATC, and Oil & Gas industries.

Concerning the firefighters' segment, despite positive reviews during pilots, no interest on purchasing the solution was displayed, up until now, at least from the public firefighting institutions. Public institutions have showed to be hard to reach, especially top managers (those who decide or create pressure for these kind of purchases). Furthermore, it is unlikely that public institutions invest in technological equipment, considering the low budgets available. For instance, The Chief Fireman of Mourão firefighting team, reported that, in 2018, one third of the corporation was unable to go to the field due to lack of equipment, and there was no money to purchase such equipment (Diário Campanário 2018). In the interviews it was said that firefighters usually buy equipment from countries that are scrapping old equipment, in some cases the purchased equipment was in second or third hand. To finish, is important to mention the food scandal, in 2017, firefighters associations reported they were being handed low quality food, which was being distributed off schedule, and, overall, the available food was scarce (L. Alvarez 2017).

It is also important to remind that there are 12 private corporations (Oliveira 2010). One private corporation is AFOCELCA, which is a joint effort between the main Portuguese pulp and paper companies (Navigator and Altri), which has a 3 million euro budget and controls a group of 250 firefighters whose mission is to protect the employers' eucalypt fields (Agence France-Presse 2019). Continental/Mabor, the tire maker, also has a private firefighter unit, as as well as Galp refineries, ANA airports, Riopele textiles, Autoeuropa and Toyota Caetano auto maker facilities, Vista Alegre ceramics and glass and, finally, Nestlé food factories (Oliveira 2010). It is possible that these institutions benefit from having larger budgets than the public corporations, which will enable them to pay for a solution such as WeSENSS. The private fire station stated, during the interview, that their firefighters already use a GPS tracking device.

If any of the previous approaches to firefighters works, WeSENSS should try to sell to individual firefighters, following a B2C strategy, even though the firefighter interviewed thinks only a residual number of firefighters would be able to purchase the solution.

Concerning the ATC segment, according to the interviews conducted, the segment would not use the full capabilities of WeSENSS's solution, in the following section, Value Proposition, the reasons for this statement are listed. Therefore, this is a segment with low potential to use the solution provided, and with low interest to be pursued.

Finally, there is the Oil & Gas segment. This seems to be the most promising one. WeSENSS's API implementation is already concluded, the stakeholders interviewed were excited with the technology, and new test pilots are being conducted. This is, up until now, the segment with the highest potential to result in a business relationship.

One of the goals of this work was to prioritize the segments in which the company should focus on. Considering what was stated above, the Oil & Gas segment seems to be the most promising customer segment, so this is the segment the company should focus on and employ more resources. The firefighters and ATC market displayed less potential to be interesting customer segments for WeSENSS. Nonetheless, the company should also try to sell to these segments, particularly, in the firefighters segment. If public fire stations are unable to purchase the solution, the company should contact private fire stations and, if none of them decides to adopt the solution, then the company should try to sell individually to firefighters. As Entrepreneur 2 stated, a startup should use any help to develop its solution, but it must have in mind that not all development partners will become customers, WeSENSS has that experience with the firefighters segment.

In a more distant future, in a pursue for growth, WeSENSS may find the need to look for new segments to focus on and new ways of doing business, such as a B2C strategy. Entrepreneur 1, during his career, had to pivot to B2C markets in order to operate at a higher scale. Scale is very important in hardware companies, as it enables them to offer the product at a much lower price.

Value Proposition

Most benefits that WeSENSS proposes are qualitative and hard to measure, which makes it harder for institutions and companies to easily accept purchasing the products, as it becomes more difficult for them to quantify their benefits. As Entrepreneur 2 states, the market buys benefits, if those benefits are hard to determine and convey, a venture may struggle to successful deploy its products into the market.

Complementing the idea of segment prioritization, WeSENSS value will be stronger for use cases where it is able to save a life or prevent an injury. These benefits are relevant and evident the in the firefighters segment, in the Oil & Gas (namely for injuries prevention), but not so much in the ATC segment.

In fact, in what concerns the ATC segment, in the interviews conducted, workers faced the solution as only being needed to help defining shift definitions. The solution was seen as a one-time study, that would be repeated once in every 2, 3, or 5 years. On one side, devices will be used sparsely and occasionally in time, with the goal of producing a report, and real time data is not an essential feature. The idea of using the service on a more frequent base was not well received and further opposition from workers was feared. Another fact that might upset ATC companies is data storage, as it was preferred to keep the data collected internally to NAV, and the solution is not designed in a way that allows it. Moreover, problems regarding workers stress and fatigue status are quite infrequent. Another aspect to be addressed is the fact that WeSENSS's competitors offer exercises or activities to mitigate stress, such as breathing or relaxation exercises, workshops, keynotes… Just measuring the data, as WeSENSS proposes, was seen as adding little value, so the team will have to develop this need internally or to find partners, in fact, some of upcoming projects are focused on solving this issue, more specifically, with mindfulness techniques.

Regarding the Oil & Gas segment, the ability to track, in real time, toxic gases was well received. Unfortunately, constant monitorisation was also considered unlikely, as in the ATC segment. Instead, the solution was considered interesting to be used in planned activities that involve harsh atmospheres. The problem is that these tasks occur every two or three years per machine.

Focusing on the firefighters segment, a problem that was mentioned during the interviews was the access to good network coverage. In fact, there are companies selling solutions just for that purpose, such as ResponderX that sells a mesh network solution (ResponderX 2019). Apart from that, the product was very well received.

It is important to detail specific needs for each segment. Firefighters and the Oil & Gas segment will obviously need both the vital signs unit and environmental unit. In the Oil & Gas segments, companies prefer to integrate WeSENSS's solution using the API, the firefighters segment also has their own dashboards, but this is not the case for the ATC segment, this segment would require WeSENSS to develop a dashboard. The ATC segment also requires that WESENSS develops skills in stress mitigation techniques (mindfulness, for example), but dismisses the environmental unit, the GPS tracking, and some certifications, such as the ATEX certification (for explosive atmospheres).

In a more distant future, WeSENSS may feel the need to look for new use cases and value propositions to grow its business. New value propositions may be designed for new customer segments, such as a B2C strategy for firefighters or a device to monitor people at risk. The spin-off must be able to make the platform valuable to be used by a single user, besides changes in customer relationships and channels must be made to pursue such segments. Other use cases may be followed, such as identifying a person through ECG waveform and sports analytics consulting branch, but these require more resources to develop, since imply more changes to WeSENSS's current solution.

Competition

This section will start with a recap of what was previously stated regarding WeSENSS's competition. The spin-off is unique in its offering of real time physiological, environmental, geo-reference data acquisition. Its patented solutions allow to read data with little noise, even if the user is moving and using rugged equipment. The quality of the acquired signal allows WeSENSS to apply better algorithms, as they use the heart's electrical activity waveform, while competitors rely on weaker signals. Finally, the company offers an API to enable its customers to integrate the solution in their own systems. Moreover, the players in the market divided themselves into companies that focus on physiological data and others environmental data. There was identified one company that presented a similar value proposition, Human Systems Integration, however, this is a rogue company. After this short summary, new data will be presented.

As the time went by, at least one new competitor has appeared, Prometeo. It is a Spanish startup, backed by IBM (which not only funds the new venture but also supplies access to IBM's cloud services) and the Linux foundation. Prometeo is conducting pilots with Spanish firefighters (Klipp 2019). Its platform is similar to WeSENSS's, with physiological, environmental and GPS data acquisition and has the goal of promoting firefighter's health and safety. The technological level of this company is uncertain, since it is in the early stages of development, but is has opted for using and arm device to read vital signals.

An additional threat WeSENSS suffers is from partial substitutes, i.e., the threat of companies that offer just a feature of the ones WeSENSS offers. Some customers segments may need just part of the solution, for instance, toxic gas monitors, GPS trackers, vital signs devices, communications and network solutions, among others. WeSENSS suffers from this problem in the ATC segment, where the environmental and GPS data is not relevant, just the physiological data matters, but several companies are already in this space, such as, Firstbeat and EliteHRV. If a client only needs part of the solution, he may disregard WeSENSS superior technology for a simpler, cheaper, more focused solution. Moreover, such companies have focused on those segments that only need physiological monitoring and develop features for the needs of that market. For example, an aspect that was mentioned during the interviews with ATC workers was that data acquisition *per se* is not enough, is important that WeSENSS can offer ways to reduce the stress of the workforce. Other companies offer online courses, workshops, exercises… to solve the problems, but the spin-off has already detected that problem and intends is developing mindfulness methods to help workers.

As a final remark, a concern voiced in the interviews, in the cases of those that work in the field, was the access to good network connection. Without a connection, workers or firefighters become unreachable, which is a major safety threat. Moreover, mesh capabilities were planned, in the initial VR2Market project. There is a company called ResponderX, which sells the TFT (TaskForceTracker), a position tracker with mesh network capabilities, so that the devices do not go offline (ResponderX 2019). This is an aspect that WeSENSS could improve in comparison with some competitors.

