



Department of Information Science and Technology

Business Plan: CardioSafety

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Abstract

Fatigue is the silent cause behind millions of euros of lost productivity, and countless incidents and accidents in companies from all business sectors.

Furthermore, companies in the critical facilities sectors face ever growing security threats, ranging from an increasing number of cyber-attacks to frequent terror threats and attacks in many European capitals.

The goal of this thesis was to create a business plan for a product developed by Cardio-ID Technologies that uses a bio-signal acquiring and processing technology. By acquiring bio-signals from the heart and processing them, CardioSafety can assess user fatigue and stress, recommending possible actions for fatigue mitigation, like a work break or a short nap.

Also, by analyzing cardio signals CardioSafety is able to successfully perform user authentications, thus it can be used as an access control system, guaranteeing only authorized personnel has access to the facility and respective systems.

From a business perspective, this project is very interesting as it works with a state of the art technology that does not currently exist in the market, bringing with it the challenges and opportunities associated with this fact.

In the end of the project it can be concluded that the product is viable, presenting good indicators for potential investors, and generating profit by the fourth year after the start of development.

Key words: Technology Based Entrepreneurship, Resource Based Theory, Critical Infrastructures, Cardiac Signals, Fatigue Management, Access Control.

Sumário

A fadiga é uma causa silenciosa por trás de milhões de euros em perdas de produtividade, bem como inúmeros incidentes e acidentes em empresas de diferentes áreas de negócio.

Empresas que operam em sectores críticos enfrentam cada vez mais ameaças de segurança, variando de ciber-ataques até ameaças e ataques terroristas em várias capitais europeias.

O objectivo desta tese foi a criação de um plano de negócio para um produto desenvolvido pela Cardio-ID Technologies que utiliza uma tecnologia de aquisição e processamento de bio-sinais cardíacos. Através da aquisição de bio-sinais do coração e do seu processamento, o CardioSafety permite avaliar o nível de fadiga do utilizador e sugerir possíveis acções que permitam mitigar a fadiga, como por exemplo, um período de repouso ou dormir uma sesta.

Adicionalmente, o produto consegue identificar o indivíduo com base nos seus sinais cardíacos, garantindo assim um restrito controlo de acessos a infraestruturas críticas.

Da perspectiva de negócio este projecto é muito interessante pois implementa uma tecnologia de ponta, inexistente no mercado trazendo com isso oportunidades mas também dificuldades.

No final do projecto, comprova-se que o projeto é viável, apresentando bons indicadores financeiros a possíveis investidores, começando a gerar lucros em 4 anos.

Palavras Chave: Empreendedorismo de Base Tecnológica, Teoria Baseada nos Recursos, Infraestruturas Críticas, Sinais Cardíacos, Gestão de Fadiga, Controlo de Acessos

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1 Introduction

This projects' goal is to create a business plan for a new product being developed by Cardio-ID Technologies, a technology based startup incubated in Audax/ISCTE.

Cardio-ID technologies, a spin-off of Instituto de Telecomunicações and Instituto Superior Técnico (University of Lisbon), was born out of research on pattern recognition and machine learning methods applied to the study of biological signals (bio-signals), especially the electrocardiogram(ECG). CardioID has created a technology that allows the ECG to be continuously acquired at the subject's hands using dry electrodes, conductive textiles or other materials, enabling the development of innovative products, with particular focus on ECG/PPG-based biometrics. This requires the development of custom hardware and electronics that enhance the signal quality, under the constraints of a tight budget, but also robust signal processing algorithms.

Core members of CardioID were involved with the design of BITalino, a low-cost toolkit to easily create projects and applications with physiological sensors. The company has established a series of industrial connections with key players in various markets in order to integrate this innovative biometric technology on their products.

The product will be a fatigue risk management system (FRMS) for individuals working in high-risk, or safety sensitive occupations. To elaborate, the system will continuously acquire employees' bio-signals and process them in order to determine the employees' real-time condition status.

If an occupation is considered to be high-risk or safety sensitive that means it i)presents a clearly significant life threatening danger to the employee that performs it, his fellow employees, or the general public and is performed in a manner or place innate or inseparable from such danger, and requires the exercise of discriminating judgment or high degree of care and caution, ii) is separate from the ability to discern impaired or enhanced performance by direct supervision iii) is not reasonably subject to other valid and available means of observation and evaluation.

One of the factors leading to errors and accidents in these types of occupations is fatigue.

Fatigue is the general term used to describe physical and/or mental weariness, which extends beyond normal tiredness. Some of the effects of fatigue may include sleepiness and a general decrease of attention and ability to perform complex, or even quite simple tasks with customary efficiency.

However, current suggested methods for fatigue evaluation are based on employee feedback, by answering questionnaires at different times of the shift, on the supervisors' assessment of the situation or regular performance tests. All of the mentioned methods have drawbacks, either by being subjective, the employees' or managers' inability to correctly assess fatigue and stress levels or by taking up work time in order to perform tests. Either way, all of the methods are *a posteriori* testing, and result gathering.

The proposed product, CardioSafety, is aimed to solve this. By analyzing real time Heart Rate Variability data, and other data gathered from the employee, either by a smart band or an off-body sensor and then processing the data through a mathematical algorithm the product will inform management and the worker himself of his fatigue, stress and other factors that deviate from the typical personal profile.

1.1 Fatigue

According to a 2008 National Sleep Study [1], 28% of the 1000 respondents reported that sleepiness interferes with their daytime activities at least a few times each month. Furthermore, NASA Aviation Safety Reporting System reports that from the 261 000 incident reports, 52 000 were fatigue related (21%). These are not small numbers, thus the Federal Aviation Administration (FAA) identified fatigue research as a critical aviation safety issue [2].

Nonetheless, sleep loss impact is not limited to a few professions. Any sectors that require 24/7 uptime, or at least 24/7 monitoring, including energy and utilities, like electrical or oil production/transmission, healthcare systems, and water systems that include wastewater management, and dams. The transportation sector is also affected by fatigue as it includes night operations, not only in public transportation, but also ports and railway systems.

Some more detailed examples, also include police officers in the US, of which 40% (344 400 individuals) work more than 12 hours a day and of which the same proportion suffers from sleep disorders such as insomnia or excessive sleepiness [3].

Also, studies have found that fatigue that arises from prolonged working hours can result in lapses in judgment and impaired motor skills among medical workers. Additionally, the New England Journal of Medicine concluded that fatigue can be a danger to physicians themselves and as it was discovered that interns whose shifts lasted longer than 24h had twice the probability of a car crash and were five times more likely to have a driving near miss as compared to interns who worked shorter shifts. [3]

Even at corporate enterprises, with “in office” positions, sleep loss is taking a toll. It is estimated that losses due to sleep deprivation are costing companies approximately \$136 billion per year in lost productivity due to do-overs and time lost on task. Even though this value seems enormous, in reality it is much larger, since it does not include fatigue related cost that are associated with accidents [4].

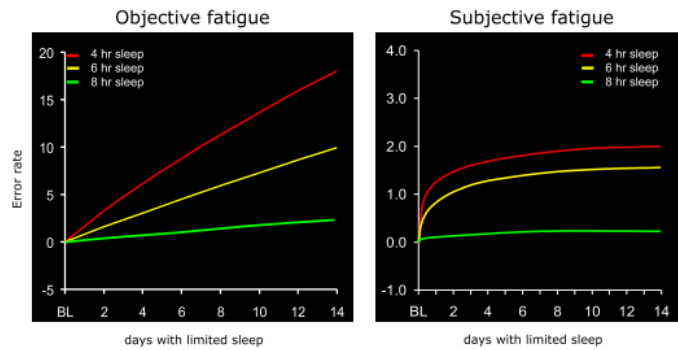


Figure 1 - Error rates vs Objective and Subjective Fatigue Assessments [2]

Additionally, available data indicates that individuals are poor judges of their own fatigue levels (Figure 2), and even employers who are trying to monitor fatigue often ask the wrong fatigue related questions when accidents happen [4].

As monitoring technology prices fall and its capabilities rise, many companies are opting to adopt these technologies, to increase efficiency, measure productivity, decrease risk, their monitor their

employees' health, and generally maximize profits [5].

Many different approaches can be made in using technology to help monitor employee health. Depending on the exact aspect that need to be monitored, distinct solutions exist. Next, some examples of technologies and their use will be described.

1.2 Keeping the Workforce Healthy and Safe

As previously mentioned, the use of different technologies for monitoring an individual's condition and surrounding environment is on the rise. Different technologies are being used for different purposes with a wide range of possibilities, starting with vital sign monitors: these are technologies that can measure different vital signs and can prevent employee illness, activity monitors: can measure activity like speed, steps taken and calories consumed, sleep monitors: allow for sleep to be monitored and allow the person to correct or change its daily activities and behaviors to sleep better thus reducing fatigue at work that can cause incidents or grave accidents. Also, fall detection technologies, provided by companies like MobileHelp, or the Phillips Lifeline with AutoAlert System, that detect falls and can automatically call for help if an individual is unable to rise on their own. Working on more passive monitoring solutions, companies like Quietcare and WellAware Systems produce environmental sensors and passive monitoring systems, that can monitor a number of items, from motion patterns to carbon dioxide, carbon monoxide and air quality to help create the most comfortable environment at work.

However, the technologies mentioned above, are mostly being used in a home setting and for personal self-monitoring but with some alterations can also be applied to a work environment. Next in this chapter, a few technologies that are currently in use for business purposes, and some success stories of how wearable and monitoring technology, were used to make the working environment a better place will be presented.

As evidenced before, fatigue is a big problem for professional drivers, working long hours and driving through nights. To help employees of transportation companies, and other drivers that drive long hours, a company called Phasya, is offering drowsiness detection for drivers by measuring eye movements (i.e. blinks, saccades, pupil dilation) using eye tracking technology [6], wants to help prevent accidents, as well as fatalities on the roads, helping drivers stay alert and awake during

long shifts. HealthyRoad a Portuguese start-up is trying to do something similar by developing artificial intelligence facial biometrics software to detect focus/distraction, drowsiness, fatigue levels, emotions and stress levels using a mix of eye tracking, face expression analysis and heart rate measurement. As one last example, there is also Hexoskin, a producer of smart shirts/smart vest that collect a wide array of biometric signals from ECG to breathing, whose mission is to “build a community of professionals and researchers who use Hexoskin for connected health projects (...) health research, clinical development, security & defense, sports & fitness, space projects.”[3].

Next, some examples of companies that leveraged wearable technologies to improve employee satisfaction at work, while also obtaining cost savings in the long run.



Figure 2 - Wearables used by BP America [121]

The first example is BP America. This company adopted Fitbit (Figure 3), a fitness-tracking device, in order to improve their employees' health habits, being this way able to reduce their insurance rates [5].

Another example is that of Bank of America. This company, ran a 6-week monitoring experiment on their employees, to find out “where employees went and who they talked to, how the tone of their voice and the movements of their body changed throughout the day.” From the gathered data, they concluded that social employees were more productive, thus they opted to change the working environment in order to encourage more informal socializing [7]. Some organizations are using wearables as coaching mechanisms, for example at physical jobs, such as those of workers who unload trucks at warehouses, if the employee is lifting objects incorrectly he receives a small alert to correct his position, thus being coached to a healthier life [8].

In conclusion, wearables and monitoring technologies have many different applications. Many of those will likely help the organization improve, as well as take better care for their employees, resulting in a win-win situation.

Furthermore, data collected by monitoring employees can be used to pinpoint exactly what caused an incident that inhibited the efficiency of an operation [5].

Nevertheless, privacy issues and what is exactly done with the information are also a major concern regarding different monitoring devices and the information they provide and how the employer uses it [5].

1.3 Objectives

The present work aims to develop a complete business plan for a technology based product, in close collaboration with a technology-based company. The host company, is a spin-off of the Institute of Telecommunications, and from Instituto Superior Técnico, University of Lisbon and has an interesting technology: it acquires the cardiac signal (in particular the electrocardiogram (ECG)), from the fingers or hands of individuals, interpreting signals with the purpose of biometrics recognition and emotional states detection.

At the first level - biometrics - it is possible to identify an individual, using the information present in the ECG/photoplethysmograms (PPG), like a fingerprint, each individual has its own cardio-signature.

At the next level - emotional states - the analysis of the cardiac signals allows to detect states of stress or fatigue of the individual.

In both situations, the information can be treated locally, on the form of authentication (giving the individual access to a protected facility, for example) or on the form of alert (emitting a sound or visual, informing the individual that is at that moment in a state of fatigue).

In a simple analysis, it is possible to envision multiple applications for both uses of CardioID technology. This implies, at the same time, a superior challenge: which product to develop, for which market?

CardioID expressly requested a work that would allow an analysis to understand and validate the use of technology, aiming at the emerging critical facilities market. In short, current times require the operators of certain industrial units to increase their accuracy in the way they authenticate and give their employees access to certain facilities and, at the same time, adequate control over their emotional state in the course of a given job.

In this context, the objective of the work is based on the study and validation of CardioID products, aiming at the exploitation and commercialization of the technology in the emerging market now called "critical facilities", having been decided that its validation shall be verified in the "Utilities" sector.

These objectives should be achieved by structuring the work in two distinct phases:

- (1) the structuring and grounding of thesis work;
- (2) the construction of a business model, and correlate it with a well-structured business plan;

2 Literature Review

2.1 Entrepreneurship

In order to drill down to the finer grain definition of technology based entrepreneurship, it is important to understand the broader term of entrepreneurship.

Entrepreneurship shows itself by solving problems in an unconventional way, be it with innovative actions, or by introducing new products and technologies [9], [10]. It can also be used to describe a person's attitude towards the world and others [9].

Entrepreneurship consists in “matching the products of human imagination with human aspirations, creating markets for goods and services that did not exist before the entrepreneurial act” [9].

In more theoretical terms, one of the possible definitions for entrepreneurship is that it revolves around the phenomenon of ‘emergence of new economic activity’. This term is inclusive enough to cover different ways of initiating new economic activity and it “embraces micro, mezzo and macro-levels of analysis” [11]. Additionally, we can look at Shane and Venkataraman, in the way that a research area is characterized by the research questions that are assigned as a starting point of any new research project in the field, this way, entrepreneurship research can be viewed as: ‘how, why, and when do entrepreneurial firms discover and exploit opportunities?’ [10], [11]

As for the entrepreneur, the literature suggests it is an individual who introduces “new combinations” of ideas and resources shaking the economy out of its previous equilibrium state [9],[12],[13], who is “an alert individual discovering an existing opportunity” [14], [15] and “an experienced individual making judgments about an unknowable future” [16].

Since the 1980s, entrepreneurship has been of interest for many researchers from various areas, from management, to psychology [11]. Some of the factors that may have sparked the interest of researchers, thus influencing the development of the field, and the research produced, were: i) the transition of the economic system of various previously socialist countries in Europe and in Asia, which led to the study of entrepreneurial contexts in new market economies as well as influence of the institutional environment on the performance of small and medium sized enterprises (SMEs) and entrepreneurial strategies [11],[17],[18]. ii) The success of longitudinal projects such as the Panel Study of Entrepreneurial Dynamics (PSED) and the Global Entrepreneurship Monitor (GEM)[19], allowed for the gathering of large quantities of reliable and quantitative data to support new research on early entrepreneurial activity across various nations [20], [21]. iii) Lastly, societal and social framework conditioning and how they impact entrepreneurship were the target of various projects and publications [11].

Resulting from this, the field of entrepreneurship was defined by remarkable growth leading to a significant widening of related topics and theoretical concepts during the first decade of the 21st century [13],[14].

Currently entrepreneurship research is one of the most compelling areas inserted in the cluster of socio-economic and managerial sciences in the last 25 years [11], [22]. Evidence of this can be observed simply by the ever-growing number of renowned international conferences on the subject at matter, as well as the number of attendees of these conferences. [11], [23], [24].

This phenomenon may have some explanation in the fact that a slowdown in the global economy can be observed in the last decade, accompanied by the evidence of the fifth long wave of economic development coming to an end [25]. As a result, one of the ways to help speed up the growth of gross domestic product (GDP) and secure a stable increase in the prosperity of nations is entrepreneurial creativity [11], [26].

Entrepreneurship arises in the center of two phenomena: the presence of lucrative opportunities and the presence of enterprising individuals [27]. Therefore, the field requires the study of sources of opportunities: the process of discovery, evaluation, and exploitation of opportunities as well as a set of individuals who discover, assess possible gains and exploit them [27].

Entrepreneurial opportunities differ from the larger set of all opportunities for profit since they require the discovery of new means-ends relationships, contrary to the larger set of opportunities that involve optimization within an existing means-ends framework [28].

According to Drucker [29], there are three categories of opportunities: “ i) the creation of new information, as occurs with the invention of new technologies;” Cardio-ID is an example of a firm exploiting this type of opportunity, as the company is built around innovative ways to harvest and use data collected from an individuals’ ECG/PPG and other vital signals. “ii) The exploitation of market inefficiencies that result from information asymmetry, as occurs across time and geography; and iii) the reaction to shifts in the relative costs and benefits of alternative uses for resources, as occurs with political, regulatory, or demographic changes.”[10].

These entrepreneurial opportunities are discovered when someone realizes that a set of resources is not put to its “best use”, for example, if resources are priced “too low” given that the output of their combination could be sold at a higher price in another location, or in other form [10]. If this intuition is acted upon, and is correct, entrepreneurial profit is earned, if not, the entrepreneur suffers entrepreneurial loss [30].

However, it is important to note that, due to asymmetry in beliefs, not all opportunities are obvious to everyone at the same time. The two categories of factors that have influence on opportunity discovery being i) possession of the prior information necessary to identify the opportunity, and ii) cognitive properties necessary to value it. Adding to different beliefs, research has shown that people vary also in their ability to combine existing concepts and information into new ideas [10]. Entrepreneurs are found to be more likely to discover new opportunities due to being less likely to devote time and effort imagining what “might have been” in a given situation, less likely to experience regret over missed opportunities as well as less susceptible to inaction inertia [10]. In other words, entrepreneurship can be seen as a process of discovering objective opportunities that are visible to people who possess prior knowledge and resources to “discover” them [31].

As suggested by Shane and Venkataraman, when opportunities are exploited, information diffuses amongst members of society who can then imitate the innovator and appropriate some of the entrepreneurial profit [10]. As this starts to happen the incentive to pursue the opportunity diminishes, since it is not as profitable now, because the profit is being divided between more actors [10].

In other words, as entrepreneurial opportunities rely on asymmetries of information and beliefs[32], it can be concluded that sooner or later they are bound to become cost inefficient to pursue [10], because the asymmetries will be corrected over time.

In summary, the spread of information and learning about the accuracy of decisions, combined with the incentive of possible profit, reduces the incentive for people to pursue any given opportunity [10].

The period of time that an idea will be profitable is influenced by a variety of factors, for example, patent protection or exclusivity contracts will increase the duration of the profitability and can be reinforced with the need for adoption of technical standards as well as learning curves, for other players trying to enter the market [10].

This being said, entrepreneurship plays a crucial role in the economic and social development, so the role of entrepreneurial education, research, education and training is vital [19] considering that a considerable amount of technical information is embodied in products and entrepreneurship itself being a system that converts technical information into these products and services. As a result, it is also a system through which inefficiencies in an economy are discovered and mitigated [33].

2.2 Technology based entrepreneurship

The dimension of entrepreneurship discussed further in this section, is related to one of the ways entrepreneurship manifests itself, this being, the introduction of new technologies.

Emerging from the interdependence between scientific and technological change as well as the selection and development of new products, assets and their attributes, technology based entrepreneurship can be seen as an investment in a project that assembles and deploys specialized individuals and heterogeneous assets for the purpose of creating and capturing value for a firm [12].

Technology based entrepreneurship can be considered a recent field of study since the majority of technology based entrepreneurship articles are not published in journals that are considered contributors to technology innovation or entrepreneurship [12], and most of the publishing was done recently. Literature dating from 2000 to 2012, accounted for 66% of the publishing around the subject of the preceding four decades [12].

The dominant theme of the articles about the subject, that accounts for 45% of the total number of articles, focuses on identifying the antecedents of technology firm formation. The target of the articles is mostly the external factors that influence firm formation as well as the supporting systems for technology firm formation. Some of the covered topics are: “characteristics of technology entrepreneurs; external events that create technology opportunities for technology entrepreneurs; university and business incubators; firm spinoff and technology transfer mechanisms; government programs that support technology entrepreneurship; funding of new technology firms; entrepreneurship education; and commercialization capability.” [12].

The second theme with more published research covers how technology based entrepreneurship influences regional development [12],[26]. The literature also focuses more on SMEs than large firms [12].

One of the distinctive points of technology based entrepreneurship from other types of entrepreneurship is that through “the collaborative experimentation and production of new products, assets, and their attributes, which are intricately related to advances in scientific and technological knowledge and the firm’s asset ownership rights.”[12]. This collaborative effort allows for creation and capturing of value for the firm, through projects that produce and adopt technology[12].

Some definitions of this dimension of entrepreneurship that can be found in the literature are:

1. Organization, management, and risk bearing of a technology based business [34].
2. Establishment of a new technology venture [35].
3. Solutions in search of problems [36].
4. Ways in which entrepreneurs draw on resources and structures to exploit emerging technology opportunities [12], [37], [38].
5. An investment in a project that assembles and deploys specialized individuals and heterogeneous assets that are intricately related to advances in scientific and technological knowledge for the purpose of creating and capturing value for a firm [12],[36].

These definitions suggest that technology based entrepreneurship is about:

“i) operating small businesses owned by engineers or scientists; ii) finding problems or applications for a particular technology; iii) launching new ventures, introducing new applications, or exploiting opportunities that rely on scientific and technical knowledge; and iv) working with others to produce technology change.” [12].

With the introduction of the technology component into a venture, or the formation of a firm around a new technology in order to exploit it, introduces additional uncertainty and complexity to opportunity exploration, so the entrepreneur must “strongly rely on interactions with stakeholders and other external actors to make sense of the opportunity at hand”. Thus successful technology-based ventures are seen to heavily depend on the outcomes of actions by entrepreneurs [26].

The development of new products, assets and their attributes is achieved by identifying, selecting and developing new attributes for the creation and capturing of value, as well as the establishment of sustainable competitive advantage [12]. For this, the culture of the organization needs to accommodate the ability to innovate, thus implementing new technology, as well as take actions towards its development [9]. The entrepreneur is in the center of this development process since he needs to act to make progress in opportunity exploration. Regardless of uncertainty and complexity, the technology entrepreneur is regarded “as an active innovator, aiming to put together the market application (or value proposition) with the technology-based product or service they are developing” [39]. This is to say the entrepreneur's capacity to understand what resources and actions are needed to produce the desired effects helps to explain some of the differences between successful and non-successful entrepreneurs [26].

This specific type of entrepreneurship plays an important role in the economic activity of a region. Even though new technology based entrepreneurship firms make up only a small fraction of the industry network, they accelerate the maturity of new technologies by assuming greater risks, thus feeding technological innovation [38]. They also boost business competition by forcing competing firms and enterprises in the same segment to accelerate their internal transformations, form strategic alliances, and renovate the offered portfolio of products and services [38].

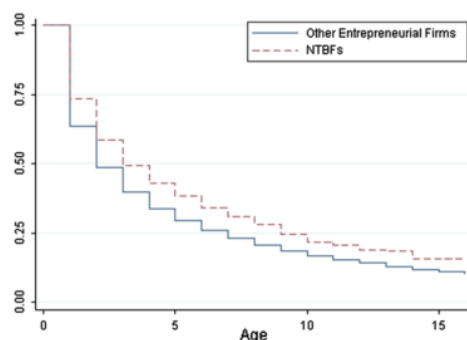


Figure 3- New Technology Based Firms(NTBFs) compared to other entrepreneurial firms in terms of survivability by age [33]

There is also evidence that technology based entrepreneurship firms have a higher survivability rate albeit only if they are able to survive past the self-employment stage (Figure 1) [40]. Emphasized is the widespread adoption of policies that promote entrepreneurial ventures, in public as well as in the private sector. Despite their effort however, the effect of these programs has been limited on high-growth and high-potential technology based entrepreneurship [41].

In conclusion, it can be established that technology based entrepreneurship, is a recent field of study that rises from the intersection of science, entrepreneurship and new product development. When compared to

other types of entrepreneurship, technology based entrepreneurship, by the essence of the technological process increases uncertainty on both the performance and timing variables [42]. This inherited disadvantage is mitigated by the characteristics of the technology entrepreneur, that has to be watchful of the emerging opportunities, and changes in the environment [43], in order for his venture to survive. Being closely connected to scientific research, and by taking higher risks, technology based entrepreneurship, quickens technology development, as well as regional development through establishment of SMEs. Everything previously referred, makes technology based ventures and interesting investment area for public and private investors.

2.3 Strategy and Resource Based Theory (RBT)

2.3.1 Strategy

Strategy is an ancient concept, the origin of the word can be traced back to the ancient Greek word “strategos”, that merges the words *stratos*(army) with *ag*(to lead), thus meaning to lead an army. Therefore, the word has a military origin, and the concept was later applied to the business environment. As companies want to possess a competitive advantage to have a fighting chance against competitors and maybe even defeat them, as well as protect themselves by protecting their competitive advantage.

Views on the concept of strategy and its definition have varied in time, thus many different definitions can be found in literature about the field. According to Chandler [44], “Strategy can be defined as the determination of the basic long-term goals and objectives of an enterprise, and the adoption of courses of action and the allocation of resources necessary for carrying out these goals”

In their book *Strategic Management and Competitive Strategy*, Barney and Hesterly [45], define strategy in an interesting way as well. According to them, strategy is a theory about how to gain competitive advantages and a valuable strategy is one that actually generates such advantages. Like all theories, strategy is based on a set of assumptions and hypothesis about how the competition in an industry is likely to evolve and how this can be exploited to earn profits. Thus, a firm is more likely to gain a competitive advantage if the assumptions it makes are correct and less likely to do so, if the assumptions made are less accurate. The challenge lies in the difficulty to actually predict how competition in an industry will evolve, hence it is rarely possible to be certain that a chosen strategy is the more suitable.

Simply put, Barney and Hesterly, consider strategy “a firm's best bet about how competition is going to evolve, and how that evolution can be exploited for competitive advantage.” [45].

Hofer and Schendel [46], present a view complementary of Chandler’s, defining strategy as “the match an organization makes between its internal resources and skills(...)and the opportunities and risks created by its external environment.”

Throughout the 1980s the main developments in strategy analysis were aimed at the relationship between the strategy of a company and the external environment, one possible example is Porter’s analysis of industries’ structure and a firms competitive positioning [47]. Whereas “the link between strategy and the firm’s resources and skills has suffered comparative neglect.” [48]. Recently, however, there has been a resurgence of interest in the role a firm’s resources play as the base for a firm’s strategy. This resurgence is a sign dissatisfaction with the equilibrium frameworks that have influenced much of modern thinking about business strategy and revived attention to earlier theories of profit and competition [48]. Development occurred in various sectors of firms. At a corporate strategy level, interest in economies of scope and transaction costs directed attention to the importance of corporate resources in deliberating the firms’ industrial as well as geographical frontiers. Complementary to this, on a business level, analysis of the relationships “between resources, competition, and profitability include the analysis of competitive imitation,[49] the appropriability of returns to innovations [50], the role of imperfect information

in creating profitability differences between competing firms[51], and the means by which the process of resource accumulation can sustain competitive advantage[52].” [48].

The convergence of these contributions is what has been described as the resource-based view of the firm.

2.3.2 Resource Based Theory (RBT)

Resource based theory was developed in order to assess if differences in the performance of competing firms could be explained by the possession of distinctive resources [53].

Following a more traditional strategic analysis a firm’s resources can be seen as the firm’s strengths that will allow it to implement a desired strategy.

The resource based view conceptualizes the company as a knowledge system or a pool of resources [54], [55]. Viewing a company in this perspective allows for a thorough point of view, since it takes into account not only the firms connections with other companies’ systems but also the relationships between internal systems [56].

The target of this view is to recognize that relationships are in fact assets, even when if their value is hard to quantify. In order to be able to use this view for strategic purposes a company must possess a certain level of technological knowledge to be able to determine the potential of the information or technology that improves its base knowledge [57].

Barney[54] pinpoints a few categories into which a firm’s resources may be classified. Physical capital resources, which include the firm’s used technology, equipment, and other tangible assets as well as the firm’s geographic location and ability to obtain materials. The second category is that of human capital resources, which includes “training, experience, judgment, intelligence, relationships and insight of individual managers and workers in a firm” [54]. The last category is that of organizational capital resources, that includes the firm’s way of doing things, meaning, reporting structure, planning, both formal and informal, controlling and coordination structures also not disregarding, group relationships inside the firm and with its environment [54].

Moreover, it is important to understand how all these resources can become the source of sustained competitive advantage of the firm. It is considered that a firm possesses a sustained competitive advantage “when it is implementing a value creating strategy not simultaneously being implemented by current or potential competitors” [54] and when these competitors are incapable to imitate the advantages of this strategy, because if the competitive advantage can be imitated it can no longer live up to that title.

In addition to understanding what makes a resource a resource it is also crucial to understand the characteristics that make them sources of competitive advantage, which is what we will see in the following part of the literature review.

Some of the attributes that can qualify resources as sources of competitive advantage are for example, rareness, inimitability and non-substitutability.

2.3.2.1 Valuable Resources

If we follow the traditional “strengths-weaknesses-opportunities-threats” framework of firm performance it suggests that firms boost their performance if their strategies “exploit opportunities or neutralize threats”.

Hence, resources are valuable to a company if they allow the firm to “implement strategies that improve its efficiency and effectiveness” [54].

As Barney [54] suggests, “A firm’s attributes must be valuable in order to be considered resources (and thus as possible sources of competitive advantage)”.

2.3.2.2 Rare Resources

Like the definition indicates, for a resource to be a source of competitive advantage or sustained competitive advantage it has to be rare.

If a firm’s resource is possessed by many other companies, this means that they are able to use it in the same way, implementing a common strategy, that provides none of the firms with an advantage.

These resources can however aid firms in achieving competitive parity in the industry. If competitive parity is reached in an industry, it means that no one firm has competitive advantage over the others, it does however, increase their chances for economic survival [54].

Subsequently, for as long as a firm possesses a rare valuable resource, and there are fewer than needed firms to generate perfect competition dynamics in the industry, the firm holds the potential to achieve competitive advantage

2.3.2.3 Imperfectly Imitable Resources

It is easy to see that valuable and rare resources can be the origin of competitive advantage. Since they allow the company to implement strategies that competing firms could not conceive, implement or both due to lack of these resources.

However, these resources can be a source of sustainable competitive advantage, for as long as other competing firms are not able to obtain them, or imitate them. Resources can be “imperfectly imitable for one or a combination of three reasons: (a) the ability of a firm to obtain a resource is dependent upon unique historical conditions. (b) the link between the resources possessed by a firm and a firm’s sustained competitive advantage is causally ambiguous, or (c) the resource generating a firm’s advantage is socially complex” [54]. Each of these reasons will be summarily explained below.

Ability to obtain a resource is dependent upon unique historical conditions. This asserts that a firm’s ability to “acquire and exploit some resources depends upon their place in time and space” [54]. If a specific exclusive time in history passes, firms that did not create space-time dependent resources, will not be able to obtain them in the future, thus they are imperfectly imitable. An

illustration of this is observed when “A firm with scientists 'who are uniquely positioned to create or exploit a significant scientific breakthrough may obtain an imperfectly imitable resource from the history-dependent nature of these scientist’s individual human capital”[58]. Additionally Barney[54] suggests that, “literature in strategic management is littered with examples of firms whose unique historical position endowed them with resources that are not controlled by competing firms and cannot be imitated”.

The link between the resources possessed by a firm and a firm’s sustained competitive advantage is causally ambiguous. Casual ambiguity arises if the link between a company’s resources and its sustained competitive advantage are not clearly understood. Since the link is not understood it is hard for competing firms to try and replicate these links[32]. Amusingly for this specific condition to occur, all competing firms must be unable to understand the link between the firm’s resources and its competitive advantage. If one of the firms understands the link, in the long run, this understanding will be dispersed to all the competitors, eliminating casual ambiguity and the imperfect imitability that was based on it.

The resource generating a firm’s advantage is socially complex. Resources can be considered socially complex if the firm is not able to consistently manage and influence it.

Some examples of socially complex resources include, a firm’s reputation with customers and suppliers, organizational culture and traditions.

2.3.2.4 *Substitutability*

The final requirement for a resource to be considered a source of sustained competitive advantage is that “there must be no strategically equivalent valuable resources that are themselves either not rare or imitable” [54].

Imagine a firm possesses two strategically equivalent resources, both of which can be separately used to implement the same strategies. Supposing that only one of these resources is rare and imperfectly imitable, the firm with that resource will be able to follow certain strategies. This strategy would provide a sustainable competitive advantage for the firm, however since there is another resource that makes it possible for competing firms to implement equal strategies even if in other ways, removing the competitive advantage from the firm[54].

It is possible to identify at least two forms of substitutability. The first occurs when competing firms are not able to obtain exactly the same resource, but are able to acquire a similar resource, enabling the firm to implement the same strategy. A practical example of this occurrence can be of a firm trying to imitate another company’s competitive advantage by duplicating the other firm’s high quality management team. The hired team will not likely be the same team, however the firm may be able to create its own high quality management team, even if with different operating practices, different backgrounds and profiles. Hence, even though the teams are different they will likely be strategically equivalent[54].

The second form of substitutability can occur because firm resources do not need to influence the firm in the same way in order to have an equivalent strategic impact. To illustrate, managers in

one firm may have a clear vision of the company's future goals and objectives due to a charismatic leader, however in another company, managers may have a clear vision of the future due to a good and clear strategy planning and diffusion. Therefore, both companies' managers have a clear vision of the future, even though it was achieved by different resources, making them substitutes for one another[54].

2.3.2.5 Strategic planning

It is unreasonable to expect *formal* strategic planning to be by itself a source of sustained competitive advantage. Considering that these planning systems enable companies to identify opportunities and threats in their environment, they may be considered valuable. However, these types of frameworks of formal planning process have been meticulously studied and documented in different public sources[54].

Furthermore, evidence suggests that a large number of firms use such formal planning, making these systems not rare, so by itself strategic planning cannot be considered a source of sustained competitive advantage. Nonetheless strategic planning allows firms to identify and exploit its resources, some of which might be sources of sustained competitive advantage[54].

In short, the resource based view, “suggests the kinds of empirical questions that need to be addressed in order to understand whether or not a particular firm resource is a source of competitive advantage: is that resource valuable, is it rare, is it imperfectly imitable, and are there substitutes for that resource?” [54].

2.3.3 Linking Resource Based Theory to Entrepreneurship

To elaborate further into what has previously been presented, entrepreneurial opportunities appear, as we have identified before, because different people have different beliefs about the value of resources. Heterogeneity is one of the common attributes of resource based theory and entrepreneurship theory if we consider that beliefs about the value of resources are in fact resources by themselves [32].

To understand the link between RBT and entrepreneurship, two entrepreneurial concepts must be introduced, firstly entrepreneurial recognition, that can be defined as the behavior of opportunity recognition and opportunity seeking, that needs to be considered a resource. Secondly the process of linking and organizing resources will also be considered a resource.

Next Alvarez [32] suggests that, despite acknowledging the importance of resource heterogeneity, strategists have given sparse attention to the process by which these heterogeneous resources are discovered, processed from inputs into outputs, and how they are used to add value to the company. In light of this, he suggests that entrepreneurship “is about cognition, discovery, pursuing market opportunities and coordinating knowledge that lead to heterogeneous outputs.”

In addition, it can also be theorized that if entrepreneurs have a unique mindset or orientation, then their cognitive approaches will have strengths and weaknesses depending on the competitive environment where they are inserted.

In their quest to discover the differences in thinking ways of entrepreneurs and managers in large organizations Busenitz and Barney [59] discovered that entrepreneurs are much more likely to rely on heuristics for decision making purposes (Entrepreneurial cognition) than their large firm counterparts that preferred managerial cognition. Managerial cognition is a more systematic decision making process where “managers use accountability and compensation schemes, the structural coordination of business activities across various units, and justify future developments using quantifiable budgets”[32], in short a more factual-based approach to decision making. On the other side, entrepreneurial cognition that entrepreneurs use is based on heuristics. Simply put, heuristics simplifying strategies that can be used to make decisions in complex situations where information is lacking or the available information is not very complete. Often with the use of this thought process entrepreneurs can make great leaps in their thinking that leads to innovative ideas that may not be very linear or factually based. Considering that entrepreneurs often find themselves situations of high uncertainty while pursuing a new venture, when the ability to readily rely on heuristics, to connect limited information for decision making purposes is the only way to breakthrough, makes entrepreneurial cognition a potential source of competitive advantage [32]. Even if we take into account that heuristic-based logic may use less information and be less accurate, the use of specific knowledge clusters eases the adjustment to emerging trends.

Whereas using a more factual-based logic when pursuing new opportunities is often too overwhelming and very costly, if not impossible.

Summarily, entrepreneurial cognition used by entrepreneurs can facilitate a potential competitive advantage by making new opportunities more visible to entrepreneurs, by connecting sparse information from different sources. Secondly, a heuristic-based decision making style may help in the initial stages of organizational development by allowing the entrepreneur to quickly solve or avoid a wide range of problems and irregularities inherent in the development of a new venture [32].

Additionally, we can conclude that this is how technology based startups operate, based on the RBT. They start by having the resources, be it a scientific discovery, a result of an ongoing investigation, or the discovery of an opportunity not yet identified by others. Afterwards they seek ways on how to exploit them, or where they can be used as a product or problem solver. Finally, they establish goals they want to achieve with this new product or innovation and their company.

3 Methodology

3.1 Methodology for idea validation

As pointed by Creswell [60], a qualitative approach to research is more appropriate when a problem or an issue has to be explored. This allows for the discovery of the variables that can then be measured. Another reason to adopt a qualitative research is to obtain a detailed understanding of the issue at hand.

Since the product that this business plan is being constructed for, is still in the early stages of development, it was decided that a series of interviews with people working in high-risk, or safety sensitive occupations was the best approach to test the viability of the project, as well as to really understand the struggles that these people and their managers face.

In order to do this, participants will be asked a series of previously prepared questions, to try and better understand the need for the product, as well as discover previously unthought of but needed features.

3.2 Business Model Methodology

There are many ways to map and discover a business model for a company or a new product. One relatively new model that have been taking the startup world by storm is the business model canvas (BMC) a model proposed by Osterwalder & Yves.

This a very simple model to build, as it is very visual, but this does not prevent the model from containing all the important information in an easy for everyone to understand way.

According to Osterwalder & Yves [61], a “business model describes the rationale of how an organization creates, delivers, and captures value”. Thus, they propose a canvas divided into 9 building blocks that are interconnected and influence each other and the proposed product. Further, a short description of all the building blocks is provided.

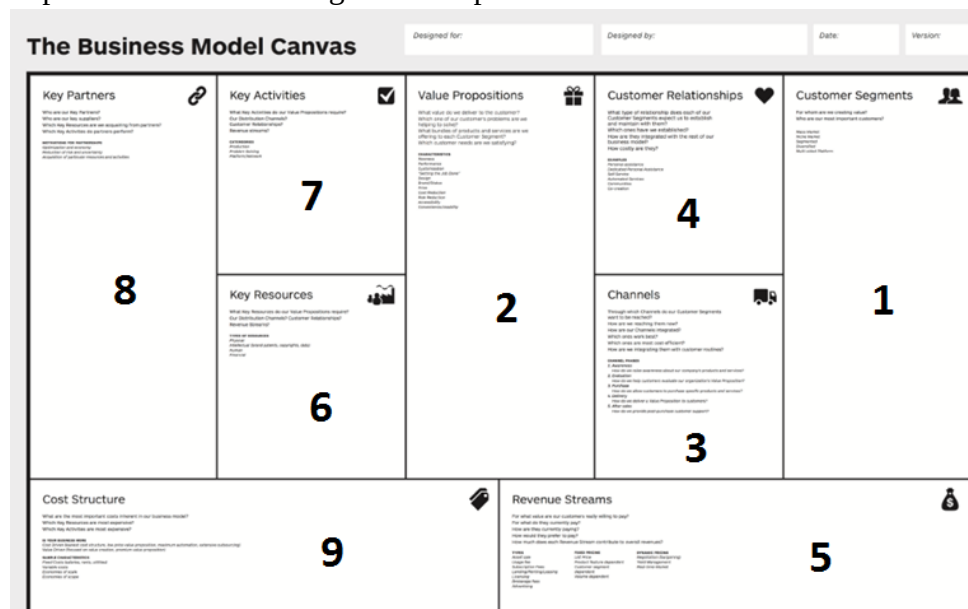


Figure 1 - Business Model Canvas Layout proposed by Osterwalder & Yves [61]

1. **Customer Segments:** This blocks defines the customers or organizations that the company will try to address and solve a need for.
2. **Value Proposition:** In the value proposition, the bundle of products and services, that will create value for the customer is described.
3. **Channels:** In this building block, it is described how a company will reach and communicate with its customer segments in order to deliver the value proposition.
4. **Customer Relationships:** Here the company sets the type of relationship it wants to have with its different customer segments. This can range from a totally automated relationship to dedicated personal assistance.
5. **Revenue Streams:** Represents the ways a company earns money from each customer segment.
6. **Key Resources:** Here the most important assets required for the business model to work are represented.
7. **Key Activities:** In this block are represented the most important activities a company must engage in order to make the business model work.
8. **Key Partnerships:** Shows the network of needed or desired partners, and suppliers for the business model to work.
9. **Cost Structure:** Describes the costs incurred to operate the business model.

Another more recent business model tool, the Lean Canvas [62] (Figure 5), was developed as an adjusted version of the BMC. Its creator, Ash Maurya, thought that de BMC's building blocks were too general and that the model lacked product/market fit, which is true if we disregard the VPC. That aside the Lean Canvas model incorporates 'Unfair Advantage' (block 9), which is something that cannot be bought or copied, to diminish the harm of competitors or imitators. The main objective of this model is to be "actionable" and "entrepreneur-focused".

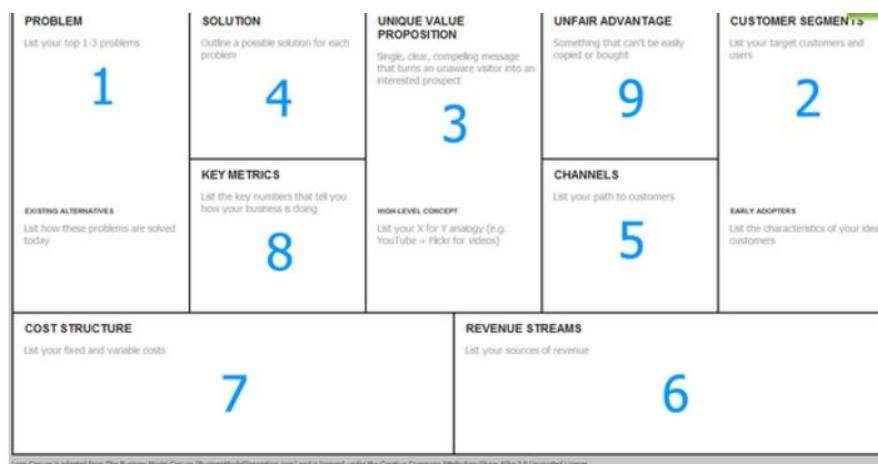


Figure 2 - Lean Canvas Model proposed by Ash Maurya [63]

As said before Lean Canvas places more emphasis on the product/market fit, the addition of building blocks like 'Problem' (1) which implies a better problem understanding thus leading to less waste of resources and more focus on a good product. Additionally the added 'Solution'(4) block proposes a solution based on the problem and the 'Key Metrics'(8), which focus on key

actions that need to be done to create revenue from the right resources [63]. The other numbered blocks, 2,3,5,6 and 7 have the same purpose as their equivalents in the BMC.

When compared to other business models tools, like the Lean Canvas, that was also presented above, the Fluidminds Business Model Canvas and the Components Business Model of IBM a table with strengths and limitations of the BMC can be built (Table 1).

Table 1 - Strengths and Limitations of the BMC

Strengths	Limitations
Visual Representation of the BMC	Neglect of external factors such as competition, imitation and market
Covers different dimensions of a business model, such as Channels, Customer Segments, Cost Structure and Revenue Streams	The building blocks have different levels of abstraction, as a result of this more emphasis is placed in building blocks such as Key Resources, Key Activities, Channels, and Customer Relationships
Value is central	Human and team interaction are not taken into account, thus an incomplete identification of the value creation can occur
	Does not take into account strategic purposes, making it more fitting for profit generation purposes than non-profit purposes.

One, or maybe both of the models presented in more detail in this section will be used further into the project. Firstly, to discover what the customer is trying to overcome, and what is the concrete problem at hand, and what can be done to help the customer solve it. Secondly, we must acknowledge that what separates the successful products from those that are not, is not necessarily starting with the perfect plan, but finding a plan that works before running out of resources. This will be done through empirical testing, by meeting with potential users and refining the proposed plan and confirm assumptions.

4 Business Plan

Executive Summary

As for the expected outcome of this thesis, it will be a business plan for a product that allows for the personnel working in high risk jobs to know when they are fatigued and be able to use this as an assessment tool for their level of fatigue. It can be used as physical evidence of their stress and fatigue levels to present to management and to better understand their limitations.

As for the managers, it will provide a better understanding of their employees, and how they feel in different situations, based on real data and not only subjective guesses. Thus allowing for better planning, and better deployment of resources in the company.

The product will be aimed for Critical Infrastructure Protection (CIP), starting with utilities companies and their infrastructures, and later, on a second iteration the aviation industry, with air traffic controllers. Both these markets are in growth, and will need to apply better security measures due to the ever-increasing number of attacks they can be target of, from cyber-attacks, to physical attacks, that have seen a big increase in Europe in the past few years.

Additionally, employee well-being and engagement has also been on the rise as core company value in many enterprises across different industry sectors, especially with workers looking for a better work/life balance in their daily lives.

This business plan will include a market analysis, a marketing plan, a business model and a financial plan.

4.1 General Company Description

Mission Statement: Provide non-intrusive and accurate real-time physiological computing platform that enables seamless management of biometric authentication, and physiophysiological states (as fatigue and stress detection tool).