Channels and Customer relationships

In the B2B context, direct contact is the common way to reach customers about a novel product. Moreover, authors argued the need to establish a business ecosystem around an IoT solution, where every player benefits from the solution is key to harness the full value of the IoT solution (Westerlund, Leminen and Rajahonk 2014). WeSENSS already established a partnership with a services provider for the Oil & Gas segment. From the interviews conducted, a possible new partnership was suggested with companies that manufacturer vehicles for the firefighters. Establishing a partnership may enable the spin-off to raise customers in a segment that showed to be hard to enter in the past. An additional path to reach potential clients, which was mentioned during the interviews, is selling the solution through insurers, since WeSENSS's solution prevents accidents and diseases. However, partner fees must be considered, these depend from partner to partner, for instance a proposal for the partner on the Oil & Gas segment was 25%, the retailer that was interviewed stated that his fees were between 35% to 50%.

WeSENSS has had such a hard time selling to the firefighters that considers selling directly to the user. However, if a B2C strategy is followed, the way to get to the customers must change, a possible way to reach customers is handing out brochures directly or sending them to their homes or fire stations.

A key moment for the company is the contact with the business customers. It is important to convince potential customers that WeSENSS's platform is a way of having a safer and healthier workplace and that it does not require or imply excessive monitorization. WeSENSS can approach labour unions to help sensitize workers about safety and health issues. Moreover, the initial contact is also important to list the specific needs of each customer so that the solution will be truly valuable for their company. Furthermore, it is important to retrieve feedback and use it to improve the platform.

In the ATC segment, in particular, it was voiced the need to not only quantitatively assess stress, but also the need to be given tools and techniques that help diminish the stress, if necessary. Currently the company already performs group and individual meetings describing the results obtained, but the interviewees suggested that WeSENSS should go further. For instance, it could conduct workshops, keynotes, develop exercises for users, imitating competitor companies. The company is planning to test mindfulness techniques it is developing currently.

Revenue streams

Since WeSENSS is a new venture with considerable resource constrains, it seems reasonable to start in Portugal and then, after meeting a feasible business model and building a sales record, start internationalizing. Entrepreneur 2 also preferred to develop his company in Portugal and approach its target market, located in the north of Europe, once the venture reached a mature stage in its original country.

To identify the target market see Table 2, Table 3 and Table 4. The tables also feature the size of some international markets in order to give an idea of the difference of market sizes and internationalization possibilities. After WeSENSS establishing itself in Portugal, the company can start look in new countries to expand. Due to proximity and free movement of goods and people, expanding to other European countries is a strong possibility. For instance, Galp already has facilities in Spain, so, if a successful relationship is built in Portugal, the gas company may

easily want to implement the solution there (Galp 2020). After Europe, the company can look to more distant locations, like North America, place of two of the biggest economies in the world (David and Machado 2017). The segment that requires more attention in this regard is the firefighting one, once the company should look for countries there are greatly affected by fires, Table 2 only presents such countries, according to the study of Doer et al. (2013).

Table 2 – Number of firefighters in several key markets (PORDATA 2019) (Firefighting 101 2011) (Karp 2020) (EPSU - European Public Service Union 2010)

Country	Professional	Voluntary
Portugal	3 750	27 000
Italy	26 000	7 000
Spain	19 886	3 437
USA	46 150	788 250
Canada	11 687	19 307
Australia	20 692	152 798

Table 3 – Number of air traffic controllers around the world (Jones 2020) (Statista 2011) (Francisco 2010)

Country	Total
Portugal	500
Europe	16 800
USA	14 000

Table 4 - Number of oil and gas workers around the world (Lusa 2018) (Data USA 2018) (Lukach, et al. 2015)

Country	Total
Portugal	1 000
Europe	160 200
USA	172 000

For the NAV coordinator, it was found they plan to use the solution as a service, they do not want to own any device, they just want to call, measure, and receive a report. The same goes to Oil & Gas segment, they want to use it to some planned tasks. In the case of firefighters, corporations are independent from one another, so each one will have its preferred payment system, as we learned from the interviews. For instance, Firefighter 2 stated that his fire station preferred a one-time only payment for equipment. While Firefighter 1 told us his fire station rented some equipment and associated services, which could be the model used by WeSENSS. So, at least in this segment a renting method may encounter some resistance.

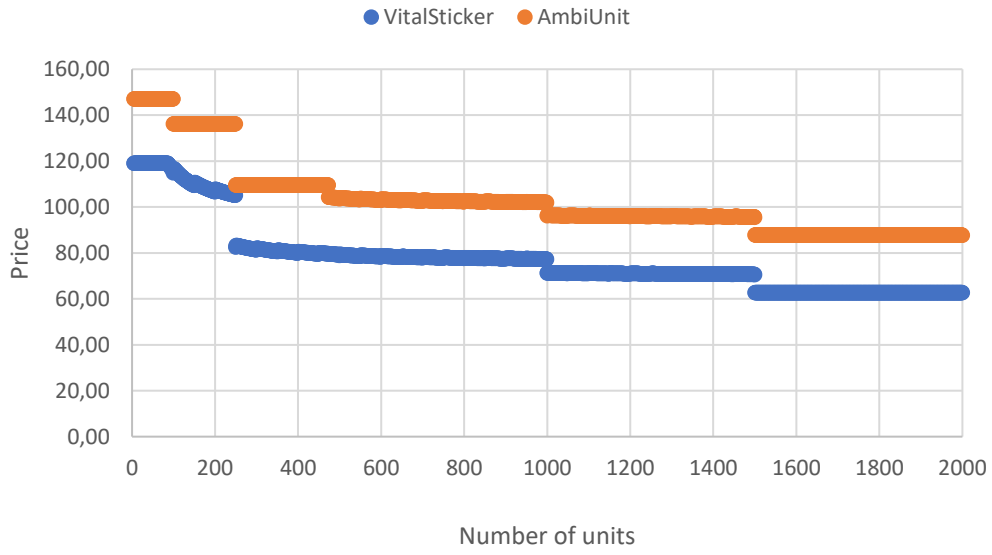

Figure 13 – Components and assembly prices of the VitalSticker and the AmbiUnit (Valente 2019).

Another important factor is price estimation. The adopted method lays on two assumptions. The first assumption is that production runs will provide enough hardware for two to three years. The second assumption is that the price WeSENSS can set for is solution is dependent of the estimated number of users. For instance, a software may be used by a hundred users or by one hundred thousand users, but for WeSENSS the price of building that software was the same, the wage(s) of the developer(s). From a hardware perspective it is also true, for instance, the components and assembly cost decreases with the number of units (see Figure 13).

Based on these assumptions, prices were estimated as follows: the costs for the production cycle were categorized (hardware or digital service related, see Table 13 in Appendix DAppendix C, summed, and divided by the production size. This gives an idea of the price WeSENSS must practise to support its costs (see Figure 14 and Figure 15 for a one purchase of the hardware plus a digital services subscription and Figure 16 for a renting option cost estimation). The most common feedback on how companies intended to use the solution was as a service, so a renting method seems to be an adequate revenue model.

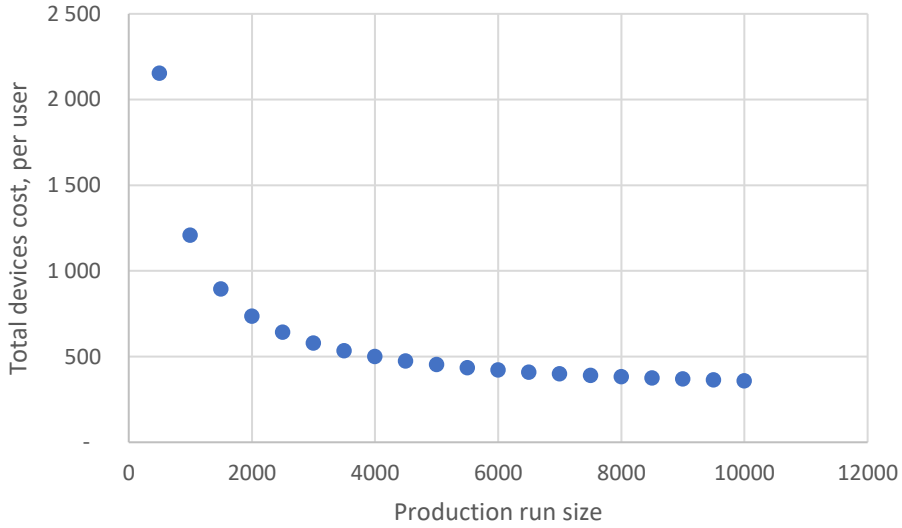

Figure 14 - Estimated device-related cost, per user

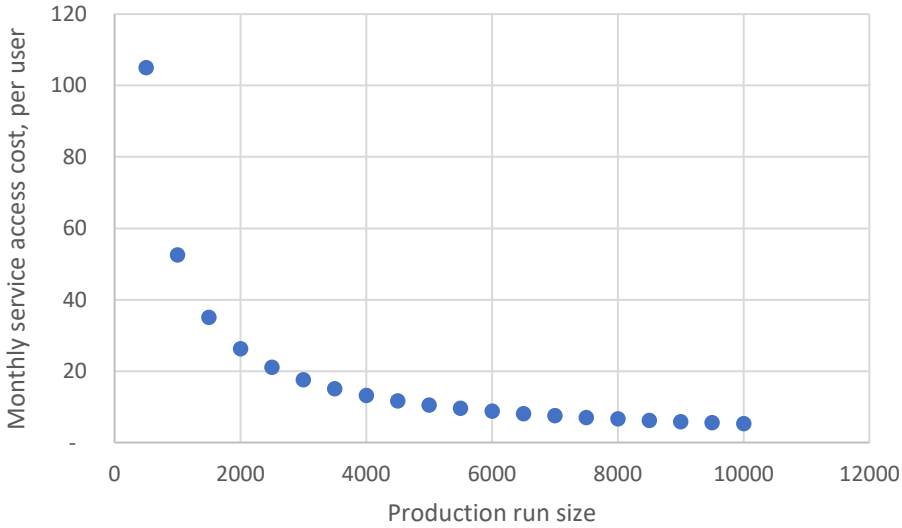

Figure 15 - Estimated cost, per user per month, to offer digital services that complement the hardware