Company Goals and Objectives: Protect 75 critical facilities by the year 2023. Additionally, monitor the health status of 750 employees by the same year, helping companies protect not only their employees but also their customers.

Business Philosophy: Continuous Physiological monitoring is one of the next big frontiers to be unveiled by advances on technology. This progresses help companies to have seamless technology that addresses on of the concerns of critical jobs - attention and fatigue. Non-intrusive monitoring technology help employees to quantify their state of awareness helping them to understand when to stop and avoiding fatigue and error. Companies will higher productivity, less stop-periods and reduce costs.

Our Industry: The industry of non-intrusive physiological monitoring is new, mainly due to recent advances on sensors and smart materials. The players that are developing this kind of technology are mainly connected to Universities and Research Centers, and are focused on different alternatives for monitoring fatigue, and in different customer segments. In the case of biometrics and fatigue management there are very few competitors: for Biometrics there exist Nymi and BSecure; for fatigue management companies working on chest straps are starting to move from the traditional heart rate monitoring to more complex heart-rate-variability (HRV) analysis. The trend of wearables that monitors heart rate is huge, but the number of devices that enables the monitoring of HRV is very small. The conjunction of biometrics and physico-physiological monitoring is not yet shown in the market, and is a challenging engineering problem.

4.2 Products and Services

The central field where CardioSafety will make a difference is in critical infrastructures protection. To elaborate, and as it has been evidenced before, fatigue is a big problem in many companies, ranging from utilities companies to air traffic control. By assessing and monitoring fatigue levels and taking precautions to mitigate it, companies can prevent a great number of incidents that put in risk many human lives, as well as infrastructures. Also, the product features a continuous authentication feature that will be described in greater detail further in this business plan.

CardioSafety will work by collecting the user's photoplethysmograms (PPG) or electrocardiogram (ECG), signals in real time via a wearable bracelet or an external signal acquiring device and sending it to the software installed in the user's computer for further analysis.

Although ECG signals have been proven to be more accurate for biometric identification, the intrusiveness of its acquisition is not convenient for this context, making ECG signals inefficient in terms of wearability convenience as compared to PPG signals.

4.2.1 PPG and ECG explained

PPG is a non-invasive method of measuring the variation in blood volume in tissues using a light source and a detector. As the blood volume is synchronized with the heart beat, this technique can be easily used to calculate heart rate. Transmittance and reflectance are the basic principles supporting PPG. For reflectance PPG, a light source, and the light detector are placed in the same side of the body part making it usable in any part of the human body, unlike transmittance PPG where the source and the receptor must be placed in opposite sides of the body part, making it only usable in a restricted number of parts, such as the finger or the earlobe. In case of reflectance PPG, which is the one that will be used for CardioSafety, the reflected light will fluctuate according to the pulsatile blood flow caused by a beating heart.

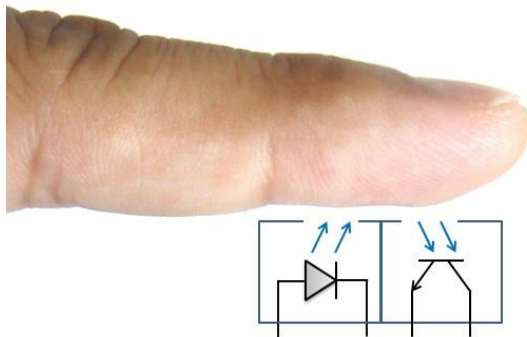


Figure 3 - Explanatory Diagram PPG functioning
[122]

The figure on the left (Figure 6) shows a simple reflectance PPG probe used to obtain a pulse signal from a fingertip. The plot of the variation in the light intensity against time is referred to as a photoplethysmographic or PPG signal. PPG will be used to calculate, heart rate variability (HRV) which will be explained next in more detail. HRV is the variation in time between each heartbeat, and is also known as R-R interval (Figure 7), or inter-beat interval. This interval is not consistent nor fixed, varying with every heartbeat, thus the term variability.

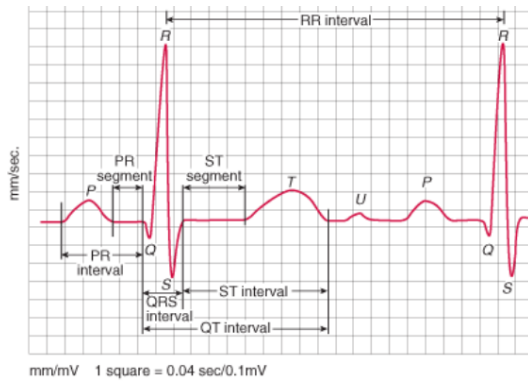


Figure 4- Image showing a normal ECG with QRS complexes and R-R interval [123]

Also, this variation can be influenced, by physiological responses to fatigue, stress, anxiety and unrest. Complementary, to this, HRV has also been shown to be a predictor of mortality after a heart attack [64] and depression [65].

There are two specific approaches to analyze HRV: time domain and frequency domain and both methods will be used in CardioSafety, thus both will be briefly explained next in this chapter.

Time domain measures are easier to calculate, but yield less detailed information than the frequency domain approaches. Time domain methods use either statistical or geometric approaches, each of which shares a common feature, using only the normal QRS complexes (combination of three of the graphical deflections seen on a typical ECG) (Figure 7) for calculations, this means that only normal electrical activation (i.e., depolarization originating from the sinoatrial node) patterns are included in the calculations, excluding irregular beats such as atrial or ventricular arrhythmias. Using this information, the “normal-to-normal (NN) interval (the interval between adjacent normal QRS complexes) or instantaneous heart rate (heart rate calculated on a beat by beat basis) is determined, and simple descriptive time domain variables such as the mean NN interval, mean heart rate, and the range (longest NN minus the shortest NN) for a given time interval can be calculated” [66] [67]. Another technique, that is easy to calculate and provides more detailed information thus making it one of the most widely used time domain indices of HRV is the square root of the variance of the NN interval (SDNN).

Regarding the frequency domain, “there are two methods to calculate the HRV. They are the nonparametric and parametric method. The nonparametric method employs (Fast Fourier Transform) FFT and parametric employ Autoregressive (AR) method. Both have some advantage and disadvantage to each other. In most cases employed FFT which is a simple method and the high processing speed are the advantages of the nonparametric method while smoother spectral representation and accurate estimation of PSD even on a small number of samples on that the signal are the advantage of the parametric method.” [68]

More techniques for HRV calculation can be seen in Appendix C.

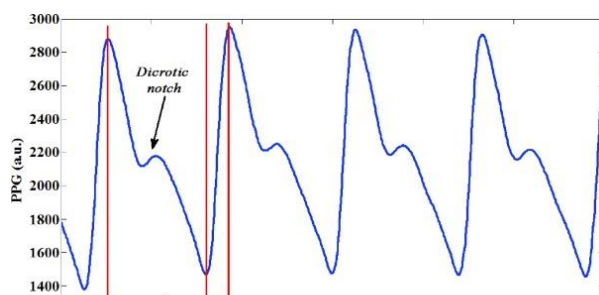


Figure 5 - Example PPG wave with explicit heart movements pointed out [124]

Regarding the use of PPG (Figure 8) for authentication a team from the University of Dallas, has successfully proven that it is possible to identify an individual based on PPG with 96.1% accuracy, and an even better accuracy can be attained if the data is filtered in the pre-processing stage. Unlike previous approaches this technique is robust against motion induced

noise making it highly recommended for day-to-day settings[69].

Contrary to conventional biometrics, like face recognition, or fingerprint that are neither secrets nor are totally robust against falsification, an individual's PPG is highly secure and impossible to be forged. In addition, PPG has an inherent real-time feature of vital signs, that ensures PPG cannot be acquired, unless the person is alive and present at the authentication point. Therefore, PPG authentication is robust enough against false credentials, and against forged credentials being enrolled in the system.

After acquisition of the PPG, the data is sent to the machine learning software installed in the user's computer via Bluetooth and processed by a proprietary algorithm to assess fatigue and stress by comparing the current reading with model data acquired from the user, and assessing if it is within acceptable thresholds. A very simplified explanatory diagram of the process, can be found in Appendix 2.

Unlike other biometric authentications such as the finger-print and retina scanners, CardioSafety can provide continuous authentication by continuous sampling and verification. One possible application of continuous authentication is proximity based device access, meaning that if an authenticated person is near the workplace, it is logged-in in all its services, if the employee is however away, getting a coffee, everything is locked, not allowing meddling with the systems.

Additionally, this allows for the person to safely login from anywhere, and the company to be sure that this login is in fact the authorized person logging in, without the need for rotating pin numbers, codes, or passwords.

The major competitive advantage of this product is, unlike current approaches, being able to analyze the data in real time. Thus, giving the individual, and his manager timely feedback on access control, and fatigue conditions, without the need to change workflows, or spend any further time on filling questionnaires and submitting them for management's review.

Another great feature of this product will be developed in cooperation with Peformetrics, allowing to measure user attentiveness while on the work post, by analyzing keystroke dynamics and mouse movement.

Summarily, the product will possess a wide variety of features, namely: user authentication, continuous user authentication, fatigue detection, alert systems for both the user and superiors, data reports, recommendations for fatigue management and attentiveness measurements.

These features produce a large spectrum of benefits for companies. By analyzing fatigue, companies can understand the wellbeing of their employees, and apply the necessary changes to boost it. This not only increases employee satisfaction at work, but also greatly reduces the number of incidents that occur as result of fatigue and can greatly endanger the employee, surrounding infrastructure and any other stakeholders, producing large cost savings for the employer.

The product will play an important protection role in the enterprise, thus it must perform in the highest standards of the industry regarding various aspects: data has to be collected correctly, data has to be processed correctly, data has to be analyzed correctly and has to be stored and protected

correctly. For this to happen, it is imperative to have a team with experience in the area. Thus, the product will be priced in the €2900 to €4000 monthly fee range.

4.3 Market Analysis

4.3.1 External Analysis

The external analysis allows to understand, the current state of the market. It can help to see if the market is open for the product being implemented and if other variables outside of the company's control are favorable for the product.

Currently, fatigue has a huge impact in the number of incidents that happen in enterprises. According to NASA's Aviation Safety Reporting System, from the 261 000 incidents reported, 52 000 of these were fatigue related [2].

According to CIPD's recent *Absence Management Survey 2016*, "nearly three-fifths report that their organization is much more reactive than proactive regarding well-being" [70].

Additionally, "awareness of mental health and stress issues is at a new all-time peak, with an estimated 1 in 6 people of working age being diagnosed with a mental health condition" [70].

The correlation between physical wellbeing and mental wellbeing is becoming more pertinent with statistics indicating that out of all employees who have a physical health condition, 1 in 5 also reported having a mental health issue[70].

4.3.1.1 PESTEL Analysis

Doing a PESTEL analysis is very important when launching a new product and when considering a new route to market. It is used to take into consideration political, economic, social, technological, legal and environmental issues that may affect the organization, even though the organization does not have control over them.

After the analysis is done, there is a much clearer understanding of the surrounding environment, enabling the assessment of potential risks, as well as of the impact ongoing external factors will have.

4.3.1.1.1 Political Factors

The main political factors influencing the market are:

- Portugal is a constitutional semi- presidential republic.
- The current president is Marcelo Rebelo de Sousa, who was also a president of the Socialist Democratic Party from 1996 to 1999.
- Currently the Portuguese governments' majority is a coalition of several parties, the biggest of which is the socialist party, but is also includes the far-left parties

like “Bloco de Esquerda”, and the Portuguese Communist Party. Thus, the opposition is composed of mainly of the socialist democratic party.

- In the previous term, the socialist democratic party had most the seats.

In summary, Portugal has a very stable government, and the governing party alters between two of the major parties, the socialist party (PS) and the democratic socialist party (PSD). [71]

According to Frank-Jurgen Richter, the government is implementing valuable measures that attract foreign investors, like stability and proactivity, inviting investment [72]

4.3.1.1.2 Economic Factors

The economic factors influencing the market are:

- Current GDP growth of 1,6% according to INE (Instituto Nacional de Estatística) [73].
- Projected GDP growth of 1,4% in 2018 and 2019 [73].
- The end of the economic crisis that started 8 years ago [72].
- Currently in Portugal, there is a big movement for the entrepreneurial spirit. With the creation of many government programs, on a national level, like Portugal 2020, but also on a more local, and more private level, with many incubators and business acceleration programs [74].
- Despite the start-up sector being new, the government offered to co-finance startups this summer (2017), and venture capitalists pledged more than 500 million euros for this sector. [74].
- New company registrations rose from 29 216 in 2012 to 35 555 in 2016 [74].

4.3.1.1.3 Socio-Cultural Factors

Some socio-cultural factors, influencing choices and decisions of the market are:

- Growing awareness of the importance of a healthy lifestyle [75].
- No protest to foreign investment, in areas like electricity, real estate, insurance or banking which is a favorable way to avoid protectionism [72].
- Well-educated young people looking for their first entrepreneurial venture [72].

4.3.1.1.4 Technological Factors

External technological factors that may influence the project:

- Rising use of mobile health applications [75].
- Decline in cost of wearable devices [76].
- By 2021, biometric recognition using wearable devices, will account for the largest market share and generate the maximum revenues [76].
- Companies are witnessing significant improvements in business processes with the adoption of IoT [76].

4.3.1.1.5 Legal Factors

Some legal factors constraining the project are:

- European Legislation:
 - European Commission push for a more strict implementation of safety and health regulations [77].
 - 2006 European Program for Critical Infrastructure Protection
 - Council Directive 2008/114/EC
 - General Data Protection Regulation (GDPR) (Regulation (EU) 2016/679), enforceable from 25 May 2018 [78].
- Portuguese Legislation:
 - Lei 67/ 98 – Lei da proteção de Dados Pessoais [79].

4.3.1.1.6 Environmental Factors

The product will not affect or change the environment drastically, thus environmental factors are not relevant for this analysis.

At most, the impact caused will be from the suppliers' production of circuit boards and wearable bands, that can be considered negligible.

4.3.1.2 Michael Porter's Five Forces Model

Porter's five forces model is frequently used to analyze industries and competitive forces within them. The model dictates that an industry's profit potential is determined to a large degree by one, or a combination of the five competitive forces within the industry.

These forces are:

- 1)The threat of new entrants
- 2)The bargaining power of customers
- 3)The bargaining power of suppliers
- 4)The threat of substitute products or services
- 5)Intensity of competition among current rivals within the industry.

After completing Porter's 5 Forces Model (Appendix A), we can see that the FRMS industry has a medium level of rivalry (3,0). Current rivals present very differentiated solutions for the same problem, be it questionnaires or 24/7 sleep monitoring solutions. However, there are no highly reputable companies with a lot of market share. Mainly due to FRMS not being mandatory in any industry, and their implementation is more related to companies wanting to understand their employees' problems, and keep them happy and healthy, while avoiding losses due to accidents.

The threat of new entrants

New entrants have a fast impact in any industry. Lowering demand for already present players thus increasing competition between rivals. The critical infrastructure protection industry is fragmented, with different companies providing different solutions depending on each infrastructure needs, or critical infrastructures developing their own in-house solutions. There are some legal restraints, regarding employee data privacy and protection, which make it harder for any company to enter the market, as well as implement certain types of solutions.

Thus, the threat of new entrants can be considered medium (3,13).

The bargaining power of customers

Customers have a higher level of bargaining in our scenario. The proposed product is not developed for a mass market but rather for a niche industry. Furthermore, the product should be compliant with different laws, and policies that the company is subject to as well, especially employee data collection, use, storage and privacy. The accuracy of the bio signals and thus the suggestions provided, also play an important role in the bargaining power of customers, giving it a higher rating (3,8).

The bargaining power of suppliers

Suppliers do not have a very strong bargaining power (2,57) since the bulk of the value proposition is produced in house at Cardio-ID. The only component that needs to be outsourced, since it facilitates the process and it is cheaper, mainly due to the need for economies of scale to make wearables market competitive, is the wearable band. Nevertheless, the supplied band must be constructed with a high quality sensor, since this will directly impact bio-signal acquisition, signal noise percentage hence, influencing the signal breakdown and analysis.

The threat of substitute products or services

The threat of substitute products, and services is one of the strongest forces (3,75). This is a result of existing substitute products being already in the market, and can be easily implemented in a varied span of industries. Despite this, the available substitute solutions are very expensive and work only on an *a-posteriori* basis. This being said, substitute products are one of the more threatening factors for the product.

Intensity of competition among current rivals within the industry.

This industry's competition among rival companies is not very intense (2,75), as said before, FRMS as well as biometric authentication is not required by law, so most firms choose to implement simpler and not so secure systems instead, just to have the minimum security required by law. This can be seen as an advantage since with current European security situation, and the constant threat of terrorist attacks, physical and cyber, companies will feel the need to upgrade their security systems. There are no major players with a lot of market share, as the market is fragmented and the services are provided by smaller companies, so there are also no renowned brands in the industry.

4.3.1.3 Identifying Opportunities and Threats

Next, after completing the analysis of global factors that condition the industry, as well as the weighted influence powers of the stakeholders, it is now possible to identify opportunities and threats to CardioSafety.

Opportunities:

- Critical Infrastructures market is very vast
- Safety concerns in Europe
- Stricter security and safety regulations
- Fast deployment
- More concerns about employee health and well-being
- Physical evidence of fatigue issues (employee view).

Threats:

- Hard to change existing processes and mindsets in these type of enterprises
- Personal data protection and collection laws
- Unwillingness of employees to cooperate
- Pressure of substitute products

4.3.2 Internal Analysis

After completing the external analysis, the need to understand the market from an internal perspective arises, thus an internal analysis is due. This analysis allows to understand the companies' strategic position regarding its resources, culture, and company values needed to face the surrounding environment.

Table 2 - Cardio-ID Technologies' resource matrix

		Tangible	Intangible
People/Assets		· Specialized team · High quality ECG acquisition and transmission technology	· Technical expertise · Accredited IST research spinoff · Good contacts in target enterprises
	Systems/Processes	· Patented ECG acquiring and continuous authentication system	· Real-time fatigue detection system · Many years of experience in bio-metric product development and testing

4.3.2.1 VRIO Framework

The VRIO Framework allows for a look at the companies' resources, and see which ones' the company should exploit and why. Above, in Table 2, we can see a Resource-Based View of the company, with the resources that can be considered the main company features.

By applying the VRIO Framework to the resources identified above we can identify those that put the

company in a parity situation, those that are temporary competitive advantages and those that provide sustainable competitive advantage. The analysis can be seen on the next page, in Table 3.

Table 3- VRIO Framework applied to Cardio-ID Technologies' most important resources.

Resource/Capability	Value	Rarity	Hard to Imitate	Organized to Exploit	Value Creation
Specialized Team	Yes	No	No	Yes	Parity
High quality ECG/PPG acquisition and transmission technology	Yes	No	No	Yes	Parity
Real-time fatigue and stress detection algorithm	Yes	Yes	No	Yes	Temporary Competitive Advantage
Patented ECG acquiring and continuous authentication system	Yes	Yes	Yes	Yes	Sustainable Competitive Advantage

To elaborate, each of the above resources will be described, and its value creation value will be explained.

- **Specialized Team:** It is not a significant resource, as many academics and practitioners are interested in bio-signals, and have experience in this area, thus with some work and budget changes, any willing company can organize a specialized team.
- **High quality ECG/PPG acquisition and transmission technology:** For now, this resource may grant a small competitive advantage, as many of the products available in the marketplace today, despite advertising, heart rate variability measuring and analysis do not do this effectively. Providing heavily filtered data, due to motion artifacts and other signal disturbances, that does not allow using this bio-signal for authentication not fatigue detection. However, in the long run it will only allow to achieve parity, since companies are working hard on bringing this data in a clear fashion to the end customer.
- **Real-time fatigue and stress detection algorithm:** As explained before, none of the current methodologies for fatigue detection and management work on an *a-priori* basis. Most of the methods work *a-posteriori* with questionnaires to employees in order to try and assess fatigue. Current state of the art methodologies go a step further, and try to predict how fatigued an employee will be in the future, considering their sleeping patterns and analyzing them with a bio-mathematical model for predictions, this approach has some drawbacks as it can fail in the predictions if data is missing, so the user must continuously

wear the bracelet. However, this advantage can only be considered temporary. Despite requiring a big effort, a system that monitors fatigue can be put together, using different data than the ECG/PPG, and since this part of Cardio-ID's algorithm is not patented, it cannot be considered a sustainable advantage, at least for now. But as for the present it can be the advantage needed to gain traction and be the differentiating factor from the competition.

- **Patented ECG acquiring and continuous authentication system:** For now, it can be considered a sustainable competitive advantage as no other authentication methods seem to provide continuous authentication using ECG or other methods. Despite some research towards this goal trying to be achieved via keystroke dynamics, the products don't seem to be available in the mainstream market yet. Additionally, none of the current authentication formats is geared towards allowing continuous authentication, working very well, but only for single authentications. Hence this can be considered a sustainable competitive advantage, for as long as the patent is valid.

4.3.2.2 McKinsey's 7s framework

For further internal analysis, McKinsey's 7s framework will be used. This framework was chosen, because it emphasizes human resources (Soft S), instead of the traditional production tangibles of capital, infrastructure and equipment, as the team is one of the main factors to make or break, not only the product but also the investor's decision on either to back the project or not.

Additionally, its main goal is to show how seven elements of the company, namely: Structure, Strategy, Skills, Staff, Style, Systems, and Shared values may be aligned, for the company to achieve effectiveness [80].

Strategy

The developed product will be called CardioSafety. It is the fusion of words, cardio, since most of the analyzed data will be acquired from cardiac bio-signals, and safety, which is what the product is trying to help achieve.

Aside from the fatigue monitoring and management, the product will be developed in bundle with an authentication system, that will be explained in more detail later in this business plan.

Skills

In the current stage of the project, the most important skills will revolve around making the product work correctly and effectively. For this, technical skills will have higher importance, revolving around signal acquisition, signal communication, signal processing and analysis, data storage, analyzing acceptable fatigue thresholds, developing suggestions for fatigue mitigation, data

presentation, report building and quality control. Initial business-related challenges will be on developing contracts with suppliers, developing relationships with lead users or development partnerships. These skills are very well represented in Cardio-ID's team.

For latter stages of the development process, some skills are lacking in the team, and are related to business-to-business marketing, customer service, return policies, product maintenance and upgrades. Possible solutions will be outsourcing this workforce, or hiring additional personnel for the in-house team.

Staff

Cardio-ID's development team is composed of highly educated engineers. Their academic work going through Instituto Superior Técnico (IST), Instituto Superior de Engenharia de Lisboa (ISEL), Universidade do Porto (UP), either for a bachelor's degree, master's degree, doctorate, or some combination of those, all in highly relevant areas for the product being developed, including biomedical engineering, computer science, machine learning and data science.

Additionally, all of the members have had previous experience in software and hardware development, in a wide range of companies, from Nokia to Talkdesk, making them an excellent fit for the development of this product.

Roberto de Souza, the business developer of the company, has had many years of experience in developing technology based products, not only in Portugal, but also in Brazil and the USA. Some projects that stand out are B-TECH - Technical resources for technology-based entrepreneurship and VortalBiz – Electronic Purchasing B2B.

Style

Democratic leadership is the leadership style present at Cardio-ID Technologies.

Final decisions are made by the leader, but all members are included in the decision-making process. Creativity is highly encouraged, and the team is highly engaged in projects and in the decision-making process. As a result, team members have high job satisfaction and high productivity. This type of leadership may not always be the most effective style, especially if spur of the moment decisions have to be made [81]. However, the advantages of this type of leadership seem to outweigh possible drawbacks.

Systems and Structure

The product and underlying service will need four full time workers.

They will be responsible for a wide range of tasks including:

- Guaranteeing good work of the back-end architecture

- Guaranteeing good functioning of the wearable bracelets
- Guaranteeing communication between the bracelet and the backend as well as accurate data collection
- Suiting existing functionalities, data display, and reporting, depending on customer needs
- Provide ‘on-location’ training, for both employees as well as their managers, to ensure the product will be used correctly, as well as its advantages understood by both parties.
- Customer support

Feedback from trial runs of the product as well as customers will be highly encouraged, to confirm the strong points of the product, and be able to correct its possible flaws, and not deploy them in the future. Problems will be reported via tickets, using an automated ticket platform, like vtiger, or directly to the sales representative.

Some business model aspects will likely change to accommodate for the changes the product and service will suffer from the obtained feedback.

Shared values

CardioSafety wants to transmit innovation, health, wellbeing and safety.

4.3.2.3 *Identifying Strengths and Weaknesses*

Strengths:

- Innovative solution
- Allows big savings with personnel costs
- 3 in 1 solution (Safety, Health, and Authentication)
- Real time sampling and analysis
- Very hard to hoax
- Proprietary algorithm

Weaknesses:

- Little brand notoriety
- Untested on scale
- Very few acquisitions in the beginning
- Some substitute products with more tested solutions

4.3.3 Competitive Analysis

Following the analysis of the market, from an internal and external perspective, an analysis of the company in its surroundings is needed. In this analysis, classical management tools will be used, such as the Industry Type Matrix, a Product Matrix, Ansoff's Matrix, as well as a SWOT analysis that will cross-reference strengths, weaknesses with opportunities and threats, to discover challenges, restrictions, warnings and risks. Additionally, it will allow to identify differentiating factors from the competition.

4.3.3.1 Industry Type

As it can be seen in the table below (Table 4), the market for Physical Identity and Access Management can be considered in perfect competition, since there are many vendors, and many different solutions, from easy to implement in house solutions, like security guards, to high end proprietary solutions like retina scanners.

Table 4 - Industry type matrix of the Physical Identity and Access Management component of CardioSafety

		Undifferentiated Solutions	Differentiated Solutions
Number of Sellers	One	Pure Monopoly	
	Few	Pure Oligopoly	Differentiated Oligopoly
	Many	Monopolistic Competition	Pure Competition

However, for the fatigue risk management solution part of the CardioSafety product the situation is a little different. For this product, the market has a few sellers, each with a different view on how to manage fatigue and providing solutions that allow to solve those problems, thus the market can be considered a differentiated oligopoly (Table 5).

Table 5 - Market type for fatigue management solutions

		Undifferentiated Solutions	Differentiated Solutions
Number of Sellers	One	Pure Monopoly	
	Few	Pure Oligopoly	Differentiated Oligopoly
	Many	Monopolistic Competition	Pure Competition

4.3.3.2 The Ansoff Matrix

Currently there are various solutions for fatigue management in the workplace, as well as authentication systems. Major competitors will be analyzed further in this business plan.

Most of the solutions work in a “one-size fits all” manner, meaning they all advertise their capability to fit any type of business and solve its problems. On the other hand, this type of solution requires a lot of contact with the customer, not only to model the processes and software correctly but also for support.

CardioSafety, wants to enter the market with a Product Development strategy (Figure 9), developing a product specifically for the Critical Facilities Protection market, focusing on people safety, and wellbeing and infrastructure security.

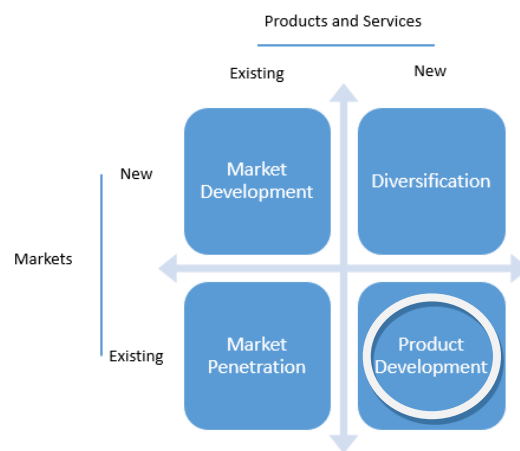


Figure 6 - Ansoff Matrix regarding the company's market strategy

4.3.3.3 Dynamic SWOT

In the analyses, previously done in this document, different aspects of the business were focused on. Strengths and weaknesses (from the internal perspective) as well as opportunities and threats (from the external perspective). Another interesting viewpoint would be to see, how these different perspectives overlap, that is where the dynamic SWOT analysis comes in. This type of SWOT analysis is very interesting from a competitive point of view since it allows to discover challenges, restrictions, warnings and risk by crossing external and internal factors.

Table 6- Dynamic SWOT analysis, cross referencing the opportunities, strengths, threats and weaknesses of CardioSafety

	Strengths 1. Innovative solution 2. Allows big savings with personnel costs 3. 3 in 1 solution (Security, Health, and Attentiveness) 4. Real time sampling and analysis 5. Very hard to hoax 6. Proprietary algorithm	Weaknesses 1. Little brand notoriety 2. Untested on scale 3. Very few acquisitions in the beginning 4. Some substitute products with more tested products 5. Not 100% accurate
Opportunities a) Critical Infrastructures market is very vast b) Safety concerns in Europe c) Stricter security and safety regulations d) Fast deployment e) More concerns about employee health and well-being f) Objective evidence of fatigue issues (employee view).	Challenges (str vs. oppor) 1.+a) Attract “traditional” enterprises to a high tech and innovative solution 3.+ c) + e) + f) Develop a seamless interface that answers the customer needs	Restrictions (weak vs. oppor) 4 + a) Even though the market is very vast, the speed at which it adopts new technologies is slow, and the existence of substitute products with more market experience can condition some of the sales. 1 + 2 + c) Little brand notoriety and no large scale testing may make the product seem as untrustworthy
Threats a) Hard to change existing processes and mindsets in these type of enterprises b) Personal data protection and collection laws c) Unwillingness of employees to cooperate d) Pressure of substitute products	Warnings (str vs. threa) 3 + c) Show employees the advantages of accepting the system, as well as the advantages for their health. 4. + e) Focus strategy, and product quality as the product will be aimed specifically to CIP, unlike the competition.	Risks (weak vs. threa) 1 + a) and 3 + d) Show clients the many benefits obtained, to reduce little brand notoriety problem

4.3.3.4 Development Strategy

Considering that the attractiveness of the industry where the company operates is the primary determinant of its profitability, then a company's positioning in that industry can be considered an important secondary determinant.

Cardio-ID Technologies possesses different strengths, that not only make it a technology based firm, but will also be crucial in choosing the best product strategy (Figure 10).

As presented before, Cardio-ID Technologies has access to a variety of resources that are quite unique, namely, access to leading scientific research, and a highly skilled and creative development team. Additionally, Cardio-ID Technologies was awarded an official spinoff certificate from Instituto Superior Técnico, conveying a reputation of quality and innovation. Combined, these factors, lead to a differentiation strategy. Using these strengths, the company is able to add value to a customer with the uniqueness of the product.

Furthermore, the company would also like to focus on the Critical Facilities Protection market, allowing it to develop a tailored solution with a broad range of product strengths that will contribute for customer loyalty, discouraging other companies from directly competing with the segment.

Some disadvantages of this strategy include other competitors using a focus strategy being able to carve out other sub-segments and serve them even better or a broad-market cost leader being able to adapt its product in order to compete directly.

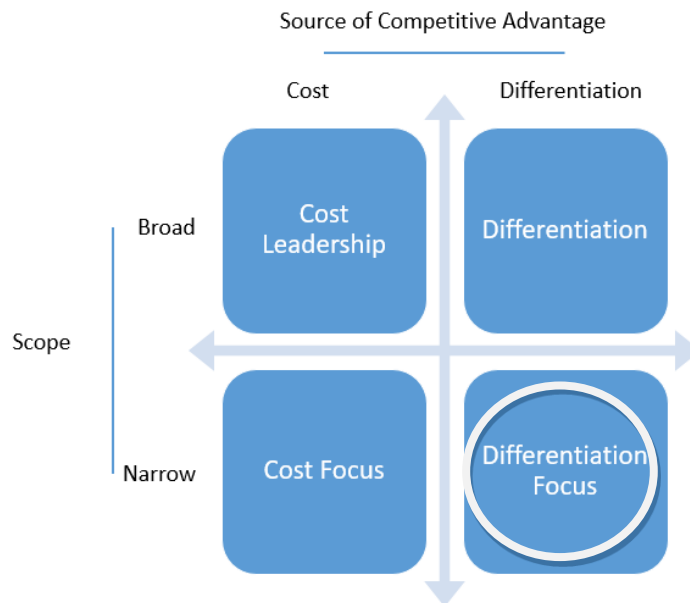


Figure 7- Development strategy to be adopted by CardioSafety, explained on a matrix

4.4 Value Proposition

By analyzing cardiac signals with state of the art patented machine learning technology, CardioSafety objectively measures workforce fatigue levels in real time, allowing companies to make timely changes to task assignment, keeping employees rested. CardioSafety can also perform user authentication, protecting companies from unlawful intrusion into critical facilities. The combination of these functionalities greatly reduces the risk of incidents and accidents.

The path for the development of this product started by discovering the resources possessed in the company. Having in hand a specialized team and the result of their research projects in Instituto Superior Técnico (IST) Cardio-ID Technologies was founded possessing a high-quality ECG acquisition and transmission technology that they readily patented.

After approval of the patent, the company researched the market to discover ways to apply the patented technology to help solve problems in day-to-day situations and that is how CardioWheel was born. CardioWheel was the first product launched by the company and consists of a driving wheel cover that analyzes the driver's cardiac signals monitoring for fatigue and warning the driver if he is exhausted. After achieving the goal of a partnership with Mobileye and Geotab for CardioWheel the company decided to branch out the use of their patented technology once again, looking for ways to use the technology in a product for a different use.

Thus, the need for this business plan arose to formulate the most appropriate product development, marketing and operations strategies for the new product "CardioSafety" as well as study its financial performance.

To review, here we see exactly what is predicted by resource based theory. Technology based companies follow this theory even if they do not realize it. These types of companies start out by having the resources that in many cases come as a product of a research project and the teams that worked on it, find ways to apply this knowledge and finally decide on the goals to be achieved.

4.5 Marketing Plan

4.5.1 Market research

It is very hard to find data regarding the investments and expenditures that companies make safety wise. More so, data about health costs and cost incurred due to incidents. It is not hard to see why companies would not want to disclose this type of information publicly as it is confidential information regarding their employees as well as internal company affairs.

Nevertheless, some more general information could be gathered regarding the industry. It is projected that the “Critical Infrastructure Protection Market is expected to grow from \$72.30 billion in 2014 to \$114.80 billion by 2019” [82], other sources, like strategyr’s Global Industry Analysis, say the market is projected to reach \$94.8 billion, and PR Newswire’s prediction is more conservative, estimating to grow up to US\$82.2 billion by 2026.

According to PR Newswire, the North American Market has the highest share with 34.6%, followed by the Asia Pacific region with 27.4%, which is closely followed by Europe with 25% [83]. If considering the most conservative of the estimates, Europe will have a US\$20.5 billion critical infrastructure protection market.

Above mentioned market studies cover a wide range of industries, technologies, and services. To name just a few where CardioSafety technology can be applied: Defense, Power Production, Railways and Airports.

Additional information was found in regards to airports, as reported by Telefonica, “From the global airport costs, 6% (9B\$) is dedicated to security costs, and this percentage is forecasted to rise even more. “ [84].

On a more national level, in Portugal, there are around 12 000 infrastructures that are considered critical. The country’s leading energy transportation company (REN) spends around €1.597.000 in employee insurance costs and another €829.000 in security costs.

Growth potential and opportunity for the business

There are huge opportunities for CardioSafety in this market.

Companies in all sectors are being pressured not only by external factors such as the European Union’s push to upgrade and introduce new safety measures to protect companies, but also internal pressures, as every day employees care more about their work conditions, their health, wellbeing and work life balance.

When entering any market, challenges arise, and the ability of a company to foresee some of these challenges and approach them in advance can make the difference and dictate if a product will be successful or not.

To elaborate, some of the problems that CardioSafety will face are customer acceptance and brand recognition, as the company is relatively new, and completely new to the critical facilities protection industry. Currently the company has some strengths for dealing with this issue, as Cardio-ID Technologies possesses an IST Spin Off certificate, and a patent for the algorithm that

analyses input data giving some reassurance on the quality of the built products, but especially on the capability of the team, as IST has a very strong reputation of educating very competent professionals in the engineering areas.

Additionally, CardioSafety will also face the need to train future users in the use of the technology, as the technology itself is quite new, and may not be perceptible for users in the first interactions. This problem is easily solved by a few training sessions with both users, and their managers.

Equally important in these situations are worker unions. For instance, air traffic controllers in Portugal, are heavily unionized, so decisions on what technologies to use, also lays in the union's hands. This may be one of the harder barriers to face. A good strategy would be to first talk privately with the union's higher representatives, better tailoring functionalities to the industry, and later bring the product to group discussion.

However, European Union laws and directives, do not solely offer opportunities for CardioSafety, they can add some difficulties as well. Legislation surrounding data collection from employees can act as a barrier to entry, depending on how the employer aspires to use it and for what ends. For now, as the product stands, no problems will ensue, if the data is stored correctly, respecting all security requirements, and the employees are informed of how it will be used

4.5.2 The Product from The Customers' View

CardioSafety features a wide range of safety technologies used for critical infrastructure protection, namely: Access Control, Fatigue and Stress Management, alarms, notification systems and data reports.

This solution covers a wide range of issues in critical facilities protection. By featuring access control, through heart rate variability the product saves a lot of time and uncertainty for the employer, as it guarantees that the person accessing a facility, and logging in into services is in fact the authorized person to do so. Other solutions for this type of control, including two factor authentication are good, however capturing the ECG/PPG waveform of the bracelet wearer goes a step further, and has been called the "Holy Grail" of multi factor authentication in the October 2014 issue of Electronic Products magazine. Considering that critical facilities need to be on the edge of security methods, using cardiac bio signals for authentication seems to be the right route to take.

Additionally, to the authentication features, CardioSafety also analyzes user fatigue. This feature allows for an objective quantification of fatigue for employers. With this data in hand employers can see how well rosters have been planned and if any changes are needed in order to always have employees in their best performing condition, preventing many dangerous situations.

CardioSafety will provide the usual after-sale services: delivery, warranty, service contracts, and especially support and follow-up as the product will be new and input from lead users will be vital for fine tuning the product to ideal performance.

Summarily the product will provide the following features and benefits:

- **Access Control:** Allows the enterprise to seamlessly control who accesses what, and be completely sure that if a user logged into the system or entered a facility, it is in fact a user with the permissions to do so.
- **Fatigue Detection:** Detect user fatigue in real time, keeping the user informed about their current state of fatigue and stress, while also providing managers with timely reports on the condition of the team.
- **Alert System:** By alerting the user that his fatigue condition is entering critical levels, and even before that, the system allows the user to change his behavior as well as take precautions to disrupt the state he is in avoiding possible incidents.
- **Data Reports:** With timely data reports, containing aggregated information about various users in different times of the working shift, cross-referenced with the activity they were performing managers can better understand activities that lead to increased or even critical fatigue and stress allowing for better personnel as well as workflow management that will prevent burn out and critical fatigue in future situations
- **Recommendation System:** The recommendation system works as a preventive mechanism. Recommending the user different suggestions based on the level of fatigue the user is at. Suggestions vary from changing to a less demanding activity, exchanging activities with a colleague to suggesting full rest intervals.

4.5.3 Customers

Growing international terrorism threats, combined with the growing number of natural disasters in each of the European Union member states make for an ever-growing challenge in critical infrastructure protection.

In accordance to CNPCE (Conselho Nacional do Planeamento Civil de Emergência), an infrastructure is considered critical if it's partial or total destruction, dysfunction or unlawful utilization can affect directly or indirectly, permanently or in a prolonged time period:

- The correct operation of the sector it is inserted into, or other sectors
- The correct operation of Sovereign Bodies
- The correct operation of National Security Bodies
- Basic commodities, affecting gravely the social well-being

According to APSEI, (Associação Portuguesa de Segurança) critical infrastructures in Portugal can be divided in two sectors, energy and transportation, and subsequent divisions can be made into subsectors.

Table 7 - Portuguese Sector and sub-sector classification of critical infrastructures

Sector	Sub-Sector	
I Energy	1. Electricity	Infrastructures and installments for electricity production and transportation
	2. Oil Industry	Production, refinement, treatment, storage and transportation of oil through pipelines
	3. Natural Gas	Production, refinement, treatment, storage and transportation of natural gas through pipelines
II Transportation	4. Road Transportation	
	5. Railway System	
	6. Air Transportation	
	7. Maritime Transportation through internal sailable paths	
	8. Maritime Transportation	

Furthermore, critical infrastructures have other characteristics that make them vulnerable, namely the networks and interdependence between sectors. One example is electricity supply. It is done through a complex network of physical infrastructures of huge dimensions scattered in the Portuguese territory. The dimension and complexity of these interactions present only one example of possible vulnerability, where an incident or failure can have huge consequences ranging from regional to international levels [85].

Needs wise, businesses in all these sectors have workers working odd shifts with rotating roasters. Also, workers have to spend lengthy periods of time at high focus to be able to manage their workload, as a simple mistake can have harsh consequences, especially in subsectors 1 to 6. Thus, the need to manage fatigue arises, as a fatigued employee is much more likely to commit mistakes.

In a first iteration, CardioSafety will be aimed towards the Electricity industry as Cardio-ID Technologies possesses some leads for big customers or development partners in this area.

In a further iteration, the Air Transportation, more precisely the Air Traffic Control will be the sector targeted by CardioSafety. Both these sectors were chosen since they have workers precisely in the conditions where CardioSafety would be a valuable contribution for day to day activities.

In addition, both these industries have been in a growing trend. Unfortunately, it was impossible to separate Electricity from Electricity, Water and Natural Gas, in PORDATA Statistics but the sector has been in growth, with business volume growing from 24.049.000,0 to 24.393.000,0 between 2012 and 2015 [86]

The Air Traffic Industry also has an interesting business volume of around 3 billion euros annually [87]. Also, the sector has seen an increase in both, passenger transportation as well as commercial transportation, with +18.6% and +17.9%, respectively [88].

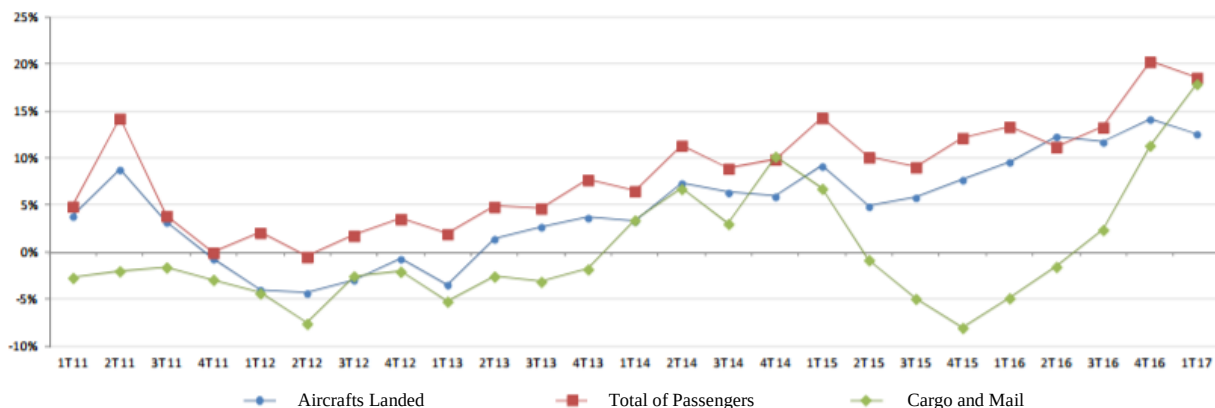


Figure 8- Homologous Variation (%) of airships, passengers and commercial transportation [82]

Cardio-ID Technologies is also working on bringing more safety to road transportation through a different product, the CardioWheel, that works on similar principles as CardioSafety, but uses an off-the-person approach with a cover for the driving wheel for bio-signal acquisition.

4.5.4 Competition

To launch a successful product, it is important to understand what similar products can be found on the market and how current products wage against each other. In this section both direct and indirect competitors will be presented.

As mentioned before, CardioSafety is an aggregation of two separate products: an Access Management System as well as a Fatigue and Stress Management System. Thus, it has competitors from both sectors.

4.5.4.1 Access Management Systems

In the Access Management Systems realm, three types of authentication can be distinguished as can be seen in the diagram below.

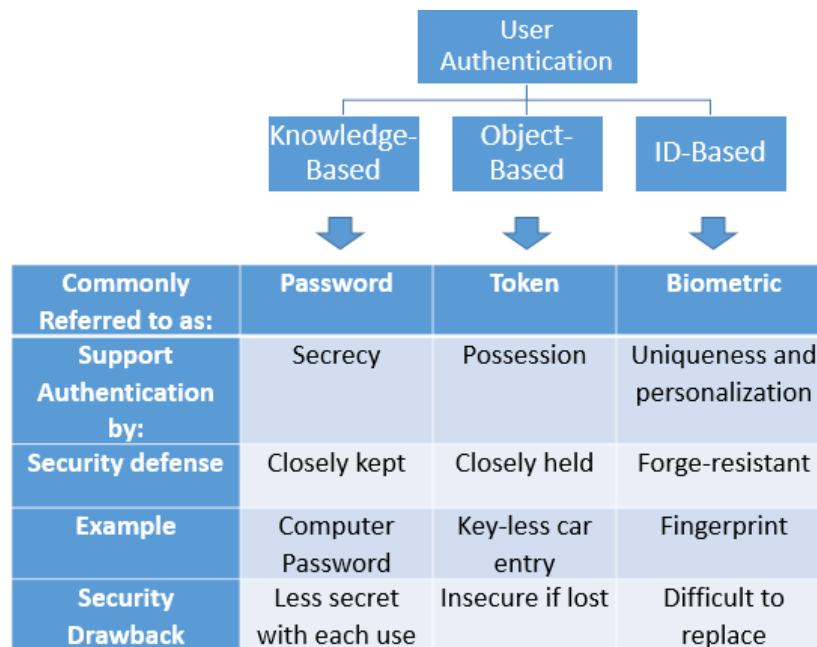


Figure 9 - Three Types of Authentication, their support for authentication, one example and main drawback [83]

Having the basics laid out, there are many more advantages and drawbacks specific to each of the authentication methods. For biometric authentication, one of the most talked drawbacks is the difficulty of replacement, with cardiac bio signals this is not a problem, since if it is not present (like it can sometimes happen to fingerprints due to strenuous hand work), the person is not fit for work.