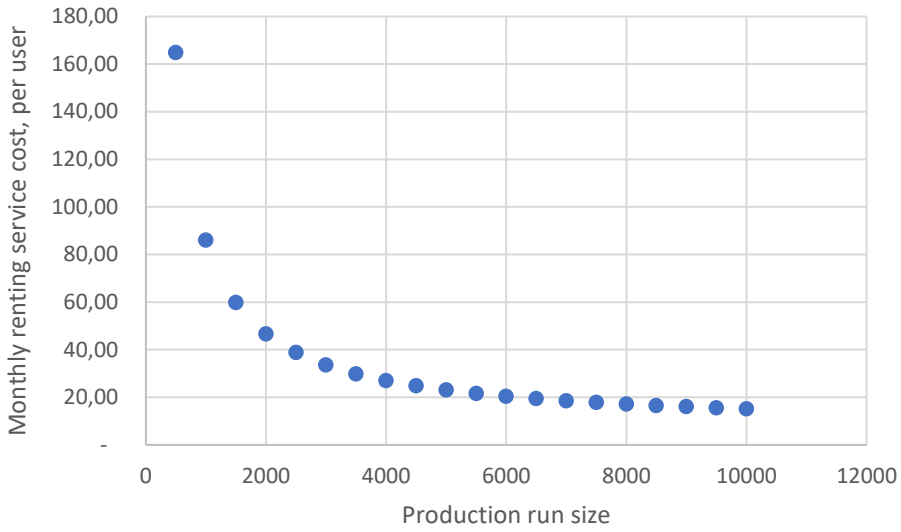

Figure 16 - Renting option cost estimation, per user per month

Since, the price is so highly dependent on the estimated number of users, which in turn impacts the size of the production run, three sales forecasts were developed. Such decision was made, because one can never estimate sales with perfect accuracy. Entrepreneur 2 said that he would set sales goals for a given period and, in the end of that period, he would analyse if his company had met the expectations, surpassed or was unable to achieved them.

In order to develop a sales forecast, it was necessary to choose between a bottom-up model and a top down-model: a bottom-up model starts from the company inner resources, i.e., its salesforce, and an estimate is made about on their performance (how much they can sell), thus obtaining the sales figures; a top-down approach, it is estimated the fraction of the global market size the company will be able to capture (Bobbink 2018). A bottom-up market model was preferred, since top-down market models may lead to sales figure inflation (Barsh 2019).

The sales figure for the first year of sales, 2022, was chosen having in consideration the size of the pilots the company has already conducted and will conduct in the future. Then it was considered each member of the salesforce would, in a year, raise a number of clients similar to the size of the pilots, for each customer segment. Three values for the salesforce performance were tested, 20, 30 and 40 new customers. The forecasts are presented in Table 5, Table 6 and Table 7.

Table 5 – Sales and revenue forecast, in euros (sales performance=20)

		'20-'21	2022	2023	2024	2025	2026
Salesforce			1	2	3	4	5
Firefighters	Estimated new users		30	40	60	80	100
	Cumulative # users		30	70	130	210	310
	Revenue		96 228	224 532	416 988	673 596	994 356
ATC	Estimated new users		20	40	60	80	100
	Cumulative # users		20	60	120	200	300
	Revenue		5 346	16 038	32 076	53 460	80 190
Oil & Gas	Estimated new users		15	40	60	80	100
	Cumulative # users		10	30	70	150	310
	Revenue		4 010	14 702	30 740	52 124	78 854
All	Revenue		105 584	255 272	479 804	779 180	1 153 400

Table 6 – Sales and revenue forecast, in euros (sales performance=30)

		'20-'21	2022	2023	2024	2025	2026
Salesforce			1	2	3	4	5
Firefighters	Estimated new users		30	60	90	120	150
	Cumulative # users		30	90	180	300	450
	Revenue		50 738	152 215	304 430	507 384	761 076
ATC	Estimated new users		20	60	90	120	150
	Cumulative # users		20	80	170	290	440
	Revenue		2 819	11 275	23 960	40 873	62 014
Oil & Gas	Estimated new users		15	60	90	120	150
	Cumulative # users		10	75	165	285	435
	Revenue		2 114	10 571	23 255	40 168	61 309
All	Revenue		55 671	174 061	351 645	588 425	884 399

Table 7 – Sales and revenue forecast, in euros (sales performance=40)

		'20-'21	2022	2023	2024	2025	2026
Salesforce			1	2	3	4	5
Firefighters	Estimated new users		30	80	120	160	200
	Cumulative # users		30	110	230	390	590
	Revenue		34 992	128 304	268 272	454 896	688 176
ATC	Estimated new users		20	80	120	160	200
	Cumulative # users		20	20	100	220	380
	Revenue		1 944	9 720	21 384	36 936	56 376
Oil & Gas	Estimated new users		15	80	120	160	200
	Cumulative # users		15	95	215	375	575
	Revenue		1 458	9 234	20 898	36 450	55 890
All	Revenue		38 394	147 258	310 554	528 282	800 442

In order to compute the revenue figures, the different scenarios allow for different prices. In the scenario with the least sales (sales performance=20), the number of users is small, therefore the spin-off would have to sell the solution for at least 165€, according to estimates, considering production runs on the whereabouts of 500 units. In the scenario with the most sales (sales performance=40), the price would be at least 60€, considering production runs of 1500 units. In the intermediate scenario (sales performance=30), the price would have to be at least 87€ for production runs of 1000 units. A mark-up of 50% of considered to obtain the price figures. Another important assumption is the fact that it is assumed firefighters will use the device in every month of the year, while each user of the other segment will use the device one time.

Regarding the feasibility of these scenarios it is also important to mention that the number of cumulative users for each segment is well under the market size in Portugal. For instance, in the scenario with the most sales, the spin-off would be able to reach 450 firefighters, when there are around thirty thousand in the country. In the Oil & Gas scenario the number of the cumulative users is half of the total workers. The only exception is the ATC segment, in the scenario with the highest sales, it exceeds the number of ATCs in the country, this implies that the company, to meet this scenario, would have to expand to other countries, fortunately for that there is already a budget for international travels in the budget. Other important remark is the fact that the scenario with the least sales, the price to be charged is significantly higher, so it is assumed the intermediate model is the most balanced between price and user growth.

In future market approaches, if the figures that customers are willing to pay are lower than the estimated, then the spin-off may be forced to decide to sell at a loss until reach a given number of active users and meet profitability.

Another aspect that may be subject to change is the monetization model, once in the beginning WeSENSS may prefer to sell the whole solutions as a global price, instead using a subscription or service fees, because with complete sales, WeSENSS gets the money back quicker, which is relevant in a cash constrained venture. If the company wants to make special prices to a given segment, to better mirror the needs of that segment, it can use the cost component breakdown present in Table 12 of Appendix C.

After deducting the cost of some capital assets, cash requirements were estimated, according to the intermediate scenario (see Table 8). If these figures are accurate the company will be close to have positive cash flows in the final year of the projections. Suggested funding figures were indicated, an initial investment to pay for the development of the platform, a second investment before starting sales. A third investment may be necessary to pay for internationalisation or in the case sales are not so positive. The suggesting funding scheme is similar to the one Entrepreneur 2 company followed.

Table 8 – Cash requirements and funding figures suggestion, in euros

	2020	2021	2022	2023	2024	2025	2026
Total cash flow from the year	-58 829	-544 185	-552 089	-531 092	-528 580	-253 363	-19 093
Cumulative cash flow	-58 829	-603 014	-1 155 103	-1 686 195	-2 214 774	-2 468 137	-2 487 231
Suggested amount financed	650 000		2 000 000				
Post-financing cash in the bank	591 171	46 986	1 494 897	963 805	435 226	181 863	162 769

Partners

The manufacturer will be a key partner, it is a factor that can lead the venture to disaster. As Entrepreneur 1 stated, the relationship with a manufacturer is like a marriage for a hardware startup, he further added that in this relationship, hardware companies have more power, once manufacturing capacity is very restricted, hardware ventures are at their mercy.