As far as the need for biometrics usage, over other authentication forms, the bottom line is that when a system is being implemented where “it is critical that the person gaining access is the authorized person, or where security against repudiation is desired”, biometrics is the better choice. [89].

Thus, CardioSafety will be competing with: iris scanners, retina scanners, fingerprint scanners and face recognition solutions, as well as other solutions that use ECG for authentication.

For comparing biometric authentication methods two of the most widely used metrics are: false match rates (FMR), meaning the percentage of invalid inputs which are incorrectly accepted, implying the system incorrectly matched the biometric input with an existing template [81] and false non-match rates (FNMR) or false rejection rate (FRR) which is the percentage of valid inputs that are incorrectly rejected [81], meaning the system failed to match a biometric input with its respective existing template. It is also important to understand that when, used for logical or physical access control, the goal of biometric systems is to deny access to unauthorized individuals under all circumstances, so a low FAR is needed for such an application, even if it comes with the cost of a higher FRR. CardioSafety allows to tune these parameters for different business needs, depending on the client's perspective.

From the listed competitors [89], the one that most closely matches CardioSafety's FMR and FNMR is: Text Independent Voice Recognition With 7% while CardioSafety's values are at 9% (more FMR and FNMR data about other biometric technologies can be found in Appendix D).

Unfortunately values for the closest CardioSafety's competitor, the Nymi Band that uses ECG for authentication, could not be found, but in other independent experiments, performed in 2010 and 2012, testing ECG as an authentication method, the values revolved around 10% – 15% [90], [91]. Nymi Band is the closest competitor as it also presents many of the same features that CardioSafety will offer, from the company's website, it can be asserted that "The Nymi Band is a wearable, multi-factor authenticator that can be used with any application, device or service to deliver always on authentication.

Through a single biometric authentication event, the Nymi Band creates a Personal Authentication Network around the user through its Bluetooth® Low Energy and NFC transports. The Nymi Band can authenticate the individual using a variety of biometric modalities, including heartbeat authentication technology, as well as Apple's Touch ID®, and other strong authentication methods." [92]

4.5.4.2 Fatigue and Stress Management Systems

In the fatigue and stress management field most of the competitors do not seem to have any projects nor representation in Portugal and are more focused on the North American Market. Nevertheless, they will be presented in the chapters and sub-chapters below.

4.5.4.2.1 Time/Shift management solutions

InterDynamics – This company presents a scheduling solution product, and has a proprietary algorithm, designated FAID (Fatigue Assessment Tool). This tool is a "biomathematical model of human alertness response to work and rest patterns" [93]. Analyzing anticipated rosters and actual hours worked, FAID allows organizations to manage fatigue in a systematic way.

The system provides a representative score of the fatigue exposure of a worker based on the following biological determinants of fatigue:

- The time of day of work and breaks
- The duration of work and breaks
- Work history in the preceding seven days
- The biological limits on recovery sleep

“An Hours of Work fatigue modelling approach, which takes into account the above factors, provides greater flexibility and risk management rigor than the mere following of prescriptive hours of service rules.” [93]

4.5.4.2.2 CIRCADIANTM – 24/7 Workforce solutions

According to their website “CIRCADIANTM is the global leader in providing 24/7 workforce performance and safety solutions for businesses that operate around the clock. Through a unique combination of consulting expertise, research and technology, software tools and informative publications, CIRCADIANTM helps organizations in the 24-hour economy optimize employee performance and reduce the inherent risks and costs of their extended hours operations.” [94].

Circadian presents the following value proposition:

- Support companies as they expand from a 5-day to a continuous 24/7 operation, including strategy and business case development and employee change management approaches
- Determine optimal staffing and crewing levels and managing overtime
- Create win-win scheduling solutions for management, unions, and employees
- Gap analyses and fatigue risk assessments of 24/7 operations
- Development of innovative technologies to assess and improve the alertness, performance, health and safety of the 24/7 workforce

Circadian also possesses a tool that evaluates if an accident is likely to have happened due to fatigue or not, based on the shift when the accident happened, and information about the previously worked shifts.

4.5.4.3 Solutions using wearable technologies

4.5.4.3.1 Fatigue Science

Fatigue Science is a company using sleep data to evaluate and predict when a worker will be unfit for work, due to fatigue.

It utilizes SAFTE (Sleep, Activity, Fatigue, Task Effectiveness), a proprietary fatigue model. According to the company’s web site it’s the “world’s leading biomathematical fatigue model. Developed by the US Army Research Lab and validated by the US Department of Transportation”.

For data collection, a wearable band (Radiband) must be used by employees during their sleep hours.

Additionally, workers can visualize their fatigue levels for the day ahead, pinpointing periods of elevated risks. Also, workers are able to view how their sleeping habits influence their fatigue levels [95].

4.5.4.3.2 CAT Smartband

CAT Smartband is an “actigraphy watch that can help you understand the connection between operator sleep, fatigue and accident risk on and off the job site”[96]. Even though it is marketed as a separate product, the CAT Smartband discloses that it is powered by Fatigue Science technology, thus it also utilizes sleep data to make predictions.

The CAT Smartband markets that it will:

- Generate fatigue reports which can be filtered by specific groups and date ranges for detailed analysis.
- Caterpillar will help you integrate this technology effectively and guide you in leveraging the data to build a robust fatigue management system.

4.5.4.3.3 Fatigue Monitoring Patent

After some research on the topic, a patent for “Method and apparatus for real-time measurement and analysis of occupational stress and fatigue and performance outcome predictions” [97] was found. The patent talks about using cognitive and physiological signals, blood pressure, speech analysis, etc. to detect fatigue. Heart rate monitors are mentioned in paragraph 030 and later heart rate is mentioned in paragraph 060, however there are no references or explanations on how these technologies will operate in a technical level, making it really vague and generic. Being this the case, the patent does not seem to have effect on CardioSafety.

For further analysis, a table for competitive analysis was made including different factors, and how CardioSafety fairs with competitors when comparing these factors. Additionally, the factors were ranked by how well they are expected to be represented in the product and how much importance the customer weights on each of the factors.

4.5.4.4 Competitive Analysis

Nymi and Fatigue Science were the chosen competitors for closer comparison, since they are the ones that more closely resemble CardioSafety’s operation.



Figure 13 - Nymi Band and packaging [124]



Figure 10- - REDIband and Fatigue Science software, on mobile and laptop [125]

Table 8- Competitive Analysis Table showing how CardioSafety fares against competitors

This table shows various aspects of the product (Factor column) marking how well they are represented in CardioSafety (CardioSafety column), on a 1-10 scale with 1 meaning strongly represented and 10 being the less strongly represented aspect. Next the strong and weak aspects of CardioSafety are selected. Following, the defining aspects of competing products (Nymi and Fatigue Science) are selected. Finally, the relative importance the customer attributes to the different factors is defined from 1-10, 1 being of the most importance and 10 being of less importance.

Figure 11 - Nymi Band and packaging [124] Figure 12- - REDIband and Fatigue Science software, on mobile and laptop [125]

FACTOR	Cardio Safety	CardioSafety Strength	CardioSafety Weakness	Nymi	Fatigue Science	Importance for the Customer
Fatigue & Stress Management	1	X			X	1
Access Management	1	X		X		3
Price	3	X			X	5
Quality	2		X			4
Selection	6		X			7
Customer Service	3	X				3
Reliability	2	X				3
Stability	2	X				2
Expertise	4	X				4
Real Time Analysis	1	X		X		3
Company Reputation	3		X		X	5
Location	6	X				10
Advertising	9		X			7
Image	5		X			5

In short, from the existing authentication mechanisms, a bio-metric solution, is recommended in situations when it is of the utmost importance to be sure that the person accessing the system is in fact the person authorized to do so, this is the case of critical infrastructures. Unlike other biometrics, like fingerprints or facial recognition, it is impossible to “collect” a sample of the heartbeat to hoax the system, like it can be done with fingerprints.

Also, when talking about fatigue risk management solutions, none seem to be present in Portugal. (Appendix E and 6). From what could be gathered from interviews, roasters are made by team managers and mutually agreed upon in advance, conversely, roasters may be proposed by the team, and agreed upon by the team manager. These methods take into account only legal factors, that depending on the industry, vary mandatory shift time and rest time, for example 3 days working 2 days resting. None of the scheduling solutions consider fatigue, or recovery rates.

Additionally, they only work in a *a-posteriori* manner, and not in a real-time, preventive manner. Unlike previously listed solutions, CardioSafety works in a seamless and timely manner. By analyzing data in real time, CardioSafety is able to take into account stimulants, like coffee, or naps that can alleviate fatigue and are not taken into account by mathematical predictive models. Also, it does not require the wearable to be worn outside of the work environment.

4.5.5 Niche

Cardio Safety will focus on the critical facilities protection niche, even more specifically in the electricity production and transportation industry in a first iteration.

This niche is very attractive for this product. As seen before, critical facilities must have the highest level of protection, not only because of the services they provide being essential for the countries' daily operations, but also because incidents can cause consequences, not only on a regional level but at international levels as well. Also, these types of infrastructures receive funding from different sources, including the EU, specifically for security and safety.

4.5.6 Marketing Strategy

Marketing in the high-technology market, where technology based companies compete can be characterized by three base uncertainties, namely market uncertainty, technological uncertainty, and competitive volatility. The figure below shows this very well.

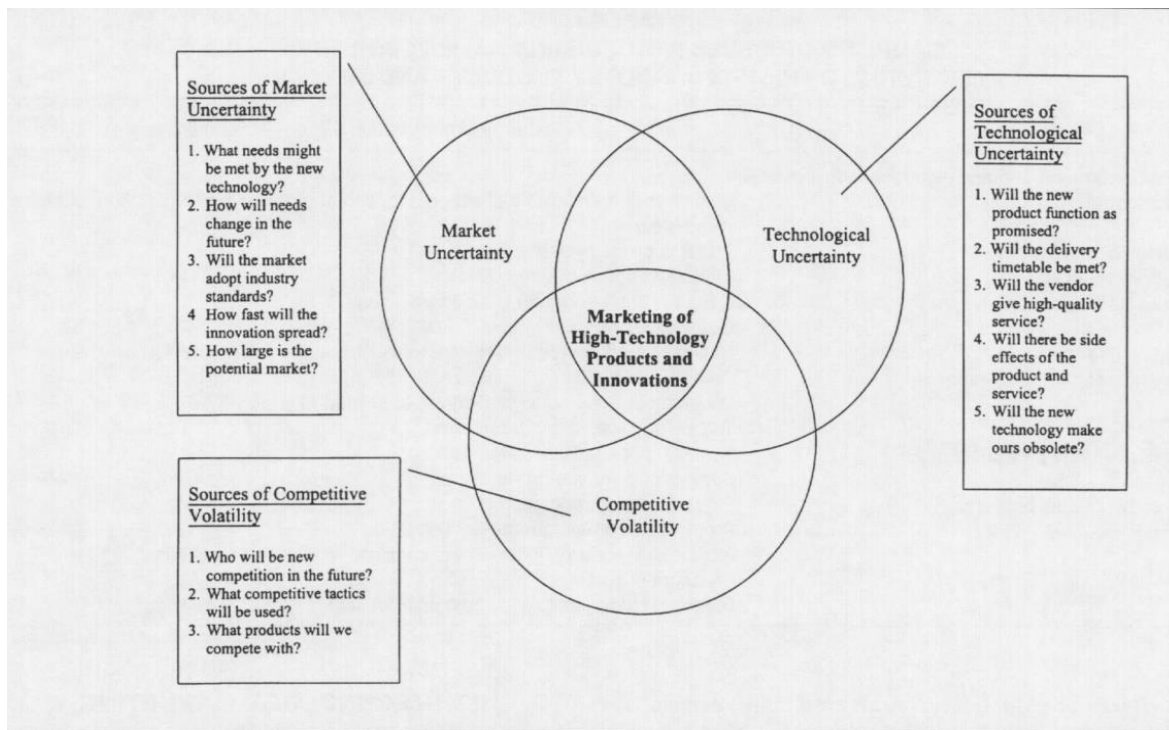


Figure 16- Marketing of high-technology products as an intersection of the uncertainties that define it. [99]

Market uncertainty is born out of the doubt the customers have about the needs that can be satisfied by a particular technology. Fear, uncertainty and doubt about the needs and problems a new technology will try to solve. Due to these factors customers are likely to delay the adoption of an innovation. To dim these effects, a high degree of education and information about the new innovation is required, additionally, reassurance and reinforcement to assuage any lingering post purchase doubts.

Also, there is uncertainty about how fast the innovation will spread. For example, 10 years after their introduction, only 20% of American households had purchased a color television [98].

Recent research also advocates that regarding products and technologies that have competing standards or require heavy investments in complementary infrastructure, initial adoption rates are usually slower. Customers are likely to postpone the purchase until enough other customers have adopted it or until the standards issue is resolved and it becomes evident which technology will move forward.

Thus the need to adopt a marketing strategy that reduces the perception of risk, hence reducing the barrier of adoption becomes a fundamental issue for the introduction and the commercialization of high technology products [99].

Possible Solutions

The first step in this strategy is to co-develop the product with lead users. Through co-development, product co-design and joint problem solving, not only the seller can reap many benefits such as “identifying new applications, lowering development costs and improving development cycle times” but the buyer is also benefited by influencing performance attributes, gaining access to new technologies ahead of competitors [100], [101].

According to Dweyer [102], new product development is positively influenced with cooperative competency of the new product development partners. Additionally, co-development relationships soften information asymmetry since it generates an environment where “sellers can cooperatively develop and share the capabilities of newer technologies while buyers impart important and often tacit information about their operating environment.” [101]. If sellers engage in co-development relationships with knowledgeable buyers they also leverage the development efforts by gaining access to the technological and market expertise of the buyer [103].

Frels, Shervani and Srivastava [104] point out that product performance is not the only determinant in organizational adoption decisions for high-tech products, but instead the relative strength of the product’s networks, this meaning, users, complementary products, and producers have more influence in adoption decisions.

According to Robertson [105] a firm can use bundling strategies in order to reduce customer uncertainty, as well as further showcase the product’s strengths. New products can be bundled with established technologies and brands to signal consumers concerning the product’s reliability and quality. This also serves as a signal of availability of complementary products and conformance to a common technological standard. Consumers are likely to assume that makers of a high-quality brand are more likely to ally the brand with other high quality products as not to damage the brand’s reputation [106].

As for establishing a customer base, new entrants face the challenge of creating a customer base while risking facing a reaction of companies more established in the market. Pre-announcing the launch of a new product technology is one of the options when a firm is new to a technology [107].

Analyzing CardioSafety's case, pre announcing the technology will likely bring advantages that outweigh disadvantages since it has a low market-share, low competitive reactivity and needs to establish industry standards [105]. Additionally, clients in the target industries have lengthy decision processes, will have high learning requirement and the product needs a complementary product to operate [105], the wearable bracelet.

Regarding how early the product should be pre-announced, a good rule of thumb is to pre-announce it the same amount of time it takes the client to make a decision. For example, if it takes a company one year to decide on which technology to further adopt, the pre-announcement should be made one year beforehand, as for the technology to be considered when planning purchasing.

Considering CardioSafety's position, developing a pioneering technology and further monetizing it will make this product a first entrant in the market and as with all things, being a first mover has advantages, but also disadvantages. Many pioneer companies gain lasting market share and being the first entrant allows them to choose the most profitable market segments and optimal product positioning [105].

Moreover, a new entrant can also ensure that the developed product is compatible with other products already in the market, thus reducing switching costs for customers. It is also advantageous if an alliance with a company already identified with the technology is possible, thus amplifying market reputation and opening access to complementary marketing assets [107].

Regarding disadvantages, the most important is of course being that new products fail, followed by higher R&D costs and the risk of going to market with a sub-optimal product or premature technology [105]. Additional advantages and disadvantages for being a first mover can be found in Appendix 3.

Considering the above information, CardioSafety's marketing strategy will need to face different types of market uncertainty. In order to reduce this market uncertainty, the product will be co-developed with a company that possesses critical facilities, or with lead users in the industry to correctly understand customer needs. Currently Cardio-ID Technologies is working on leads to find a partner for this co-development venture. Furthermore, to reduce customer uncertainty and risk perception, thus diminishing decision time and support product adoption decisions, the product will be marketed as a bundle with an access management component and an attention level solution through a partnership with Peformetrics.

Promotion

Generating sales is difficult even during good times if you have an established product, having a new high-technology product aimed at businesses only magnifies the challenge. Further magnifying the challenge is the changing nature of sales processes. Lead generation has changed from “traditional cold calling or meet in-the-street selling, to digital demand generation, leaving companies to re-craft their sales and marketing functions” [108].



Figure 19- Customer Generation Funnel

Figure 20 - Gantt chart with the product development stages, and their respectful duration
Figure 21- Customer Generation Funnel

In the past, sales teams were responsible for lead generation, nurturing and closing business. In the present days, the process has changed. Being able to target a potential client directly using web-based tools, changed the entire chessboard for sales and marketing teams in a variety of companies, from different sectors.

It is important to take advantage of digital advertising and lead generation to increase efficiency in sales and marketing [108].

Another essential point is to define the sales funnel (Figure 16) which goes through four steps. First, arises the need to correctly characterize customers. A possible customer that is not aware of the company's products and services is a “suspect”. Suspects can be generated using a variety of techniques namely: Content marketing, Search Marketing, Social Media Marketing, Email Marketing, Pay-Per-Click and Paid Advertising [109].

Further down the sales funnel are prospects. Prospects are the type of people that are aware of the brand, but do not know how to engage as a customer – how the brand can be used. They need to research more about the benefits the company can bring, and how it compares to the competition.

Online sales and marketing programs can be very helpful to determining who the prospects are and how they can be lead to the lead stage [108].

After doing their research on the company, the prospects transform into a true lead. Now the marketing team can build a relationship using digital marketing techniques to earn the lead's business when the time is right.

Finally, using ongoing nurturing campaigns, aligned with lead scoring, the lead can become an opportunity for “personal sales follow-up and, finally, a customer acquisition” [108]. It is critical to understand that the sales funnel starts well before the lead stage in order to align marketing with sales and take advantage of the power of new digital marketplaces.

Another important technique in acquiring leads in business-to-business (B2B) marketing is the use of influencers. Business decision makers do not simply “ go to a website, add a data center to their shopping cart and check out” [110], the typical sales cycle for technology software typically ranges from 12 to 18 month. Reaching B2B decision makers is difficult, they are sophisticated, well-educated and extremely skeptical about marketing, cold calling them is very difficult and they rarely read press releases or company websites, before they decide it’s time. This is understandable, as they are the most marketed-to segment online. Here is where influencer marketing comes in. In the consumer space, influencer marketing in the consumer space is straightforward. There are networks in the market (like Clever and InstaBrand) that have established relationships with Youtube, Instagram and Snapchat influencers. In the B2B space it gets more complicated. Not only is it important to know how many followers the influencer has, but also keywords and topics they are discussing, that way pitches and content programs can be crafted in order to deeply resonate with what they care about. Influencers push the market, they create the conversations everyone talks about. They are the driving forces behind buzzwords, new markets and they influence search terms. When an influencer talks about a certain topic in a particular way, and is repetitive in the used terminology, other people will start searching for that language.

Due to the complexity of this process, Cardio-ID Technologies will outsource the product marketing process to a specialized company, being able to focus on product and feature development. Later moving the marketing to in-house if it is necessary. Pinpointing the right influencers is the first step.

Additionally, to digital marketing, there is a variety of outlets and events that would be of interest to showcase CardioSafety. In this case, it would be better for the development team to attend these events, due to the complexity of the product, making it easier for customers to have all their questions answered.

Critical Facilities Summit [111]– Allows for contact with different industries and the way they do business. Important opportunity to discover pains that were not identified before. Also, interesting for future internationalization strategy.

Health at Work Summit 2017 [70]- “The changing nature of work, unpredictable environmental factors and the tightening of health and safety penalties mean that reviewing and strengthening your health and wellbeing strategy is now more important than ever”.

10th International Conference on Managing Fatigue [79] – “The "Managing Fatigue" conference series is an established and respected forum for research updates and discussions within the fatigue management community.”

Additionally, advertising in Ground Support Worldwide[112] magazine and Air Traffic Management magazine [113], could also be interesting, but perhaps in later stages of the process

and on a second iteration of the product, specially due to the difficulty in calculating the return on investment in these types of advertising campaigns.

Pricing

Analyzing the competition pricing in the table below, and considering the focused differentiation product strategy, and bundling marketing strategy explained in the previous section we can estimate an adequate price for the possible products and products bundles.

Table 9 - Competitors' pricing

Brand/Company	Product Name	Price	Source
Nymi	NymiBand	\$150 - \$200	Source
InterDynamics	FAID	\$1250 – \$10 000 + variable yearly fee	Source
Fatigue Science	ReadiBand	\$250/band + \$10 each report	Source

It can be observed that Nymi charges \$200 per bracelet, but installation costs, demonstrations and maintenance are not mentioned.

Next, InterDynamics is the most expensive solution of all having a varying value from \$1250 – \$10 000 depending on the features required by the customer, and the size of the organization.

The middle-priced product seems to be the ReadiBand, however, \$10.00 per report per user can add up to hefty value by the end of the year.

Now, the assumptions for CardioSafety's pricing. It is important to remember that this is a high-technology based product, aimed at critical infrastructures, that have to work 24/7, and where a mistake can lead to costly damages or even deadly outcomes, so the product must have a high precision, accuracy and deliver on all promised functionalities.

Considering an absolute minimum scenario of 40 working hours per week and the need for 24h coverage, translates into the need to cover 168 hours per week (24×7). $168/40 = 4.2$, or 5 full time employees.

However, most companies use at least two people per shift for a variety of reasons: as a failsafe mechanism, make the position less monotonous, or even because they are required to do so by law. Thus, the minimum number of workers is 10 (5×2).

This translates into a need of at least 10 wearable bracelets, per customer. Each bracelet costs €180.00, (this price is the highest possible acquisition price, no commercial discounts are taken into account, and the price is explained in more detail later in the Suppliers section). Adding a small premium for Cardio-ID, to compensate for possible extra taxes, ordering and handling times, will sum up to €200.00 per bracelet, adding €2000.00 to the total cost. Since the European warranty policy is 2 years, one can assume that is the lifespan of the product, as the manufacturer must replace or fix the product if it becomes unusable inside that time window, adding it a €1000 per year ($2000/2$) to the price of the product.

Table 10- CardioSafety pricing, dependent on the chosen product bundle

	Cardio Safety – Fatigue Only	Cardio Safety – Fatigue + Authentication	Cardio Safety – Fatigue + Authentication + Attentiveness*
Wearable Band Price	€ 2,000.00	€ 2,000.00	€ 2,000.00
Software Year Licence	€ 1,500.00	€ 1,900.00	€ 3,000.00
One Time Deployment Fee	€ 500.00	€ 700.00	€ 750.00
First Deployment	€ 2,000.00	€ 2,600.00	€ 3,750.00
Year Total for 10 workers	€ 2,500.00	€ 2,900.00	€ 4,000.00*

*This product will be developed in partnership with Performetric, a company that measures attentiveness via keystroke dynamics and mouse movement on screen. Thus, the price for this version of CardioSafety also includes the fee for Performetric, of €1200/year (10 workers x 12 month x €10/user fee), in case no partnership discount is negotiated.

The deployment fee will be offered to first time clients or for the installation on the first facility, this way offering an incentive for being the first to pay, plus it works as a nice incentive for companies that sign up for the project upon pre-announcement, or in any events promoting the product launch.

Proposed Location

Currently, Cardio-ID is very well positioned. Being incubated in AUDAX-Labs, it is situated in the center of Lisbon and in the center of the country, making any location accessible by a five hour drive in the worst case scenario.

Most companies also have their headquarters situated in Lisbon, giving Cardio-ID a good positioning since its proximity allows for face to face meetings with company stakeholders and easy, on location, troubleshooting in case something is not working correctly.

Distribution Channels

Given the market niche where the product will be inserted, and the companies that it will be developed for, it is very hard to leverage more modern selling and distribution techniques, like e-commerce, for CardioSafety.

Additionally, high technology products must be well understood by the customer. The customer needs to correctly understand what advantages they will gain through product adoption, and what pains will be solved and how. Subsequently, CardioSafety should have its own, highly informed sales team, thus being able to answer any question the client may possibly have converting leads into customers.

This being said, it is important to not forget that extensive information about the product has to be available online and on request, for lead acquisition.

4.6 Operational Plan

Daily operations will be very similar to those of a software development company. Software will be developed using SCRUM methodology. Customer service and inventory control will be done using a CRM tool called “vtiger” [114].

4.6.1 Production

In this section, different methods inside the company will be explained, in order to understand the processes and methods underlying in product development, quality control, customer service, sales process and inventory control.

For product development (Figure 17), a SCRUM methodology will be used. Because using this methodology it is easier for the project to be flexible, allowing to accommodate changes that will cater to customer needs during the development process.

Quality control in SCRUM development will be done by the product owner. The product owner can monitor his projects, and evaluate quality assurance activities to ensure the team continues to agree and comply with the quality standards that have been set.

End-to-end quality assurance may be addressed during final testing of the product, a Release, or a Sprint. A comparison of the number of issues encountered versus the number of User Stories completed can be done. The product components that have defects can be incorporated as Prioritized Product Backlog Items (PBIs), which can be worked upon by either the team or by one person at certain times during the Sprint, depending on the number of defects.

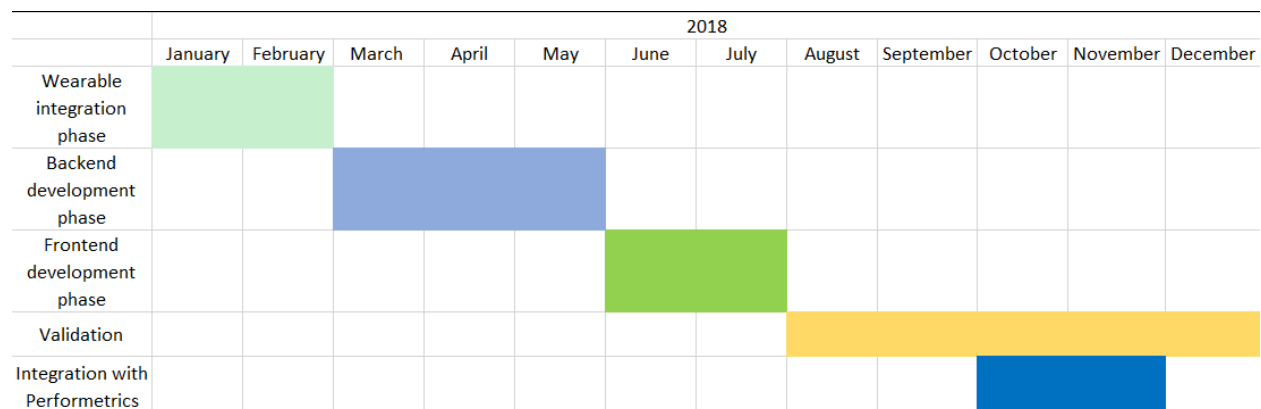


Figure 22 - Gantt chart with the product development stages, and their respectful duration

Figure 23- Simple diagram describing how the sales process will be controlled in vtiger
Figure 24 - Gantt chart with the product development stages, and their respectful duration

4.6.2 Customer service

Customer service will be done through an automatic “Customer Portal” available also in vtiger that operates via a ticketing system, where the user submits a ticket explaining the issue

occurred, the development team gets the ticket and answers when the problem is solved or asking for more information. This will be the case in later stages of the product life cycle.

In the beginning, problems will be directly reported to the team via telephone, or to a member of the team dispatched to the occurrence site, this way developing a closer and stronger relationship with the lead users/co-developers.

4.6.3 Sales Process



Figure 25- Simple diagram describing how the sales process will be controlled in vtiger

As it can be seen in Figure 17, vtiger covers all steps of the sales process from contact to invoice. The process is very straight forward. When a lead is converted, Cardio-ID (“Organization” in the image) gets in touch with the customer proposing the product, thus creating an opportunity, this influences the sales forecast and a Quote with the price is generated. When the quote is accepted by the customer (via eSignature) the quote transitions into a sales order and the client is invoiced. In the beginning this process will go through a more manual process, with contacts being done personally, with product presentations and show-cases. The approving of the quote will also be done in person, in order to again, strengthen the relationship with lead customer or co-developers.

4.6.4 Inventory control

Inventory control (Figure 18) will be fully controlled in vtiger. This CRM allows to keep track of the product every step of the way, from a closed deal, to shipping, also managing payments and stock levels. Describing the process in more detail: after a deal is closed, a sales order is sent to the system, triggering the shipping process, and the inventory control processes (for first installations), also creating an invoice and sending it to the customer. If it is not the first installation, vtiger sends an invoice of the product subscription to the customer for payment.

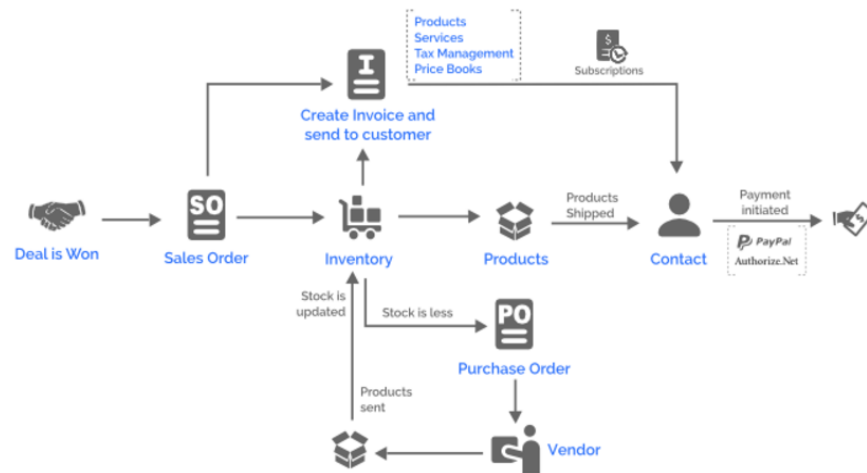


Figure 28 - Simple diagram describing how the inventory will be controlled in vtiger.

Figure 29- Organizational Matrix of Cardio-ID TechnologiesFigure 30 - Simple diagram describing how the inventory will be controlled in vtiger.

4.6.5 Legal Environment

Legal environment refers to legal surroundings that currently affect or will affect the project. It is a bundle of acts, rules and regulations defining what the project is able and unable to do.

Legal environment is majorly concerned with:

- Protecting the interests of clients, companies, employees and society.
- Present grounds on which projects activities can be performed. Encouraging or restricting activities by providing facilities to law abiders and punishing lawbreakers.
- In case of biometrics the main concerns for their use fall on:
 - Environment, purpose and efficiency for their adoption
 - Transparency and security when biometrics are in use.

Projects must be certain that their activities conform to laws and must comply with legal provisions in effect.

4.6.5.1 Regulations Regarding Biometrics in the Workplace

Regarding Biometrics in the workplace, a series of requirements exist, that are imposed by the European Union, namely, the General Data Protection Regulation, the Data Protection Directive, and Data Protection Acts

These regulations address Europeans' concerns about their privacy and personal data usage through:

- **A right to be forgotten:** "When an individual no longer wants her/his data to be processed, and provided that there are no legitimate grounds for retaining it, the data will be deleted" [115]
- **The right to know when one's data has been hacked:** "Companies and organizations must notify the national supervisory authority of data breaches which put individuals at risk and communicate to the data subject all high-risk breaches as soon as possible so that users can take appropriate measures." [115]
- **Data protection by design and by default:** 'Data protection by design' and 'Data protection by default' are now essential elements in EU data protection rules. Data protection safeguards will be built into products and services from the earliest stage of development, and privacy-friendly default settings will be the norm.

Proportionality is also a concern regarding biometrics in the workplace.

According to [Section 2\(1\)\(c\)\(iii\)](#) of the Data Protection Acts states that data *"shall be adequate, relevant and not excessive in relation to the purpose or purposes for which they were collected or are further processed."* [116]

The key point here is "excessive", thus the first question that must be answered to justify the use of biometrics is if the problem can be successfully solved using less intrusive methods.

What is excessive requires a case-by-case analysis. A few factors which are factored into the analysis are:

- **Environment:** "Does the nature of the workplace require high levels of security? Are there areas containing sensitive information, high value goods or potentially dangerous material which may warrant a higher level of security than would areas with low value goods or areas with complete public access?" [116]
- **Purpose:** "Can the intended purpose be achieved in a less intrusive way? A biometric system used to control access for security purposes might be more legitimate than a system used by the same employer purely for time management purposes." [116]
- **Efficiency:** "Ease of administration may necessitate the introduction of a system where other less invasive systems have failed." [116]

In the case of critical facilities, we can recognize that the environment requires high levels of security, not only for handling sensitive information but also because any error or unlawful meddling can have severe consequences, not only for the operator, but also to many other individuals.

As for purpose, critical facilities need to be on the front line of safety and security due to the crucial role they play in a wide range of national and international affairs. Furthermore, it has been backed up by different studies that people in general are bad at evaluating their personal level of fatigue, hence, a-posteriori fatigue assessment tools are not the right fit in industries where a fatigued employee may put in danger not only his, but other people's lives.

Employing biometrics also needs some degree of transparency as “Section 2D of the Acts require that an employer provide at least the following information to employees when processing their data:

- The identity of the employer.
- The purpose in processing the data.
- Any third party to whom the biometric data will be given to.” [116]

Security wise, the requirement, under section 2(1)(d), it that the employer has appropriate security measures in place to prevent the unauthorized access to, or the unauthorized alteration, disclosure or destruction of data would appear to promote the use of technological solutions such as encryption.

Additionally, REGULATION (EU) 2016/679 of the European Parliament, will be strictly enforced starting from 25 May 2018, as it does not require national governments to pass any enabling legislation, and is thus directly binding and applicable [78].

Besides the mentioned above EU directives, Portuguese law also determines that a request to CNPD (Comissão Nacional de Protecção de Dados) must be made to analyze the legitimacy of the need to collect personal data for the project specified. This formal request need to specify the following aspects: i) a person or company responsible for the data ii)categories of personal data that will be treated iii)receivers of the data and under what conditions iv)to what end the data will be used v)entities where data may be transmitted to vi)low long the data will be stored vii)how can an individual access his data and rectify this data viii)expected transfer of data to other countries ix)eventual interconnections of data from other sources or companies x)brief description that will allow for a preliminary analysis of the effectiveness of measures taken to guarantee the security of the data.

A more detailed description can be found in the directive itself “Lei da Protecção de Dados Pessoais (Lei n.º 67/98 de 26 de Outubro)”. [117]

Summarily, security wise, four points have to be considered namely: the state of technological development, the cost of implementing such technology, the nature of the data being protected, the harm that might result through the unlawful processing of such data [116].

4.6.6 Patents

As of December, 2014, Cardio-ID Technologies has been granted a patent for “Device and method for continuous biometric recognition based on electrocardiographic signals”, Publication

number: US 2014/0361871 A1, and it is valid in Portugal, USA, Japan and is currently pending in the EU, Brazil, South Korea and Canada.

This patent protects the intellectual property behind the continuous authentication process using ECG, that will be used for CardioSafety and that is currently in use for CardioWheel.

4.6.7 Management and Organization

Cardio – ID Technologies is a technology based startup, thus its development team is heavily composed of its founders. The company also does not have many employees so its organizational structure is quite lean. An organizational matrix can be found below.

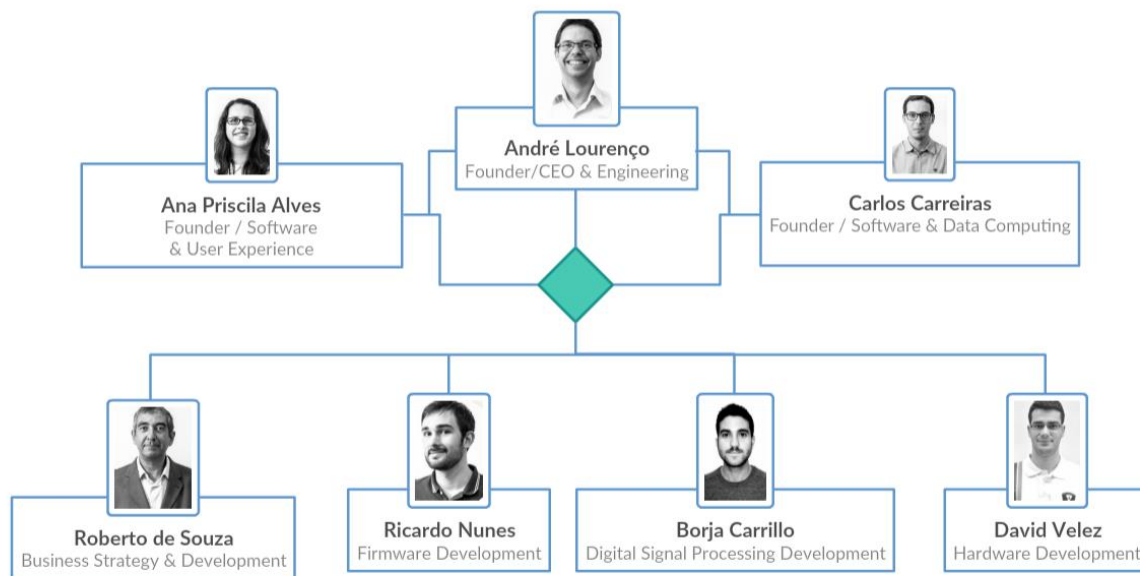


Figure 31- Organizational Matrix of Cardio-ID Technologies

Figure 32 - Business Model Canvas applied to CardioSafety Figure 33- Organizational Matrix of Cardio-ID Technologies

4.6.8 Personnel

Ideally, for the development on this product a team of four professionals will be needed. In the table below, their functions description as well as academic background will be described.

Background	Function Title	Functions Outline	Nice to have previous experience
Electrical Engineer	Back-end developer	Bio-signal acquisition	Previous experience with IoT products

		• Back-end architecture design and implementation • Communication to back-end architecture • Data storage	and/or bio-signal processing
Bio-Medical Engineer	Product Developer	• Signal Analysis • Determining fatigue thresholds • Develop relevant alarm system • Develop pertinent suggestions for users and management	Previous experience in Bio-signal processing.
Software Engineer	User Experience/User Interface	• Display acquired fatigue data at different granularities • Display suggested actions for fatigue management • Produce comprehensive fatigue reports for management.	Previous experience in data display and reporting.
Business/Management	Business Development	• Lead Pursuit • Requirements Gathering • Partnership development • Contract Negotiation with suppliers and customers	Previous experience in business development of technology based products.

As it can be seen, the current team working at Cardio-ID Technologies has the expertise as well as the know how needed to successfully develop the product.

Another nice-to-have for all personnel would be experience using Agile methodology, as the product will likely need to accommodate many changes during its development.

4.6.9 Inventory

The inventory that will be kept is wearable bands and electronic components, thus Cardio-ID will not incur on additional costs for storing.

Regarding lead-time for orders, one month and a half can be considered reasonable for some components that are ordered from China, as that is how long it takes for them to arrive in Portugal without additional shipping costs, other delivery services and origin countries have shorter delivery times, but usually, higher costs.

4.6.10 Suppliers

CardioSafety can work with any wearable band that transmits RR intervals to the CardioSafety software. This considered, the wearables market is very fragmented, with each major wearable manufacturer having a device that supposedly sends RR interval data to an app of the user's choosing for analysis.

However, after testing done by Marco Altini [97], wearables like the Scosche Rhythm+, or the Mio alpha armband, heavily filter the signal in order to correctly measure heart rate, thus not providing accurate RR intervals.

Additionally to providing accurate RR intervals the wearable band also needs to transmit the data via Bluetooth Low Energy and have an open API(Application Programming Language).

For now, there are two possible candidates to be used as the wearable band in the product, are PulseOn and ZoomHRV. Both have the needed features mentioned above. Next, both wearables will be described in more detail.

ZoomHRV

ZoomHRV, a wearable designed to move past heart rate monitoring to more sophisticated heart-beat analysis. As for now, the company does not ship to Portugal from their website, but an inquiry regarding the situation has been made and, it is only possible to order the product internationally from amazon.com which will add additional costs of \$51 to the order, pricing the product at \$190,99 [118].

Pulse On

The PulseOn wristband stands out for a couple of reasons for use as the wearable band for CardioSafety:

- 1) the company implemented the standard Bluetooth low energy heart rate profile, therefore allowing any app to communicate with the sensor pretty much like a Polar H7 would do
- 2) the company also put some effort in providing reliable beat to beat data and not only averaged heart rate as output, as many brand with more notoriety are doing.

Additionally, PulseOn provides B2B tailored solutions, allowing Cardio-ID to develop a band ideal for CardioSafety, as well as custom brand it.

There is an older version of the band available for sale at [amazon.co.uk](https://www.amazon.co.uk) for £37.00 [119], and has an added £6.00 for shipping and handling, totaling at £43.00 (€47.00).

On the company's website, the most recent version of the wearable is retailing at €159.00, adding a €20.00 shipping fee [120], will total the product at €179.00. As the company is based in Finland, so no further importation fees are expected.

Both bracelets come with a 1 year guarantee, and 15-day defect swapping policies.

In general, prices in the wearables market have been declining very quickly, so a price surge is not likely to happen, nor a supply is likely to end, in case one suppliers ceases to exists or produce certain product, it is not hard to find a replacement, and with some tweaking of software make a new wearable work with the analyzing algorithms.

In conclusion, for initial development and testing, Pulse On will be used, as it is the more affordable version, has two possible suppliers, collects and communicates quality heart rate variability data, and can produce a custom version with custom characteristics if necessary in the future.

4.7 Business Model

The business model canvas will present an overview of the whole project, it will work as a summary, of everything that has been presented in this document before. Each section of the canvas will be explained in more detail, as well as each item if necessary.

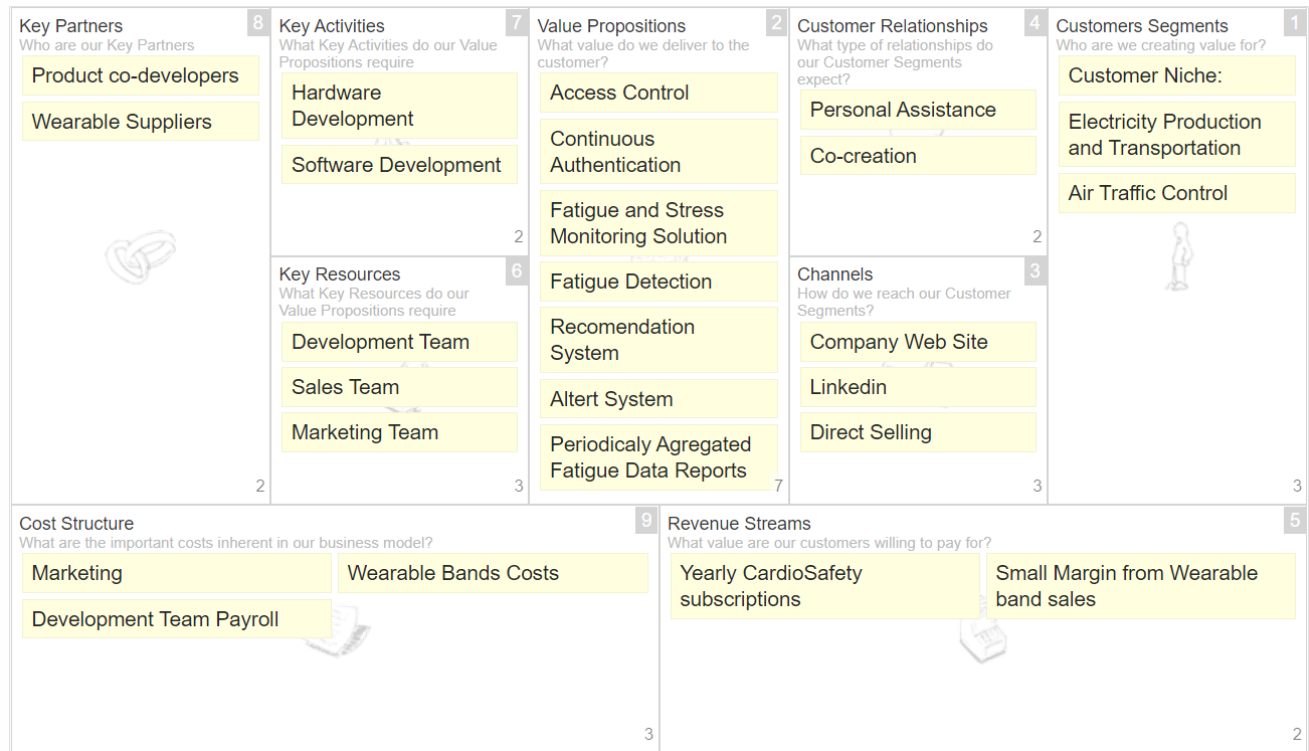


Figure 34 - Business Model Canvas applied to CardioSafety

Table 11 - Financial Plan - Exportation Sales

- Customer Segments:** As defined before, CardioSafety will be targeted towards niche industries with business-to-business propositions, and not the consumer technology market. It will be available for industries in the electricity production and transportation, on a first iteration, and will later be available for the air traffic control industry, in a second iteration. These industries were chosen since they have working positions that have to be monitored 24/7 and require workers to spent long periods of time highly focused, which is the perfect setting for elevated mental fatigue that can lead to accidents due to operator fatigue.
- Value Proposition:** CardioSafety's value proposition for the customer is the ability to monitor and mitigate employee fatigue in real time. Providing features that include fatigue and stress detection, recommendations to the employee for mitigating fatigue, alert systems for the operator to know when he is not in working conditions, as well as for the team leader or

manager. Also, regular aggregated team fatigue reports can be produced for managers for better shift and workflow organization. Reducing the risk of dangerous accidents that could happen due to operator mental fatigue, or low focus.