Besides, for each segment, it would help if contacts could be made with the purpose of increasing each segment stakeholder awareness for the need of a safer, healthier workplace. For example, try to hold conversations with the firefighters and ATC unions and showcase the impact a platform like WeSENSS could have.

A topic addressed in the interviews, more specifically, with the consultant for the Oil & Gas market, was the possibility of partnering with insurance companies. These may also be interested in a solution like the one WeSENSS offers since it diminishes health expenses with workers and asset damage costs due to poor work performance.

WeSENSS may feel the need to partner with companies that complement WeSENSS' offering, for instance, the spin-off focuses on data acquisition and analysis, but it may feel the need for skills regarding what to do with the data, that is, on how to mitigate the customers' stress. This is a pressing problem in the ATC segment.

Concerning the firefighter's segment, during the interviews, that was the suggestion to try to offer WESENSS solution alongside car purchases, since its common firefighters raise money to buy vehicles and these usually bring all the necessary equipment for fire suppression.

Consulting companies can also be an interested party, once these companies must support their work on data, which can be provided using an IoT solution like WeSENSS's. The company already has a relationship with one type of this company.

Due to the fact the company has university routs, it benefits from the privilege access to IP, talent, and close potential business partners.

Key Activities

WeSENSS had previous roadmaps and operational plans, but due to a number of reasons, such as not being able to secure the necessary funds, it was unable to follow those, but that is normal, startups reality changes rapidly. That said, a new roadmap was designed relying heavily on what the WeSENSS's members though they were able to achieve (see Figure 18). The goal was to make a feasible, realistic plan. The plan time horizon begins in January of 2020 and considers seven years of existence.

During the first year of the plan, several initiatives will still occur, but under the helm of INESC TEC and research partners, these activities were excluded from the plan. The only activity venture members will focus on is fund raising.

During the second year, the venture will be developing the platform with the goal of making the solution market ready, at the same time pilots will also occur. These pilots are the source of invaluable insights for the correct development of the platform. The hardware development is expected to last two years and is divided in three aspects, hardware development, software related development and dashboard development if deemed necessary. To perform these tasks, staff will be hired, a hardware developer, a software developer, web designer and data analyst a psychologist (see Figure 17). Besides a CEO and CTO will also be admitted.

In the third year and following years, sales related task will begin, thus hiring sales representatives will be necessary. Their main function will be finding new customers, conduct demos and convert demos into sales. Prior to making the product available to the market, it will be necessary to certify the product (CE mark, if necessary, ATEX). The technical team will scale according to the size of the operation. After the initial development, they will be responsible for platform updates based on customers feedback and maintenance related tasks.

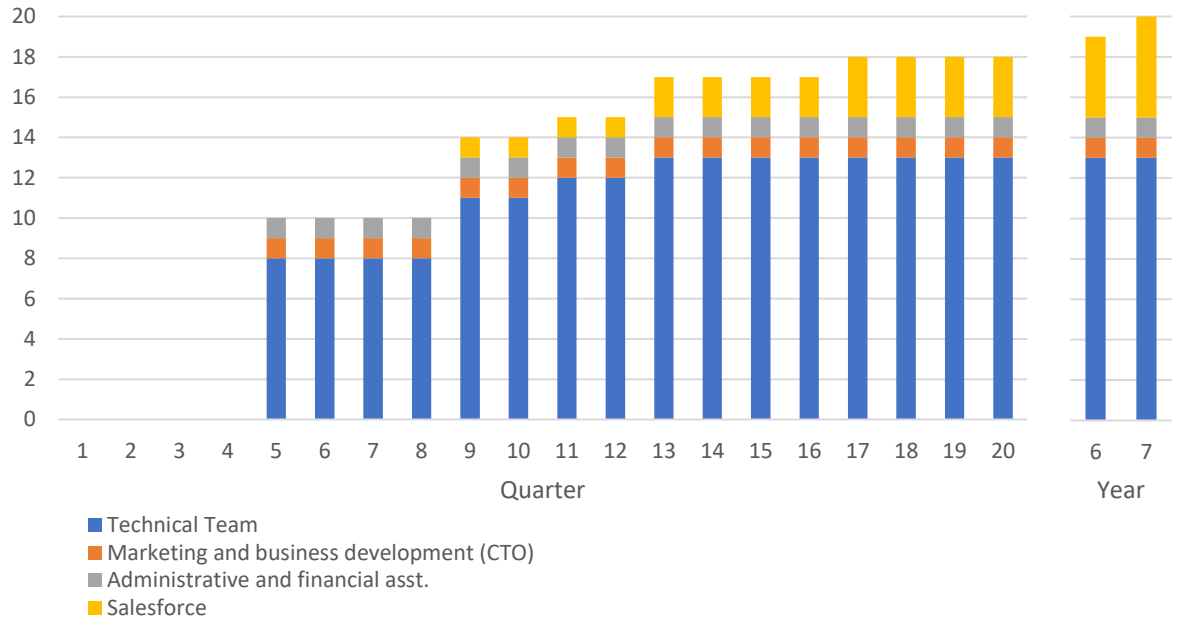

Figure 17 – Number of workers estimation

Costs

Staff wages is a huge stake on the expected cost WeSENSS will incur. The company will need 10 people in the beginning, by the end of the plan the number of expected employees almost doubles (see Figure 17). These employees will be in charge of the initial development and then with further developments clients demand. The staff wages include food allowance (4,27€ per working day), plus the cost of a work insure (1% over the worker gross salary) and tax (23,75% over the worker gross salary) (CGD 2013). Salaries vary from 32 thousand euros to over 50 thousand euros. If the company ends up dropping the ATC segment, the dashboard developer

will not be necessary, implying an annual saving of around 35 thousand euros (see Table 9). All values were determined in conjunction with WeSENSS's team members, which are quite experienced in budgeting, unless stated otherwise.

Other considered expenses include: rent of office space and related expenses (Internet service provider, for example), it was considered each worker needs 10 square meter, and each square meter costs 8€; domestic and international business travels cost; server cost, which grows proportionally with the number of users; and website service cost. Then, all sorts of fees were considered, such as the IP use fee the company must pay to INESC TEC (5%, after the third year of operation) and IP renewal expense, accounting, law, banking services fees. These costs can be consulted in detail in Table 13 of Appendix D.

After the platform launch engineers will also be needed for further software and hardware development.

Regarding manufacturing cost, it is possible to see, on Table 10 and on Figure 13, that the unitary cost of building the hardware decreases steeply with the number of units built. The unitary prices were determined by Valente (2019), in a previous project. It is predicted an initial 100 lot, to use in development, and 500 units production run to start sales. Finally, 800 units of VitalStickers, around half that value of AmbiUnits (ATC segment doesn't require such device) is predicted to resume sales. It is important to refer that the initial lots include specific cost related with initial manufacturing designs, device certification and testing, these cost 33 800€ (Valente 2019) and are included in Table 10 COGS for 2020.

Table 9 – Estimated salaries of WeSENSS's team

Role	# of workers	Salary (€)
Technical Team		
Device dev	2 to 3	38 411
Dashboard dev	1	34 669
ICT structure	2 to 3	40 906
Data Analysis	2 to 4	38 411
CPO of Psychology	1	40 906
WEB design	1	32 174
Administrative and financial asst.		
CEO	1	50 886
Marketing and business development (CTO)		
CTO	1	50 886
Salesforce	1 to 3	37 164

Table 10 – Production plans

Production								
		2020	2021	2022	2023	2024	2025	2026
Number of devices needed	VitalSticker			65	180	270	360	450
	AmbiUnit			45	120	180	240	300
Number of produced devices	VitalSticker	100	500			800		
	#Unit Price (€)	267	79			78		
	AmbiUnit	100	500			500		
	#Unit Price (€)	321	104			104		
Device number control	VitalSticker	100	600	535	355	885	525	75
	AmbiUnit	100	600	555	435	755	515	215
	COGS (€)	58 829	91 199	-	-	113 881	-	-

	'20Q1	'20Q2	'20Q3	'20Q4	'21Q1	'21Q2	'21Q3	'21Q4	'22Q1	'22Q2	'22Q3	'22Q4	'23Q1	'23Q2	'23Q3	'23Q4	'24Q1	'24Q2	'24Q3	'24Q4	2025	2026
Phase 1: Proof of concept																						
Fund raising																						
Phase 2: System development																						
Device dev																						
Dashboard dev*																						
ICT structure																						
Data Analysis																						
Product Certification CEM																						
Product Certification ATEX*																						
Product Update																						
Server Maintenance																						
Phase 3: Staff hiring																						
CEO																						
CTO																						
Technical Team																						
Device dev																						
Dashboard dev*																						
ICT structure																						
Data Analysis																						
CPO of Psychology																						
WEB design																						
Sales rep																						
Phase 4: Market strategy																						
Pilot tests																						
Website dev*																						
Fairs																						
New clients discovery/Demo																						
Feedback																						

* These are activities depend on how the market entry decided by the company, for instance, if the ATC is dropped, no dashboard development will be necessary. The ATEX certifications is exclusive to the Oil & Gas segment.

Figure 18 - Operating plan

<table>
<tr><th>Partners</th><th>Activities / Manufacturing</th><th>Value Proposition</th><th>Customer Relationships</th><th>Customer Segments</th></tr>
<tr><td rowspan="3">Consulting companies
Equipment companies
Manufacturing companies
University connection
Insurers
Unions</td><td>R&D
Pilots
Sales demos
Staff Hiring</td><td rowspan="3">Incident prevention
Automatic reporting
Better team management
Health record
Schedule evaluation
Real time gas exposure</td><td>Demonstrations
Feedback
Customer support
Follow-up on evaluations</td><td rowspan="3">FF Dept. (incl. private FF)
ATC organisations
Oil & Gas companies</td></tr>
<tr><td>Resources</td><td>Channels</td></tr>
<tr><td>Skilled team
Privileged access to IP</td><td>Sales pitch
Partners
Website</td></tr>
<tr><th colspan="3">Costs</th><th colspan="2">Revenue Sources</th></tr>
<tr><td colspan="3">Staff
Hardware
IP fees
Other expenses (law, accounting and bank fees, travel expenses…)</td><td colspan="2">Partner sales (Consulting companies)
Partner sales (Equipment companies)
Partner Sales (Insurers)
Renting</td></tr>
</table>

Figure 19 – Proposed business model canvas

6 Discussion and Conclusions

The current work aimed to create a BM for a recent spin-off, WeSENSS. The company was built to commercialize products leveraging technologies developed in a research laboratory, INESC TEC. The solution this company is offering is an IoT-based platform that allows to monitor physiological and environmental variables and, thus, evaluate a user health status. The company is able to assess the health condition of workers that work in challenging conditions, whether those who face harsh environments, such as firefighters, or those who are constantly challenged with mentally demanding tasks, such as ATCs. This work aims to contribute for the company to successfully entering the market.

The adopted methodology was the Lean Startup, introduced by Blank (2013). Briefly, this method proposes that entrepreneurs must state their hypotheses about how their business and products should be modelled and then interview relevant stakeholders to validate those hypotheses.

The work aimed at defining a new BM, but to achieve that it was necessary to define a baseline, the initial hypotheses, in compliance with Blank's (2013) methodology. This work was performed by holding informal talks with members of the company and by consulting several documents from previous projects that preceded WeSENSS creation.

After setting the initial hypotheses, a series of interviews were conducted with relevant stakeholders, which, in conjunction with information from other sources, such as scientific papers and websites, were the raw material for the new BM.

The data collected, revealed that the customers segments the company has been focusing, firefighters, ATC and Oil & Gas, were not equally interesting. This indicates that the customer segment prioritization made during this work was relevant and will help WeSENSS in the future. One aspect in which the interviewees diverged was on how they would use the devices. They clearly stated that constant monitorization is highly unlikely to be implemented. Both the Oil & Gas and the ATC segment were inflexible in that the product should be used in much more specific tasks. For ATC those tasks would be evaluating how close to optimal is shifts, every three to five years, as fatigue or stress cases were infrequent among its workers. For the Oil & Gas those tasks would be machine maintenance, more precisely, concerning machines that expose workers to toxic gases, i.e., activities that quite clearly put the workers life at danger. Planned maintenance happens every two or three years for each machine. Both segments were unsure the value constant monitorization could bring and warned that workers would not agree with such thing. In the firefighters segment the value of the platform is undeniable, according to the feedback from the interviews. Unfortunately, it is a market with very restricted resources, as fire stations even lack basic material. Therefore, introduction of a wearable device will certainly be quite hard, if not impossible, considering the price of the solution. To sum up, it was found that the most promising segment would be Oil & Gas, with firefighters and ATC segments presenting a lower potential.

WeSENSS's solution is unique, it combines physiological, environmental and GPS data in a single platform. Its design enables to acquire data with little noise, even if the user is in movement. Its algorithms use the heart's electrical waveform, while competitors rely on weaker signals. Moreover, it offers an API that facilitates integration with other platforms. But the spin-off must be alert, since new players are entering the market, namely, Prometeo, a Spanish startup with a similar platform. Furthermore, the spin-off faces tougher competition on segments in which only part of the solution is needed, for instance, in which physiological data is more relevant, such as the ATC. There are many players with specific solutions for that segment.

It was found that a key barrier the spin-off must overcome is educating people about the platform, more particularly, convincing them that the monitorization implied in its use aims at

improving their health and safety and not to control them. This fear is not so strong in cases were the user life is at risk, such as the firefighters.

IoT-based solutions achieve their full value creation potential when they bring value to many actors in a business environment (Westerlund, Leminen and Rajahonk 2014). In the case of the Oil & Gas, WeSENSS already counts with the help of a consulting company to help sell and promote their products. The spin-off has had difficulties to sell in the firefighters segment, therefore it was suggested to partner with an emergency vehicle manufacturer, since vehicles usually bring all the necessary equipment.

Another goal was defining revenue models for each one of the target segments. It was found that companies prefer requesting WeSENSS solution when needed, so a renting option was considered the most adequate. Unfortunately, interviewees were at a loss to set a benchmark product, once there is not really a platform such as WeSENSS, and they were unwilling to state a figure. Nevertheless, based on the estimated costs, price estimates were made. The prices WeSENSS could offer to its clients are highly dependent on the number of users, therefore, different price points were estimated according to the user base (volume of sales). Moreover, three different sales scenarios were made, with three different sales performance figures and the adequate price for each scenario. Based on the intermediate sales estimate, the cash requirements were estimated, the company achieves was close to have a positive cash flow in the final year of the projections.

An updated operational plan was also proposed. It highlights the most relevant activities of the spin-off, such as, the initial development of the platform, the development of new features and devices, among others. Furthermore, there are sales-related activities, for instance, finding new customers, close deals and bringing feedback from customers. Currently, WeSENSS is at the right position, as we learned from Entrepreneur 2, on the development phase, a company should find partners to help develop the product, regardless if the partner is part of the target market of the company or not. Being able to use the product in real life settings and receiving feedback from real companies, is extremely valuable. In the future, it is intended that the company uses the developed plan to guide its operations.

For each component, there was an attempt to anticipate how the BM will change in the future, respecting the dynamic view of a business model found on more recent literature. Several growth opportunities were foreseen during this work. Regarding the current segments several alternatives were given, for instance, it was suggested to try and contact private Fire Corporations, in order to penetrate that segment. For a more distant future, new customer segments and value propositions were suggested, that aim to give the company options to scale its business. It was studied an option that can benefit a bigger number of people, a health monitor for consumers at high health risk; another option that was explored was a capability that the spin-off is not currently exploring, bio identification; and a third option, within a market that has substantial available funds to invest, the sports market. If the company also feels the need to start approaching the consumer, instead of businesses, the impact of such change was also foreseen.

It was also analysed potential countries to which the spin-off could expand its operation after consolidating its business in its home country, with special attention to the firefighters case, since there are countries much highly affect by fires than others, such as Spain and Italy, in Europe, and the U. S., Canada and Australia, in other continents.

The link between the solution price and the number of users was studied. The result is a tool WeSENSS can resort, periodically, to determine the price it should sell its solution to its customers. Furthermore, it was found that offering the solution in a renting method is more adequate, according from to feedback from the interviews, but alternative revenue models were also presented, more specifically, a one-time hardware purchase with digital services subscription.

From a more theoretical point of view, this project tried to summarize the current accepted BM definition and contribute to convergence, rather than confusion. Besides, as previously mentioned, great relevance was given to the dynamic aspect of a business model, an aspect that has gaining emphasis in the most recent literature related with the BM concept.

To conclude, it would be interesting to have performed a higher number of interviews and with people that work in the marketing office, that would have been beneficial to better test the prices estimated and would also help to better support some assumptions took in the sales forecast. Another element that would have helped in the price estimates and sales forecasts would be if the BM was effectively being applied, in fact, some authors, Vossler (2015) for instance, argue one can truly test a BM in those conditions.

In the future, it is expected that the company tests the new hypotheses raised during this work. Hopefully, the market responds positively to the paths suggested. If not, the company can rely on alternative solutions, that were also addressed.