3. **Channels:** As evidenced before, CardioSafety will have its own sales team, due to the highly innovative and highly technological nature of the product. Customer leads will be generated through direct selling, social media campaigns on Linked-In and other B2B marketing strategies, like the use of influencers. Direct selling is very important for a company like Cardio-ID, as it grants many conveniences for the customer, like personal demonstrations, on site training and satisfaction guarantees. Also, this is a great way to establish long lasting relationships with the customer, and once again gain insight into the preferences of big customers. Return on investment on direct selling also tends to be higher and allows for the company to control, brand image and company positioning. The drawback being that the this channel, is limited in it's possible reach, creating dependence on people that can quit the company and take their clients with them.
4. **Customer Relationships:**
 - 4.1. Co-creation:
 - 4.1.1. Co-creation is very important for CardioSafety. By changing the relationship with the customer and involving them in the design and creation of the product, gives them greater ownership of the product, often resulting in the creation of product or brand champions in the market. Additionally, by closely listening to co-creators and lead users, the product can be better tweaked to best suit the industry needs.
 - 4.2. Personal assistance:
 - 4.2.1. CardioSafety's customer relationship will be characterized by human contact. Customers will have the ability to directly interact with the sales representative while making their purchase decision or later for customer support.
5. **Revenue Streams:** Revenue from Cardio-Safety will come from sales of the wearable bands, and from a yearly fee paid for software usage by client companies.
6. **Key Resources:** Key resources are pretty straight forward. The product is a technology based product that will leverage current technologies to help fight worker fatigue. Thus the most important resources will be the development team, for both components, hardware and software. A little further down the development process the sales and marketing teams will have a very important role to play as well, in identifying more customers besides the co-creators of the product.

7. **Key Activities:** As marketing activities will be outsourced and not done in-house, the key activities that must be done by Cardio-ID in order to successfully develop the product are, hardware and software development.
8. **Key Partnerships:** The identified key partnerships are wearable suppliers, as the product can not work without a wearable bracelet, and Cardio-ID is not able to produce them in a cost-efficient manner, like a industrial supplier can, thus making them the main partner. Also, co-developers are considered partners, as depending on the nature of the developed partnership, partners can not only have access to state of the art technology before competitors but also divide the development risk with Cardio-ID.
9. **Cost Structure:** Cost structure is also simple to understand, as the costs that Cardio-ID will incur are the outsourced marketing costs, the acquisition cost of the wearable bands and the payroll of the development team, some costs will likely be put aside as contingency cost in case of unforeseeable circumstances.

4.8 Financial Plan

The financial plan consists of a 10 years projection of sales (Appendix G.1, Appendix G.1.1, Appendix G.1.2), costs of goods sold (Appendix G.2), supply and external services (Appendix G.3), personnel costs (Appendix G.4, Appendix G.4.1, Appendix G.4.2, Appendix G.4.3, Appendix G.4.4), operating fund (Appendix G.5), funding (G.6), critical point (Appendix G.7), profits and losses (Appendix G.8), cash flow (Appendix G.9), financial plan (Appendix G.10), financial statement (Appendix G.11 and G.11.1) and main economic and financial indicators (Appendix G.12). Together they constitute a reasonable estimate of the project's financial future.

4.8.1 Sales Forecast

Sales - National Market	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cardio Safety – Fatigue Only		€ 2,500	€ 15,000	€ 37,500	€ 55,000	€ 82,500	€ 110,000	€ 135,000	€ 185,000	€ 240,000	€ 300,000
Quantities Sold		1	6	15	22	33	44	54	74	96	120
Unit Price	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500
Cardio Safety – Fatigue + Authentication		€ 5,800	€ 20,300	€ 43,500	€ 69,600	€ 98,600	€ 136,300	€ 185,600	€ 255,200	€ 331,760	€ 377,000
Quantities Sold		2	7	15	24	34	47	64	88	114	130
Unit Price	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900
Cardio Safety – Fatigue + Authentication + Attentiveness			€ 4,000	€ 12,000	€ 36,000	€ 56,000	€ 72,800	€ 94,800	€ 123,600	€ 160,800	€ 209,200
Quantities Sold			1	3	9	14	18	24	31	40	52
Unit Price	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000
TOTAL		€ 8,300	€ 39,300	€ 93,000	€ 160,600	€ 237,100	€ 319,100	€ 415,400	€ 563,800	€ 732,560	€ 886,200

It is important to mention that these projections for number of sales are very conservative, and have a modest growth rate. It is also important to remember that the software is sold in a

subscription model, meaning the sales of a year are an addition to the sales from the previous year and the sales of the year in question, for example, for CardioSafety – Fatigue Only in 2027, 96 sales, mean actually 22 new customers, since the other 74 transit from 2016. Some client cancellations have also been taken into account.

Additionally, some assumptions were made as of the price of dislocations and stays, it was considered a €500.00 value for travel tickets + 100€/day for accommodations. Thus 10 travel days per year, every year, for contact gathering, and lead acquisition were estimated.

4.8.2 Financial Indicators

Financial Indicators for CardioSafety for the Investor	
Return on Investment (RoI)	35%
Net Present Value (NPV)	283,894
Internal Rate of Return (IRR)	15.79%

As it can be seen by the indicators, and by the projections in Appendix, this project is viable, and starts to be profitable from the year 2023 (see profit and loss projection in Appendix G.8), just 4 years after acquiring its first pilot projects, or in 3 years if the development year is not taken into account, which is the expected period for hardware start-ups. The capital required for funding, €375,000 not only guarantees the sustainability of the company for the development period, and before becoming profitable, but also includes a margin precisely for unforeseen situations that might affect development time, or the need to increase the amount spent on marketing and sales efforts.

5 Conclusion

In the beginning of this thesis, while doing its structuring and grounding, a clear need for a product like CardioSafety presented itself. With evidence from completely unrelated business sectors, from NASA, to the FAA, passing in medics and policeman to people in office jobs, fatigue is taking a toll on people. Current methods are not working as marketed. They rely on employee feedback, at different times of the shift, on the supervisors' assessment of fatigue or regular performance tests. All these methods have drawbacks, either by being subjective, the employees' or managers' inability to correctly assess fatigue and stress levels or by taking up work time in order to perform tests. Either way, all of the methods are *a posteriori* testing, and result gathering. Wrapping it all up is the fact that according to available data, people are poor judges of their own fatigue levels.

On the other side, there was also a need to protect highly sensible infrastructure (Critical Facilities) from intrusion, and to guarantee that people accessing critical systems were rightfully doing so. For this some solutions were available, in the form of well-known biometrics, like the finger print, or the retina scanners. Nonetheless these biometrics have a shortcoming, they are not 100% hoax proof. Here the need for CardioSafety was established. A product that simultaneously can: determine the fatigue level of an employee objectively and in real time, while also guaranteeing access control to the employer.

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Appendixes

Appendix A - Weighted values for each of Porter's Five Forces

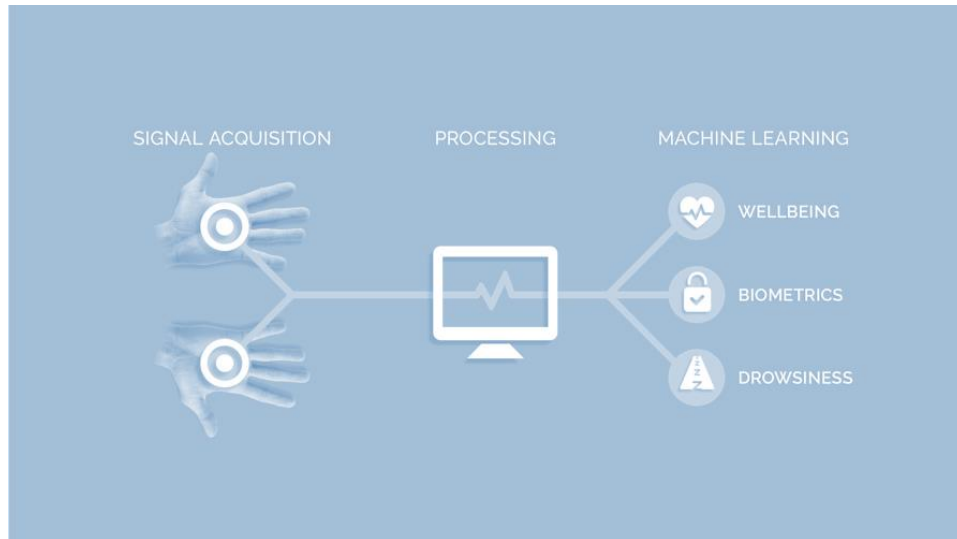
Weighted values for each of Porter's Five Forces based on each of the contributing factors.

Industry Analysis	Contribution of the Force (1 to 5, 5 being a stronger contribution)
Threat of new entrants	
Economies of Scale	3
Product Differentiation	5
Brand Reputation	2
Need for capital	3
Switching costs for clients	2
Protective Policies	2
Difficulty to access the technology needed	4
Probability of retaliation from existing companies	4
General Force Value	3.13
Rivalry Among Existing Firms	
Number of competing companies	2
Market growth	3
Fixed costs	2
Stock keeping costs	1
Product Differentiation degree?	3
Switching costs for clients?	4
Company differentiation degree	3
Effect of the strategic decisions	4
General Force Value	2.75
Threat of Substitute Products or Services	
Availability of substitute products	4
Switching costs (for customers)	4
Rentability of suppliers of substitute products	4
Aggressiveness of suppliers of substitute products	3
General Force Value	3.75
Continues on next page.	

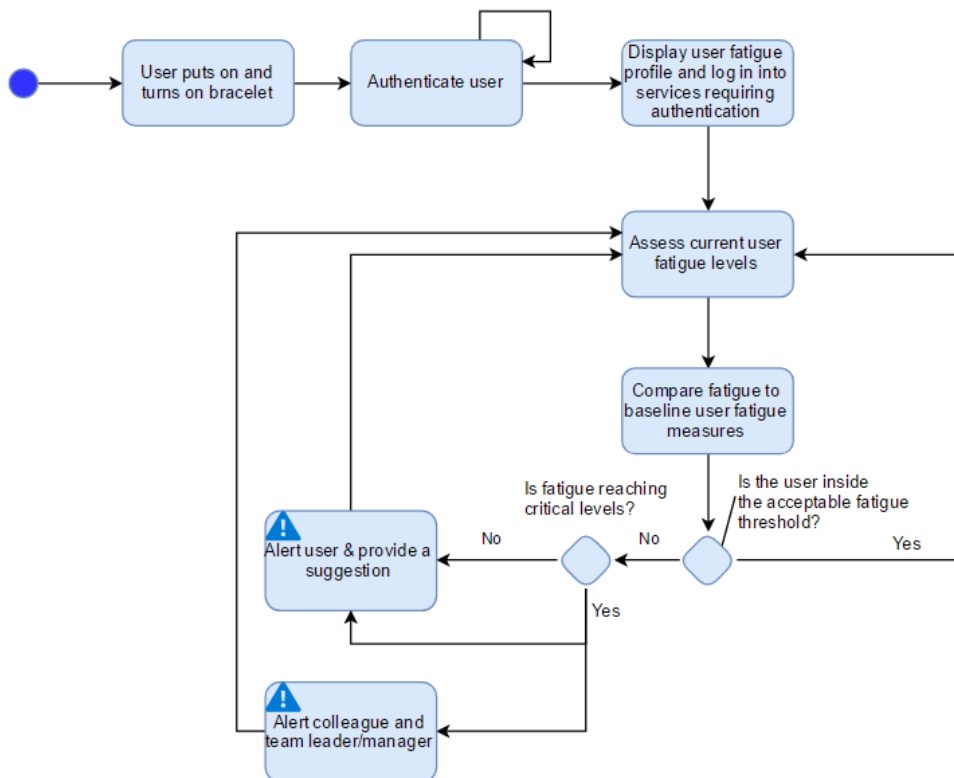
Bargaining Power Of Suppliers	
Number of industry suppliers	2
Concentration and dimension of suppliers	2
Importance of the industry as a client	1
Average size of orders from the suppliers	2
Weight of the cost of products bought by the industry?	2
Concern over the overall quality of the acquired products	5
Differentiation of the products acquired by the industry	4
General Force Value	2.57
Bargaining Power of customers	
Number of clients in the industry	5
Average volume of products bought by the customer	4
Cost of switching for the client	2
Client rentability	4
Weight of the cost of the products sold by the industry for the customer	4
Concern over the overall quality of the products bought	5
Differentiation of the products offered by the industry	4
Availability of substitute products for the customer	4
Threat of vertical integration by the clients	3
Availability of information about the industry	3
General Force Value	3.8

Appendix B - Simple diagrams explaining how the product will work.

Simple diagram explaining how the product will work on a very high level of abstraction



More technical diagram showing how the product will work, can still be understood by the average customer



Appendix B – Other time domain and frequency domain measures.

Variable	Units	Definition
TIME DOMAIN MEASURES		
a. Statistical		
SDNN	ms	SD of all normal R–R intervals
SDANN	ms	SD of the average normal R–R intervals calculated over short time periods (usually 5 min) for the entire recording period (usually 24 h)
RMSSD	ms	The square root of the mean squared differences between adjacent normal R–R intervals
SDNN index	ms	Mean of the SD of the normal R–R intervals calculated over short periods time (usually 5 min) for the entire recording period (usually 24 h)
NN50		The number of pairs of adjacent normal R–R intervals that differ by more than 50 ms
pNN50	%	NN50 divided by the total number of normal R–R intervals $\times 100$
b. Geometrical		
HRV triangular index		Number of normal R–R intervals divided by the height of the histogram of all the normal R–R intervals measured on discrete scale with bins of 1/128 s (7.8125 ms)
TINN	ms	Baseline width of the minimum square difference of triangular interpolation of the highest peak of the histogram of all normal R–R intervals
FREQUENCY DOMAIN MEASURES		
Total	ms ²	Area under the entire power spectral curve (usually ≤ 0.40), variance of all normal R–R intervals
ULF	ms ²	Ultra low frequency power (≤ 0.003 Hz)
VLF	ms ²	Very low frequency power (0.003–0.004 Hz)
LF	ms ²	Low frequency power (0.04–0.15 Hz)
HF	ms ²	High Frequency power (usually 0.15–0.40 Hz*)
LFnu	nu	Normalized low frequency power (LF/LF + HF)
HFnu	nu	Normalized high frequency power (HF/LF + HF)
LF/HF		Ratio of the low-to high frequency power

*Nu, normalized units; * HF is shifted to higher ranges (0.24–1.04 Hz) in infants and exercising adults.*

Source: G.Billman, “Heart Rate Variability ? A Historical Perspective” [67]

Appendix C – Potential advantages and disadvantages of being a first entrant.

Potential advantages and disadvantages of being a first entrant in a technology market.

Potential Advantages	Potential Disadvantages
Higher levels of awareness	Most new products fail
Superior reputation	Higher R&D costs
Higher rates of customer trial	Risk of premature technology
Greater likelihood of brand loyalty	Risk of suboptimal product features
Selection of most profitable segment	Higher costs of market development
Selection of optimal positioning	May create market for competitors
Insight from lead users	Timing may be premature for product takeoff.
Choice of most efficient distribution channels	
Lower costs due to greater experience and scale and price leadership	
Opportunity to set standards	

Source: T. Robertson, “How to reduce market penetration cycle times” [105]

Appendix D - Recognition error rates for several biometrics and from different tests

Source: L. O'gorman, "Comparing Passwords, Tokens, and Biometrics for User

Biometric	Test	Test Parameter	Attempts	FNMR	FMR
Face	FRVT [54]	11-13 mo. spaced	1	16%	16%
	CESG [56]	1-3 mo. spaced	3	6%	6%
Fingerprint	FVC [55]	Mainly age 20-30	1	2%	0.02%
	CESG [56]	Mainly age 30+	3	2%	0.01%
Hand	CESG [56]	-	1	3%	0.3%
	CESG [56]	-	3	1%	0.15%
Iris	CESG [56]	-	1	2%	0.0001%
	CESG [56]	-	3	0.25%	0.0001%
Voice	NIST [53]	Text independent	1	7%	7%
	CESG [56]	Text dependent	3	2%	0.03%

Authentication," 2003 [89]

Appendix E - Company interview – REN

This interview was done in person and anonymously.

Unfortunately, I was not allowed to record this interview for further transcription. The answers given here are what I recorded in written form during the interview.

1. Dimensioning the problem

a. Number of people involved in the critical facilities processes (number of workers each shift, etc.)

In the dispatch center, two people must always be present. In total, there are 12 people working the two positions in rotating shifts.

b. Other resources involved with control and monitoring

Various "secondary" positions, including maintenance vehicles and fast response teams. Unable to give exact number

2. Can fatigue and stress be considered problem in your company?

Unable to answer

3. What impacts do you notice in your employees related with fatigue?

Unable to answer

4. What impacts do you notice in the company related with fatigue?

Unable to answer

5. Estimated losses due to fatigue?

Unable to answer, this kind of records is not kept.

6. Can it be considered hard to manage shifts? How is this management done? Any methodologies involved? Are stress and fatigue accounted for?

Could not answer but said that, shifts are proposed to the grid engineers and they approve it, or change it depending on conditions.

7. Are there laws in place, requiring only a certain number of hours to be worked per employee?

Currently, this deal was struck with the workers and they either 3 days and one night and then rest, or work two days and rest one.

8. What are the departments of higher risk?

The dispatch center

9. Is it possible to point out an accident that happened due to operator fatigue?

No.

10. Are you familiar with any automatic fatigue risk management systems?

(Interdynamics, Circadian, Worktech)

No

11. Is there a fatigue risk management system currently in use?

No.

12. Would you be interested in a product that detects employee fatigue in real time, and sends warning notifications to the employee and the managers?

13. How is access control done in the company? What are the possible risks of strangers entering the premises? Is that a problem?

Answered later, about how. Regarding strangers access, it could have a very bad outcome.

Questions about the employee.

14. Location of the company, workplaces, geographic area, distances travelled by critical facilities workers while on the job?

Across country.

15. Time management systems, human resources location, working conditions (standing, sitting, etc.)

Unable to answer

16. How do employees currently authenticate themselves?

Access is done using a RFID card, and a PIN code.

Better understanding the work performed by the employee.

17. How is the time on the post controlled?

18. How are work task performed (standing, sitting, on a computer, on paper, outside the work post)

Depends on the function. In the dispatch center, it is done sitting.

19. Attention level required

a. Is the required attention level continuous or intermittent?

Intermittent

b. Is this monitored in any way?

No

20. In what other areas you think this technology could be applied?

Terminal, underground storage and electricity stations.

Appendix F - Company interview – Airport

As the previous interview, this interview was granted anonymity and was originally preformed in Portuguese (original version follows) and was translated for this business plan

1. Dimensioning the problem

a. Number of people involved in the critical facilities processes (number of workers each shift, etc.)

“It’s variable, this airport specifically has a lot of movement for half of the year, and little movement the other half of the year, during the busier times the teams are more numerous, during the less busy period they are reduced, having four people in the morning shift and four people in the afternoon shift, when it gets busier it can get up to 6 people in the morning and 5 in the afternoon shift. Inside the shifts the team rotates positions, including a rest position after 1,5h of work, work and time conditions are

agreed upon between the airport administration and the air traffic controllers' union. In the air traffic industry, there is protection regarding maximum hours of work that can be done before mandatory breaks, these times vary depending on the country, between 1,5 and 2 working hours, followed by 1,5 and 2 resting hours, depending on what post the worker is coming from.

b. Other resources involved with control and monitoring

“Here we have the tower and the air traffic controllers, a flight data support service and the maintenance crews. However, I don't consider fatigue to be a concerning factor there.”

2. Can fatigue and stress be considered problem in your company?

“Of course, I mean, not a problem in the literal meaning, but definitely a concern”

3. What impacts do you notice in your employees related with fatigue?

“I would have to divide fatigue in two parts. The fatigue that comes from the hours worked, and individual fatigue that each of us brings from home. Individual fatigue, can only be detected from each individual's irritability, for example, how an argument can happen, over nothing. Or hypersensitivity to a question or behavior wise. From a professional standing point, we associate fatigue with stress. Common signs are, higher voice volume, speed of speech, which is faster when a person is stressed, like you said, even if it seems nonsensical. Particularly in radar control, the attention span gets shorter, and the person can leave certain areas of the radar unmonitored, and has it has to be pointed out by a colleague. But the “protection” on this profession is so good that these are very rare signs. If we were in an environment where we had to work for 4 or 5 hours straight, these signs would be more visible, but how things have been agreed on with the union these situations are very rare. Eventually like I said, this technology would be a lot more interesting in Santa Maria Airport, as I have had both experiences, I feel it would be a great change there.”

4. What impacts do you notice in the company related with fatigue?

Answered in the question above.

5. Estimated losses due to fatigue?

“Here we can talk about atypical events, that are due to fatigue. For example, during days of high workload, when it is necessary for planes to take-off every 2 minutes or every 1,5 minutes, fatigue can make this gap bigger reducing the overall number of take-offs, landings and simultaneous movement in the “plane parking area”(...) for example all the movement here have to be done following safety distances between aircrafts, now if you imagine 5 aircrafts simultaneously asking to do a reverse maneuver, my response capacity is different when I'm tired and when I'm not. If I'm not watchful and aware, I ask them to stand-by, thus reducing the overall possible aircraft turnover.”

6. Can it be considered hard to manage shifts? How is this management done? Any methodologies involved? Are stress and fatigue accounted for?

“We have a mechanism implemented in the company where we work 3 days and rest 2. This is very comfortable and helps the controller to be well rested. However, when we are lacking staff, and have more movement, we call people in and they work overtime, thus their rest is not done. People come in to work on their days off, earning more, obviously, but fatigue doesn’t care if you are being paid better, right? It only knows that you have been working for several days, and haven’t yet rested. The maximum a person can work, following current agreements is 8 days and must rest on the 9th. However, this reduces the rest times, and in a month, you can work almost the triple of what you are used to. Evidently this scenario is very, very rare but it is common for us to use 4 days off of the controller, meaning we theoretically “stole” 4 or 5 rest days, but it is still manageable, fatigue wise.”

7. Are there laws in place, requiring only a certain number of hours to be worked per employee?

Answered in the question above.

8. What are the departments of higher risk?

“Here in the tower, we consider controlling simultaneous maneuvers a position of higher risk, as well as the management of the landing strip (take offs and landing) when there is only a short time between maneuvers.”

9. Is it possible to point out an accident that happened due to operator fatigue?

“No, an accident is very rare in aviation, and inside the rare, many of them are due to technical problems of the aircrafts, some can be attributed to human error or fatigue of the flight crew, captain and co-pilot, and when it was not their fault, it can eventually be the controllers fault, but these situations are very rare, and are reviewed worldwide, and happen every, I don’t know 10 years maybe. Still, it would have to be understood if it was due to fatigue. On a national level, there is no record of this kind, attributing the accident to the controller. More than keeping track of accidents, there is a meticulous tracking of incidents, which are security breaches that don’t result in an accident, there we can try to understand if there are more incidents due to fatigue or not, but no work has been done in this area.”

10. Are you familiar with any automatic fatigue risk management systems?

(Interdynamics, Circadian, Worktech)

No

11. Is there a fatigue risk management system currently in use?

Not Applicable

12. Would you be interested in a product that detects employee fatigue in real time, and sends warning notifications to the employee and the managers?

“It would be really interesting!”