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Appendix A: Common Business Models Types

Table 11 - List of business models archetypes (M. Johnson 2010)

Name	Description	Example
Affinity club	Pay royalties to some large organization for the right to sell your product exclusively to their customers.	MBNA
Brokerage	Bring together buyers and sellers, charging a fee per transaction to one or another party.	Century 21, Orbitz
Bundling	Package related goods and services together.	Fast Food value meals, iPod/iTunes
Cell phone	Charge different rates for discrete levels of a service.	Sprint, Better Place
Crowdsourcing	Get a large group of people to contribute content for free in exchange for access to other people's content.	Wikipedia, Youtube
Disintermediation	Sell direct, sidestepping traditional middlemen.	Dell, WebMD
Fractionalization	Sell partial use of something	NetJets, Time-shares
Freemium	Offer basic services for free, charge for premium service.	LinkedIn
Leasing	Rent, rather than sell, high-margin, high-priced products.	Cars, MachineryLink
Low-touch	Lower prices by decreasing service.	Walmart, Ikea [Ryanair?]
Negative Operating Cycle	Lower prices by receiving payment before delivering the offering.	Amazon [retailers]
Pay as you go	Charge for actual, metered usage.	Electric companies
Razor/blades [hook and ...]	Offer the high-margin razor blades below cost to increase volume sales of the low-margin razor blades.	Printers and Ink [Gillette, Nespresso]
Reverse razor/blades	Offer the low-margin item below cost to encourage sales of the high-margin companion product.	Kindle, iPod/iTunes
Reverse auction	Set a ceiling price auction have participants bid as the price drops.	Elance.com

Product to service	Rather than sell a product, sell the service the product performs.	Zipcar [Hilti]
Standardization	Standardize a previously personalized service to lower costs.	MinuteClinic
Subscription	Charge a subscription fee to gain access to a service.	Netflix
User communities	Grant members access to a network, charging both membership fees and advertising.	Angie's List

Appendix B: Perspectives on the business model term

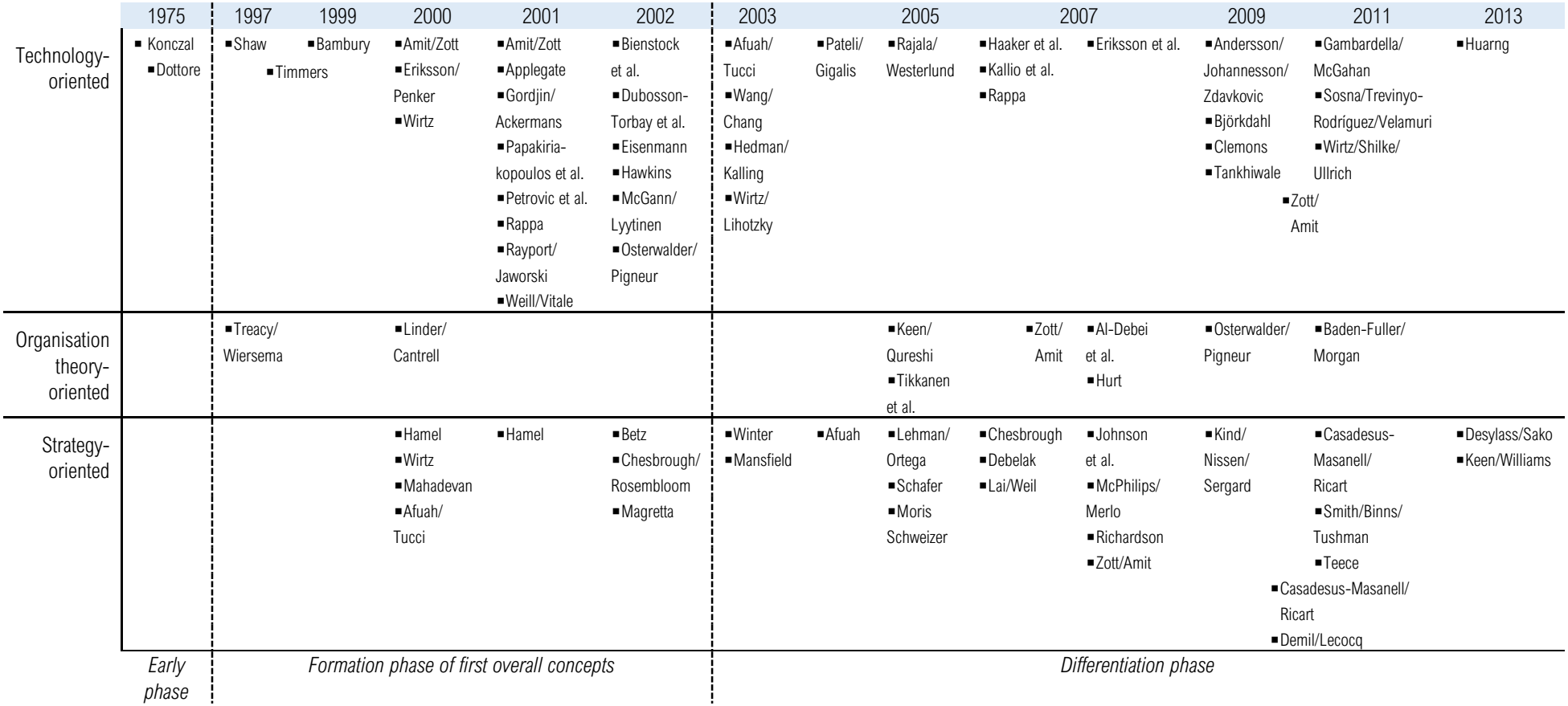

Figure 20 - Research field in which the BM term has been framed (Wirtz, et al. 2016).

Appendix C: Cost components breakdown

Table 12 – Cost components breakdown, in euros

Production	One-time HW purchase plus subscription				Renting				
(In units)	VitalSticker	AmbiUnit	**Devices**	**Digital services**	VitalSticker	AmbiUnit	Devices	Digital Services	**Total**
500	1 065,53	1 087,94	**2 153**	**105**	29,60	30,22	59,82	105,00	**165**
1000	593,03	615,44	**1 208**	**53**	16,47	17,10	33,57	52,50	**86**
1500	435,53	457,94	**893**	**35**	12,10	12,72	24,82	35,00	**60**
2000	356,78	379,19	**736**	**26**	9,91	10,53	20,44	26,25	**47**
2500	309,53	331,94	**641**	**21**	8,60	9,22	17,82	21,00	**39**
3000	278,03	300,44	**578**	**18**	7,72	8,35	16,07	17,50	**34**
3500	255,53	277,94	**533**	**15**	7,10	7,72	14,82	15,00	**30**
4000	238,66	261,06	**500**	**13**	6,63	7,25	13,88	13,13	**27**
4500	225,53	247,94	**473**	**12**	6,26	6,89	13,15	11,67	**25**
5000	215,03	237,44	**452**	**11**	5,97	6,60	12,57	10,50	**23**
5500	206,44	228,84	**435**	**10**	5,73	6,36	12,09	9,55	**22**
6000	199,28	221,69	**421**	**9**	5,54	6,16	11,69	8,75	**20**
6500	193,22	215,63	**409**	**8**	5,37	5,99	11,36	8,08	**19**
7000	188,03	210,44	**398**	**8**	5,22	5,85	11,07	7,50	**19**
7500	183,53	205,94	**389**	**7**	5,10	5,72	10,82	7,00	**18**
8000	179,59	202,00	**382**	**7**	4,99	5,61	10,60	6,56	**17**
8500	176,12	198,52	**375**	**6**	4,89	5,51	10,41	6,18	**17**
9000	173,03	195,44	**368**	**6**	4,81	5,43	10,24	5,83	**16**
9500	170,27	192,67	**363**	**6**	4,73	5,35	10,08	5,53	**16**
10000	167,78	190,19	**358**	**5**	4,66	5,28	9,94	5,25	**15**

Appendix D: Price estimation

Table 13 – Costs categorization, in euros

Costs	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	HW ratio	SW ratio
Device dev	-	76 823	115 234	115 234	115 234	115 234	115 234	100%	0%
Dashboard dev	-	34 669	34 669	34 669	34 669	34 669	34 669	0%	100%
ICT structure	-	81 813	102 266	122 719	122 719	122 719	122 719	0%	100%
Data Analysis	-	76 823	115 234	153 645	153 645	153 645	153 645	0%	100%
CPO of Psychology	-	40 906	40 906	40 906	40 906	40 906	40 906	0%	100%
WEB design	-	-	32 174	32 174	32 174	32 174	32 174	0%	100%
Administrative ass. Fully loaded employee cost	-	50 886	50 886	50 886	50 886	50 886	50 886	50%	50%
Marketing and Bus. Dev. Fully loaded employee cost	-	50 886	50 886	50 886	50 886	50 886	50 886	50%	50%
Sales reps. Fully loaded employee cost	-	-	37 164	74 328	111 492	148 655	185 819	50%	50%
Facilities cost	-	850	1 210	1 410	1 490	1 570	1 650	10%	90%
Website maintenance	-	30	30	30	30	30	30	50%	50%
Accounting services fees	-	3 000	3 000	3 000	3 000	3 000	3 000	50%	50%
IP use Royalty*	-	-	-	-	-	29 421	44 220	0%	0%
IP renewal fee	-	-	3 000	-	-	3 000	-	50%	50%
Payment service fees	-	300	300	938	1 895	3 171	4 766	50%	50%
Law service fees	-	-	100	100	100	100	100	50%	50%
Server costs	-	1 000	1 000	3 127	6 316	10 570	15 886	0%	100%
Travel expense	-	5 900	8 100	12 500	16 700	28 450	40 200	50%	50%
Manufacturing Costs*	58 829	91 199	-	-	113 881	-	-	0%	0%
Total cost of computers, phones, desks	-	20 000	10 000	4 000	22 000	12 000	6 000	10%	90%
Manufacturing equipment	-	6 000	-	3 000	-	-	-	100%	0%
Prototyping	-	1 500	1 500	1 500	600	600	600	100%	0%
Proof-of-concept equipment	-	1 600	100	100	1 600	100	100	100%	0%
								Average	Total
HW related costs	-	143 509	223 390	245 411	265 980	290 082	313 245	263 070	1 315 349
Digital services related costs	-	309 477	474 967	550 339	590 961	612 881	636 624	572 623	2 863 114

* These items can be directed affected to a sale, so they were summed afterwards.

Appendix E: Interview Guides (Examples)

Guide #1

Focus: obtaining information to better define the revenue streams of each segment.

Segment: Firefighters

Intro: I am a student at Industrial and Management student at University of Porto and, as part of my master's dissertation, I am evaluating the feasibility of an innovative solution, the WeSENSS platform. Briefly, this solution consists of a set of devices, one that is used in the abdomen, another that is used close to the body, and that can measure several variables (electrical activity of the heart, temperature, harmful gases, location...) and transmit them to a control post. It is a solution that can save lives and help firefighters. For example, the devices can alert if a firefighter is exposed to a toxic environment for a long time, if he is in a situation of dehydration or extreme fatigue. Furthermore, it can help the coordinators to position the operatives in the theatre and the data collected serves as a health history of the operative. The focus of the following issues will be to determine how best to bring this solution to market (price, method of payment...).

Questions:

- Do you think that the solution WeSENSS is offering has the potential to improve firefighting, both from the firefighter's point of view, in the sense that it promotes his health and safety, but also from the organisation's point of view, since it can improve effectiveness in fighting flames? Do they already use or have knowledge of similar equipment? Do good practices at work eliminate these incidents?
- Considering your expertise about firefighting in Portugal, are there specific teams that would benefit more from this solution than others?
- Have you seen any measures implemented to protect firefighters from the fatalities of the last decades? Where did these initiatives come from: government, league, union...?
- What are the technological elements of your personal protection equipment? It is important to mention the price associated with these elements.
- When an element of your equipment breaks down, what is the process of obtaining a replacement? Does it involve a lot of bureaucracy, many decision makers, are suppliers already pre-established? What are the distribution channels?
- What is the usual payment model used to purchase the equipment, paid at once, in installments...?
- In the specific case of the introduction of new equipment, never used, what is this process. For example, how do you find out about new equipment, what are the legal procedures? Certifications? Which suppliers? Payment? Is it a simple or complex process?
- Present the interviewee with some price options.
- Finally, I can only ask if you have any general comments to make, if you have any suggestions?
- Do you know if there is anyone who could provide more information on the topic?

End the Interview: Thank you for answering to these questions, I will take your answers into consideration, your comments will certainly improve the WeSENSS solution.

Guide #2

Intro: Brief context of the project (wearable; IoT; first responders & stress management; various pilots; prototype phase)

Opening question: Do you think it is an interesting solution? Especially in the case of using stress monitoring, the value proposition is difficult to materialize (it will save so much x, it will gain more y), given the reality of Portuguese companies, would they be willing to invest in such a product?

Topics to be addressed:

- Producing hardware effectively;

- Reaching the customer;

- Adapting the organizational structure with growth (staff, funds, internationalization...);

- Overcoming obstacles.

Blocks to be explored:

- Key activities;

- Key Features;

- Costs;

- Customer Relationship;

- Partnerships.

Final Question: Finally, I would like to ask if you have any general comments to make, any suggestions, if you think we are making a mistake at some point, any critical aspect that has not been addressed?

End interview

Appendix F: Summary of the Interviews

Interview #1

Interview details

- Interviewee: António Veríssimo
- Position: Mais Que Cuidar representative
- Interview method: written
- Day of the interview: 7th of May 2020
- Focus of the interview: Understanding if there was a need for a real time monitorization device for people suffering from chronic disease.

Main Ideas

The interviewee stressed that WeSENSS solution added value to the market and posed a strong value proposition for those suffering of life-threatening diseases. For the others, healthy people, the value proposition is weaker. In these cases, the users may feel that their privacy and freedom is being attacked.

Regarding a marketing strategy, the interviewee stated that recommendations from doctors are a huge persuader to convince a patient into purchasing the product. Besides, it is also important to announce the product through other channels, like social media.

Regarding distribution channels, selling those in pharmacies and health stores is a good option, in the interviewee's opinion. WeSENSS must expect a 35% to 50% fee over the selling price for the distributor.

The interview further added that in order to be eligible to be sold in Portugal, the product must be awarded a CE mark and an INFARMED certification in its respective class.

To finish, the interviewee reminded that there must be a service dedicated to receiving distress calls. The team behind this service must have the adequate qualifications to give assistance to users in danger.

Interview #2

Interview details

- Interviewee: Firefighter 1
- Position: Private Fire Station
- Interview method: phone call
- Day of the interview: 11th of May 2020
- Focus of the interview: Understanding how private firefighter institutions value WeSENSS' products.

Main Ideas

The interviewee showed real interest in the presented solution, particularly in the gas monitorisation and environmental temperature tracking. He reinforced the platform relevance, once it is a matter of safety.

He stressed that connectivity is a problem, using lower bandwidth networks, like GSM, is feasible, but more capable networks, like 3G or 4G, is hard in the kind of environments they operate.

Currently, Firefighter 1 fire station already uses a dashboard, used mainly on larger operations, based on the WebSig platform, so, there is a strong opportunity for integration.

Concerning a method to sell the platform, the interviewee gave an ongoing deal to use has benchmark, they use a tracker that cost 10 euros per month on a 24-month contract. Besides, he added the current price for their PPE (personal protection equipment) is around 500 euros. He stated that the product must be functional, but it is key to be affordable for the institutions, otherwise it is going to be impossible to sell. The fire season is usually between June and September, this is the period resources are more requested and when WeSENSS product is the most necessary.

Interview #3

Interview details

- Interviewee: Entrepreneur 1
- Position: Former CEO of wearable-based company
- Interview method: videoconference
- Day of the interview: 19th of May 2020
- Focus of the interview: Learning from a former CEO of a hardware company the challenges such business presents.

Main Ideas

The interviewee acknowledges that the Business Model is a key aspect for the success of a startup. It cannot be based on reason alone. Real life, the contact with the market, guides the formation of a business model and it must change every time conditions that surround the company change. For instance, a BM depends strongly on the amount of funds raised during several key stages of a venture. From its experience highly complex BM will not work, once people bet on simpler BMs, BMs they can understand.

Unfortunately, the interviewee does not expect companies to spend money on stress management solutions for their employees. Moreover, the health sector has few players, which do not welcome new companies. Regarding the firefighter's use case, he believes the market is controlled by a small group of players that hamper the entry into the market.

In his opinion, WeSENSS should look for other countries to deploy its tech, once, in some countries, innovation is fostered, Portugal is not one of those countries. Due to this lack of innovation culture, new initiatives are usually stopped by opposition from competitors and stakeholders. The interviewee emphasizes knowing the competition better than one's own company is key to be successful. Besides, other countries have a larger market size which is essential for hardware companies, once larger scales allow for lower production costs (per unit). WeSENSS should focus on solutions for huge markets, which would compensate both the costs of building complex hardware and the cost of distributing the country. Maybe looking for consumer applications would help, the interviewee had to do it a few times in his career.

Another message the interviewee was quite vocal about was Product Design, that is, going from a prototype to a product. Manufacturing is hard and reaching a point where a product can be mass produced and meets all the customers' needs and expectations is hard. The clients' perception of the product is king, not the entrepreneurs' perception. WeSENSS must be quite thorough about analysing the ergonomics and usability of its products, once it may be a deal breaker factor.

To finish, the interviewee stated that, on university spin-offs, founders may be trapped to use cases they found, during scientific research, were good proof of the products relevance. The process of detaching from pilots and proven use cases, to use cases that are interesting to the market is a skill that members from the academia may not be versed on.

Interview #4

Interview details

- Interviewee: Entrepreneur 2
- Position: CEO of energy solution for the trucking industry
- Interview method: videoconference
- Day of the interview: 28th of May 2020
- Focus of the interview: Learning from a former CEO of a hardware company the challenges such business presents.

Main Ideas

The interviewee warned to clearly differentiate the customer from the client. He gave the example of the firefighters, according to him, most of them are volunteer and may be quite open to use a solution like WeSENSS, but due to their volunteer condition, they expect the state to pay for these solutions. So, it is important to define why the solution matters for the government. The market pays for benefits, not products or technologies. For instance, in the WeSENSS case, the value is not on acquiring data, is in the knowledge the company can extract from the data.

Building on that idea, it is important to understand which are the existing value chains, that is, who is the user, who pays for the service, who distributes the goods… Then, a venture must decide on who to approach, for instance, sell directly to the user or license the technology to a current solution provider. The interviewee suggests that enticing the final user may be easier in the first place, big players probably will not care about an unproven product.

The interviewee also gave a few remarks on how he found the most promising use cases and segments in his current company, stating that it is a really long process, one must rely on intel from the field. Is an hands-on process and, in the end, one may conclude that a segment or a use case isn't worth investing in it. It is a process that only finishes when clients are willing to pay for the solution.

During the development phase it is interesting for a company to make contacts and work alongside players who are not the target market, the ability to a have a development partner is invaluable for a startup.

Concerning which market to address, in geographical terms, the interviwee said that his startup developed in Portugal and waited till having a mature product start commercialisation on the markets they found more interesting, the north of Europe. They knew that Portugal was not the right country because few players from the car industry exist in the country, there was no critical mass in the country.

Then the interviewee spoke about how his company scaled through time. They started in 2014, with 5 employees, developing the product in Portugal, making use of an initial investment. This development phase ended in 2016, by that time they already had 9 employees. After the initial development, the tech was quite mature, the next step for the company was establishing business relations in Germany and certifying the product. This phase took 2 years, ended in 2018 and required a new investment in 2017, the company also gained a new employee (they became 10). In 2019 the commercialisation phase began, and the first sale came. This phase required a new investment, which was used, in part, to contract two new employees. Sales grew naturally, a year after the company had already 100 units on the road and the team grew to 15 workers.

Interview #5

Interview details

- Interviewee: Controller 1
- Position: NAV manager
- Interview method: videoconference
- Day of the interview: 1st of June 2020
- Focus of the interview: Evaluating air traffic controllers' receptiveness to WeSENSS' solution.

Main Ideas

The interviewee stated that, as far as he knows, that have not been problems with fatigue at NAV. But he sensed that, due to the rise of air traffic in the Portuguese air space, the limit of the installed capacity at NAV was being reached right before the pandemic, and that could be a source of fatigue and stress related problems.

To mitigate fatigue, special working conditions were adopted, for instance, more frequent days off, intra shift resting hours and time is divided between executive worker and a more relaxed support function. Since the beginning of the year, a fatigue initiative was put in place, which seeks to help workers with their stress. Workshops on nutrition, relaxation exercises, among other activities were also held to help employees.

Despite all workplace health promoting measures periodic evaluations to assess the stress status of the workers were inexistent. The only tests ATC are subject to are the initial ones (FIST, behavioural, English, medical and final interviews).

The interviewee believes that WeSENSS' solution should be used in moments when managers feel the shift sequence and length is not beneficial for the workers, something that would happen every 3 to 5 years. He believes that using the solution on a day-to-day basis is not viable, because people would not accept it, it would be motive of stress and distraction. Moreover, using this tech in the admission tests is also unlikely, in the interviewee's opinion.

When NAV resorts to external entities, it generally firms outsourcing deals. That would be the preferred way to do business with WeSENSS. But António stress that establishing a business relationship with is not easy, there are a lot of approvals, form NAV, associations, workers… Confidentiality matters must be well defined, for instance data must stay within NAV. A key factor to have in consideration is explaining the purpose of the solution to the workers, they must be convinced it is something to improve their working and health conditions, and it will have no downside.

Interview #6

Interview details

- Interviewee: Consultant 1
- Position: EQS Digital manager, responsible for services digitalisation and digital-related business opportunities
- Interview method: videoconference
- Day of the interview: 5th of June 2020
- Focus of the interview: Learning from a business partner from an Oil & Gas Company how WeSENSS solution may be presented to this market.

Main Ideas

The interviewee acknowledged that there is a need by Oil & Gas companies for a solution like WeSENSS. More precisely, there are quite risky tasks that should not be perform by people

with a high stress level, WeSENSS could estimate a stress index in real time. The interviewee has identified a raising concern regarding preventive safety measures, instead of the usual reactive measures. Besides, there are occurrences of people dying due to harmful gases exposure, once again WeSENSS solution can track that in real time.

Oil & Gas companies already use equipment to measure harmful gases concentration, sniffers, but the measures are not in real time and do not track the cumulative exposure to those gases by workers. Drones and robots have also been used to replace humans in those risky tasks, but some of them are still performed by humans.

Regarding how this product can be used by refineries, the interviewee thinks a gradual process will take place, that is, first the solution will only be used to monitor workers in harsh environment. These make part of a planned maintenance plans (machines are inspected every 2 or 3 years usually). Once employees become familiar with the solution, constant monitorisations may be an option. This gradual approach is better to ease the fear of control workers may sense from using IoT devices.

The interviewee stresses that the main obstacle of implementing WeSENSS' solution is convincing people. It is easier during time delimited task, in which the operator life is at risk, but for continuous control, Hugo thinks people will have a hard time accepting it. Then, he also anticipates that getting a sale from a refinery will be difficult, once it is a bureaucratic process, that has to travel through the desks of people from several hierarchy levels and each one of those people needs to be convinced.

To finish, concerning monetary aspects, the interviewee stated that companies will only purchase if they believe the return on their investment is bigger than the necessary investment. This poses a problem because companies will not disclose how much money incidents cost them (not all accidents are linked with stress or harmful gases) and insurance companies will never reveal how much money save. Moreover, the interviewee is unable to state a product to use as a benchmark, to compare prices, for example. Besides, he is inclined to say companies will prefer to use WeSENSS as a service and use it for the riskier tasks, to start.

Interview #7

Interview details

- Interviewee: Psychologist 1
- Position: Clinical psychologist, CISM manager
- Interview method: videoconference
- Day of the interview: 5th of June 2020
- Focus of the interview: Understand how a stress monitor solution can be applied in an air traffic control tower

Main Ideas

The interviewee has a very different view on how WeSENSS' solution may be used to help ATC. In her opinion, continuous use is unlikely, because people would not like to do it, due to ergonomics and fear of being controlled/evaluated. Using the devices on the recruitment phase is also unlikely because it is a very controlled process. She thinks it should be used has a support tool, workers would use to make a quick measurement of stress and fatigue, always at their discretion, and then take a few relaxation exercises. She clearly states that just measuring the variables has little added value, WeSENSS must figure a way to lower its customer's stress. Moreover, WeSENSS must ensure deep depth of data, otherwise people may use other devices. She stated a competitor, Heart Math, that enables its users to perform relaxation exercises according to their psychological status.

Apart from that, she recognized that air traffic controlling is a stressful profession, stress that comes from a wide range of reasons, like high traffic situations, working in shifts (which highly impacts sleep quality), overtime work, stress from extra work aspects. To mitigate the stress that comes from the job, she stated that there were applied bonified work conditions (rest hours, days off…), besides, a fatigue mitigation program and a CISM office were created.

The interviewee states that the acquisition of new equipment is subject to a public tender.

Interview #8

Interview details

- Interviewee: Firefighter 2
- Position: Firefighter of a public Fire Station
- Interview method: videoconference
- Day of the interview: 9th of June 2020
- Focus of the interview: Understand how a stress monitor solution can be used and purchased by fire departments

Main Ideas

The interviewee clearly states that WeSENSS solution will be seen has a huge value-added solution by most of the firefighters. Besides, it is also a huge help for the organisation, once on the theatre of operations several entities work at the same time, but articulation is very hard to attain. Especially because both at individual level and organisational level, norms are frequently disrespected, promoting risk situations. The interviewee stresses, however, WeSENSS must overcome a cultural characteristic, as some more advanced technical solutions are already available to firefighters, but people do not take advantage of them.

The interviewee gave a special emphasis to one factor, firefighters lack of financial resources. Firefighters departments are independent associations from one another and general terms, budgets are slim even to replace basic equipment. In many associations, some components of the PPE are not available for all firefighters, equipment is shared between members. From Pedro's experience, equipment was often purchased in second or third hand from associations that were renovating their equipment stock. Due to fact that fire departments are independent from one another, each one will have a preferred way to purchase items. For instance, in Pedro's corporation, equipment was purchased in one-time payments, no renting contracts were made.

The interviewee hinted that WeSENSS's solution could come together with vehicles, because it is common, in this market, for equipment to come with vehicles and adjusted to the vehicle occupancy.

One relevant aspect to have in consideration is the fact that is important to offer a replacement plan in case of damage, once associations struggle to replace damage equipment due to their lack of financial resources.

Concerning bad network access, the interviewee stated that in some areas of the country the network coverage is bad, so WeSENSS must figure a solution for that.

To finish, the interviewee thinks it would be unlikely firefighters would purchase this system individually, one of the main reasons, in his opinion, is that equipment main be incompatible from other manufacturers.