13. How is access control done in the company? What are the possible risks of strangers entering the premises? Is that a problem?

“The risk is very low, but it is done with an RFID card”

Questions about the employee.

14. Location of the company, workplaces, geographic area, distances travelled by critical facilities workers while on the job?

Not Applicable – All the workers are inside the tower.

15. Time management systems, human resources location, working conditions (standing, sitting, etc.)

Not Applicable – All the workers are inside the tower.

16. How do employees currently authenticate themselves?

“RFID personal card”

Better understanding the work performed by the employee.

17. How is the time on the post controlled?

“Here it is done by a signed sheet, in other places it is done using a finger scanner”

18. How are work tasks performed (standing, sitting, on a computer, on paper, outside the work post)

“Most of the work is done sitting and is mixed between computer, paper and voice”

19. Attention level required

a. Is the required attention level continuous or intermittent?

“Intermittent, depending on workload”

b. Is this monitored in any way?

“Not automatically, eventually by the supervisor and the team”

20. In what other areas you think this technology could be applied?

“In the plane’s cockpit, undeniably (some examples were given off record), It would also be interesting in the airport operations level.”

[Appendix F.1 - Company interview – Airport \(Original\)](#)

Perguntas sobre a empresa

1. Dimensionar o problema por banda da empresa:

a. N° de pessoas envolvidas com o processo das critical facilities (n.º trabalhadores em cada turno, horas de trabalho)

“É variável de facto, este aeroporto tem metade do ano muito movimento e metade do ano pouco movimento, na altura do ano que tem mais movimento, as equipas sao mais numerosas, na altura com menos movimento as equipas sao mais reduzidas, ficando com 4 pessoas no turno da manhã e 4 pessoas no turno da tarde, quando existe mais movimento pode chegar a 6 pessoas no turno da manhã e 5 à tarde. Dentro dos turnos, as pessoas rodam pelas posições, inclusive de descanso ao fim de 1,5 horas de trabalho, os termos de trabalho sao acordados entre o sindicato dos controladores aéreos e a administração do aeroporto. Existe no meio aeronáutico protecção, existem tempos mínimos de trabalho consecutivo com depois direito a descanso, estes tempos variam, entre 1,5 horas e 2 horas, de país para país, sendo o descanso de 1,5 horas ou 2 horas, dependendo de que posição se sai para o descanso. Também depende do aeroporto que se está a falar, se estivermos a falar de um aeroporto mais movimentado, os tempos de trabalho poderão ser maiores.

b. Outros recursos envolvidos com a monitorização e controle, trabalhadores de "piquete", etc).

Para esta função, temos a torre, os controladores de tráfego aéreo, e temos outro serviço de apoio de dados de voo, e ainda temos o serviço de apoio de manutenção. No entanto não considero que a fadiga seja um factor preocupante nestas funções

2. Considera fadiga e stress como problemas na sua empresa?

“Claro, quer dizer, não um problema no sentido do termo, é sim uma preocupação.”

3. Que impactos nota nos trabalhadores, que estejam relacionados com a fadiga?

“Teria que dividir a fadiga em duas partes. A fadiga proveniente das horas de trabalho, e a fadiga individual de cada um de nós traz de casa. A fadiga individual de cada um traz de casa, só é possível de detectar, pelo estado de irritabilidade da pessoa, por exemplo, pela maneira como pode surgir uma discussão do nada, ou hipersensibilidade nalguma questão ou ao nível do comportamento. A fadiga do ponto de vista profissional, nós associamos a fadiga ao stress, no nosso caso. Vamos beber a informação ao stress, aumento do volume da voz, rapidez do discurso, que é mais rápido quando a pessoa está mais stressada, apesar de parecer um contrassenso, mas como tu falaste e muito bem. Particularmente no controlo de radar, o foco passa a ser mais curto, do que o desperto, a pessoa pode começar a deixar áreas do ecrã/radar a nao prestar atenção, a ser chamado à atenção por outro controlador de tráfego aéreo, enfim. Mas a proteção alcançada na profissão é tão boa que são sinais raros, compreendes? Se nós estivéssemos inseridos num meio onde a pessoa tivesse que estar sentada 4 e 5 h numa profissão stressante o cansaço poderá ser mais visível, com a forma como as coisas estão legisladas internamente com os sindicatos, não sao acontecimentos notórios facilmente. Eventualmente como digo, um órgão onde isto seria mais visível/relevante seria no aeroporto de santa maria, como vivi essa experiência sinto que faria grande diferença.”

4. Quais são os impactos que nota na empresa que estejam relacionados com a fadiga?

Respondido na pergunta anterior.

5. Quantificação/Estimativa de perdas devido a fadiga

“Aqui pode ser de eventos atípicos derivados da fadiga. A fadiga aqui, pode fazer com que, em dias de muito movimento, quando por exemplo é necessário descolar aviões de 2 em 2 minutos ou de 1,5 em 1,5 min, a fadiga pode fazer aumentar o gap entre movimentos de aterragem e descolagem, ou reduzir o número de manobras em simultâneo na placa (zona de “estacionamento” das aeronaves), menos aterragens e descolagens por hora(...)por exemplo todos os movimentos na placa têm que ser feitos mantendo os padrões de segurança de distância entre aeronaves, agora se imaginarmos aqui a placa cheia, e de repente houver 5 aeronaves a pedir em simultâneo para fazer a manobra, a capacidade de discernimento que eu tenho, se tiver atento é uma, se não estiver atento começo a dizer stand-by,(aguarde), stand-by, e assim estou a reduzir o fluxo de movimentação das aeronaves, portanto nesses momentos mais críticos, mais apertados, de maior pico de tráfego, a quantidade de manobras em simultâneo, nesta zona, provavelmente vai ser reduzida, em relação a aquilo que seria a capacidade máxima que o sistema consegue completar.ok? ”

6. Considera difícil gerir turnos? Como é feita a gestão? Metodologia? É tido em conta stress e fadiga?

“Nós temos um mecanismo implementado na empresa, que funciona da seguinte forma, trabalhamos 3 dias e depois descansamos 2. Isto só por si já é muito bom,ou seja enquanto uma pessoa normal, trabalha 5 dias e descansa 2, nós trabalhamos 3 e descansamos 2, digamos que a nossa semana tem 5 dias, e mantemos 2 dias de descanso. Isto torna-se mais confortável e mais descansado para um controlador de tráfego aéreo. Contudo, quando há falta de pessoal, chamamos a pessoa para vir trabalhar em extraordinário, ora aí, nalgumas situações de falta de pessoal, ou de maior procura, pode significar que o descanso não se verifica. As pessoas vêm trabalhar, vêm mais bem remuneradas, na sua folga, mas na verdade, do ponto de vista do cansaço, o cansaço não sabe se estás a ganhar mais dinheiro ou menos dinheiro não é? Só sabe que tu trabalhaste X dias e nunca descansaste. Ora a empresa implementou descanso obrigatório, no 9º dia, portanto tu podes, trabalhar 8 dias e descansar o 9º, trabalhar 8 dias e descansar o 9º, trabalhar 8 dias e descansar o 9º, e aquela vantagem de 3 dias 2 dias, desaparece, a pessoa trabalha quase o triplo do que está habituada. É claro que este cenário que pintei agora já não está a acontecer (é muito raro acontecer), mas acontece com frequência nós utilizarmos 4 folgas por mês do controlador de tráfego aéreo. Ao utilizarmos 4 folgas do controlador, significa que lhe “roubámos” teoricamente 4 ou 5 dias de descanso, contudo ainda assim a situação ainda é confortável.”

7. Existem requisitos da lei sobre número de horas no posto vs horas de descanso?

Respondido na pergunta anterior.

8. Departamentos de maior risco e porque?

“No âmbito da torre de controlo de tráfego aéreo não é? Sim, nós consideramos por exemplo, neste momento, que o controlo das manobras simultâneas, está a atingir um nível de intensidade muito grande, e tem algum risco, algum risco de erro, e ao nível da gestão da pista, aterragens e descolagens, em curto espaço de tempo também tem um certo grau de risco.”

9. Possível descrever algum acidente que se deveu à fadiga do operador? Danos?

“Não, acidente é uma coisa muito rara na aviação e dentro dos raros, muitos deles são derivados de problemas técnicos da própria aeronave, alguns poderão ser atribuídos a erro humano ou fadiga da tripulação do avião, piloto e comandante, e obviamente quando não é estas duas causas a causa também pode ser o controlo de tráfego aéreo, mas esses também são muito raros e são revistos a nível mundial, acontecem uma vez, sei lá, de 10 em 10 anos. E ainda assim teria de se perceber se seria derivado de fadiga. A nível nacional não há nenhum registo dessa natureza, responsabilizando o controlador aéreo pelo acidente. Poderá é haver, mas não está quantificado em controlo de tráfego aéreo, mais do que contabilizar acidentes contabilizam-se incidentes, que são falhas de segurança mas que não resultam em acidente, aí poder-se-ia já ter mais dados para poder perceber se há maior ocorrência de incidentes pelo cansaço ou não, mas não nenhum trabalho feito nessa perspectiva, de se ter derivado do cansaço ou não. Partindo sempre do princípio que o cansaço não terá sido o factor, devido aos momentos de descanso, e devido ao cumprimento do 9º dia de descanso após vários dias de trabalho consecutivo.”

10. Conhece algum sistema de gestão automática de riscos relacionados com a fadiga? (Interdynamics, Circadian, Worktech)

“Não.”

11. Existe algum sistema de monitorização de fadiga actualmente em utilização? Qual? Como funciona? Onde falha? O que pode ser melhorado?

Não Aplicável

12. Estaria interessado num produto que detectasse em tempo real o estado de fadiga dos colaboradores enviando avisos ao colaborador e chefias?

“Seria mesmo muito interessante!”

13. Como é feito o controlo de acessos na empresa? Quais os riscos da entrada de pessoas estranhas ao serviço? É mesmo um problema?

“O risco é muito baixo, é feito através de um cartão magnético, pessoal e intransmissível”

Perguntas sobre o colaborador.

14. Localização da empresa, locais de trabalho, zona geográfica e distâncias percorridas pelos trabalhadores que atuam em situações críticas.

Não Aplicável – os trabalhadores estão sempre na torre de controlo.

15. Instrumentos de gestão do tempo, da localização e dos fatores humanos, existentes. Explicar o modo de trabalhar (em pé sempre, sentado sempre, etc.)

Não aplicável. – os colaboradores estão todos na torre durante o tempo de trabalho.

16. Como é que os colaboradores se authenticam actualmente?

“Novamente é através de um cartão magnético, pessoal e intransmissível”

Compreender melhor o trabalho desempenhado pelo colaborador, em ambientes críticos, ie, se tem de estar muito tempo no computador, atento a monitores, etc.

17. Como é controlado o tempo passado no posto?

“Aqui, é feito através de uma folha de presença assinada pelo colaborador. Noutros locais já é feito com uma autenticação feita com a impressão digital”

18. Funções desempenhadas, e como (sentado,em pé, no PC, em papel, fora do posto)

“Sentado, maioritariamente sentado, e raramente de pé. E o tipo de trabalho é misto, tanto em computador como em papel, e por voz”.

19. Nível de atenção

a. Nível de atenção tem que ser contínuo? Ou é díspar/intervalado?

“O Nível de atenção sofre oscilações de acordo com o aumento do movimento e de trabalho.”

20. Isto é controlado de alguma forma?

“Não automaticamente, eventualmente pelo supervisor da equipa e pelos colegas.”

21. Em que outras áreas considera que se poderia aplicar a tecnologia

“No cockpit dos aviões, indiscutível (foram dados alguns exemplos fora de registo). Também seria interessante ao nível das operações aeroportuárias, no sentido de quem gere a atribuição dos lugares de estacionamento, quem cuida das regras de circulação de viaturas na placa, é quem distribui a alocação dos tapetes de bagagem e corredores de embarque, não sei o nível de automatismo deles.”

Appendix G – Financial Appendixes
Appendix G.1- National Sales Appendix

Table 12- Financial Plan - National Sales

Sales - National Market	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cardio Safety – Fatigue Only		€ 2,500	€ 15,000	€ 37,500	€ 55,000	€ 82,500	€ 110,000	€ 135,000	€ 185,000	€ 240,000	€ 300,000
Quantities Sold		1	6	15	22	33	44	54	74	96	120
Unit Price	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500	€ 2,500
Cardio Safety – Fatigue + Authentication		€ 5,800	€ 20,300	€ 43,500	€ 69,600	€ 98,600	€ 136,300	€ 185,600	€ 255,200	€ 331,760	€ 377,000
Quantities Sold		2	7	15	24	34	47	64	88	114	130
Unit Price	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900
Cardio Safety – Fatigue + Authentication + Attentiveness			€ 4,000	€ 12,000	€ 36,000	€ 56,000	€ 72,800	€ 94,800	€ 123,600	€ 160,800	€ 209,200
Quantities Sold			1	3	9	14	18	24	31	40	52
Unit Price	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000
TOTAL		€ 8,300	€ 39,300	€ 93,000	€ 160,600	€ 237,100	€ 319,100	€ 415,400	€ 563,800	€ 732,560	€ 886,200

Appendix G.1.1-Exportation Sales Appendix

Table 13 - Financial Plan - Exportation Sales

Sales - Exportation	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cardio Safety - Fatigue + Authen.					€ 5,800	€ 11,600	€ 17,400	€ 26,100	€ 39,150	€ 58,870	€ 89,900
Quantities Sold					2	4	6	9	14	21	31
Unit Price	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900	€ 2,900
Cardio Safety - Fatigue + Auth. + Atten.					€ 4,000	€ 12,000	€ 18,000	€ 27,200	€ 40,800	€ 61,200	€ 92,000
Quantities Sold					1	3	5	7	11	16	23
Unit Price	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000	€ 4,000
TOTAL					€ 9,800	€ 23,600	€ 35,400	€ 53,300	€ 79,950	€ 120,070	€ 181,900

Appendix G.1.2-Total Sales Appendix

Table 16 - Financial Plan - Total of Sales

SALES TOTALS		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
TOTAL SALES - NATIONAL MARKET		€ 0	€ 8,300	€ 39,300	€ 93,000	€ 160,600	€ 237,100	€ 319,100	€ 415,400	€ 563,800	€ 732,560	€ 886,200
TOTAL VENDAS - EXPORTATIONS		€ 0	€ 0	€ 0	€ 0	€ 9,800	€ 23,600	€ 35,400	€ 53,300	€ 79,950	€ 120,070	€ 181,900
TOTAL SALES		€ 0	€ 8,300	€ 39,300	€ 93,000	€ 170,400	€ 260,700	€ 354,500	€ 468,700	€ 643,750	€ 852,630	€ 1,068,100
VAT ON SALES	23%	€ 0	€ 1,909	€ 9,039	€ 21,390	€ 36,938	€ 54,533	€ 73,393	€ 95,542	€ 129,674	€ 168,489	€ 203,826
TOTAL BUSINESS VOLUME		€ 0	€ 8,300	€ 39,300	€ 93,000	€ 170,400	€ 260,700	€ 354,500	€ 468,700	€ 643,750	€ 852,630	€ 1,068,100
VAT		€ 0	€ 1,909	€ 9,039	€ 21,390	€ 36,938	€ 54,533	€ 73,393	€ 95,542	€ 129,674	€ 168,489	€ 203,826
TOTAL BUSINESS VOLUME + VAT		€ 0	€ 10,209	€ 48,339	€ 114,390	€ 207,338	€ 315,233	€ 427,893	€ 564,242	€ 773,424	€ 1,021,119	€ 1,271,926

Appendix G.2-Costs of Goods Sold Appendix

Table 19 - Financial Plan - Costs of Good Sold

Costs of Goods Sold	Gross Margin	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
NATIONAL MARKET			€ 3,030	€ 15,305	€ 36,825	€ 66,160	€ 98,310	€ 131,745	€ 171,100	€ 231,300	€ 300,556	€ 367,010
Cardio Safety – Fatigue Only	60%		€ 1,000	€ 6,000	€ 15,000	€ 22,000	€ 33,000	€ 44,000	€ 54,000	€ 74,000	€ 96,000	€ 120,000
Cardio Safety – Fatigue + Authentication	65%		€ 2,030	€ 7,105	€ 15,225	€ 24,360	€ 34,510	€ 47,705	€ 64,960	€ 89,320	€ 116,116	€ 131,950
Cardio Safety – Fatigue + Authentication + Attentiveness	45%		€ 0	€ 2,200	€ 6,600	€ 19,800	€ 30,800	€ 40,040	€ 52,140	€ 67,980	€ 88,440	€ 115,060
TOTAL COST OF GOODS SOLD												
EXTERNAL MARKET						€ 9,800	€ 23,600	€ 35,400	€ 53,300	€ 79,950	€ 120,070	€ 181,900
Cardio Safety – Fatigue + Authentication						€ 5,800	€ 11,600	€ 17,400	€ 26,100	€ 39,150	€ 58,870	€ 89,900
Cardio Safety – Fatigue + Authentication + Attentiveness						€ 4,000	€ 12,000	€ 18,000	€ 27,200	€ 40,800	€ 61,200	€ 92,000
TOTAL Costs <u>od</u> Goods Sold			€ 3,030	€ 15,305	€ 36,825	€ 75,960	€ 121,910	€ 167,145	€ 224,400	€ 311,250	€ 420,626	€ 548,910
VAT	23%		€ 697	€ 3,520	€ 8,470	€ 15,217	€ 22,611	€ 30,301	€ 39,353	€ 53,199	€ 69,128	€ 84,412
TOTAL Costs <u>od</u> Goods Sold + VAT			€ 3,727	€ 18,825	€ 45,295	€ 91,177	€ 144,521	€ 197,446	€ 263,753	€ 364,449	€ 489,754	€ 633,322

Appendix G.3-Supply and External Services

Table 22 - Financial Plan - Supply and External Services

	VAT	Monthly Cost	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Marketing Services	23%	€ 1,500			€ 12,000	€ 12,000	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Dislocation and Stays	23%	€ 500	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000	€ 6,000
Rent Costs	23%	€ 360	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320	€ 4,320
TOTAL SES			€ 10,320	€ 10,320	€ 22,320	€ 22,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320
VAT					€ 2,760	€ 2,760							
TOTAL SES + VAT					€ 25,080	€ 25,080							

Appendix G.4-Personnel

Table 25 - Financial Plan - Personnel - Number of months paid

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Number of Month	14	14	14	14	14	14	14	14	14	14	14
Annual Raise (Salary + Food allow.)	0	0	0	0	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%	1.00%

Table 28 - Financial Plan - Personnel - Number of Employees

Numb. Employees	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Administration	1	1	1	1	1	1	1	1	1	1	1
Electrical Engineer	1	1	1	1	1	1	1	1	1	1	1
Bio-Medical Engineer	1	1	1	1	1	1	1	1	1	1	1
Software engineer	1	1	1	1	1	1	1	1	1	1	1
Business/Management	1	1	1	1	1	1	1	1	1	1	1
Marketing							2	2	2	2	2
Sales					1	1	2	2	2	2	2
TOTAL	5	5	5	5	6	6	9	9	9	9	9

Appendix G.4.1-Personnel (Cont.)

Table 34 - Financial Plan - Personnel - Number of Months Worked

Staff Number of Month Worked	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Each Employee	12	12	12	12	12	12	12	12	12	12	12
Personnel Costs											
Each employee's monthly salary	€ 1,000	€ 1,000	€ 1,000	€ 1,000	€ 1,010	€ 1,020	€ 1,030	€ 1,041	€ 1,051	€ 1,062	€ 1,072

Table 31 - Financial Plan - Personnel – Total Employee Base Salary

TOTAL EMPLOYEE BASE SALARY	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Administration	€ 14,000	€ 14,000	€ 14,000	€ 14,000	€ 14,140	€ 14,281	€ 14,424	€ 14,568	€ 14,714	€ 14,861	€ 15,010
Electrical Engineer	€ 14,000	€ 14,000	€ 14,000	€ 14,000	€ 14,140	€ 14,281	€ 14,424	€ 14,568	€ 14,714	€ 14,861	€ 15,010
Bio-Medical Engineer	€ 14,000	€ 14,000	€ 14,000	€ 14,000	€ 14,140	€ 14,281	€ 14,424	€ 14,568	€ 14,714	€ 14,861	€ 15,010
Software engineer	€ 14,000	€ 14,000	€ 14,000	€ 14,000	€ 14,140	€ 14,281	€ 14,424	€ 14,568	€ 14,714	€ 14,861	€ 15,010
Business/Management	€ 14,000	€ 14,000	€ 14,000	€ 14,000	€ 14,140	€ 14,281	€ 14,424	€ 14,568	€ 14,714	€ 14,861	€ 15,010
Marketing					€ 0	€ 0	€ 28,848	€ 29,137	€ 29,428	€ 29,723	€ 30,020
Sales					€ 14,140	€ 14,281	€ 28,848	€ 29,137	€ 29,428	€ 29,723	€ 30,020
TOTAL	€ 70,000	€ 70,000	€ 70,000	€ 70,000	€ 84,840	€ 85,688	€ 129,818	€ 131,116	€ 132,427	€ 133,752	€ 135,090

Table 37 - Financial Plan - Personnel - Other Expenses

Other Expenses		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Social Security												
Governing Bodies	23.8%	€ 3,325	€ 3,325	€ 3,325	€ 3,325	€ 3,358	€ 3,392	€ 3,426	€ 3,460	€ 3,495	€ 3,530	€ 3,565
Personnel	23.8%	€ 13,300	€ 13,300	€ 13,300	€ 13,300	€ 16,791	€ 16,959	€ 27,406	€ 27,680	€ 27,957	€ 28,236	€ 28,519
Accidents at Work Insurance	1.0%	€ 700	€ 700	€ 700	€ 700	€ 848	€ 857	€ 1,298	€ 1,311	€ 1,324	€ 1,338	€ 1,351
TOTAL OF OTHER EXPENSES		€ 16,625	€ 16,625	€ 16,625	€ 16,625	€ 20,150	€ 20,351	€ 30,832	€ 31,140	€ 31,451	€ 31,766	€ 32,084
TOTAL PERSONNEL COSTS		€ 86,625	€ 86,625	€ 86,625	€ 86,625	€ 104,990	€ 106,039	€ 160,650	€ 162,256	€ 163,879	€ 165,518	€ 167,173

Appendix G.4.3-Personnel (Cont.)

Table 40 - Financial Plan - Personnel - Summery Board

Summary Board	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Compensations:											
Governing Bodies	€ 14,000	€ 14,000	€ 14,000	€ 14,000	€ 14,140	€ 14,281	€ 14,424	€ 14,568	€ 14,714	€ 14,861	€ 15,010
Personnel	€ 56,000	€ 56,000	€ 56,000	€ 56,000	€ 70,700	€ 71,407	€ 115,394	€ 116,547	€ 117,713	€ 118,890	€ 120,080
Social costs	€ 16,625	€ 16,625	€ 16,625	€ 16,625	€ 20,150	€ 20,351	€ 30,832	€ 31,140	€ 31,451	€ 31,766	€ 32,084
Accidents at Work Insurance	€ 700.00	€ 700.00	€ 700.00	€ 700.00	€ 848.40	€ 856.88	€ 1,298.18	€ 1,311.16	€ 1,324.27	€ 1,337.52	€ 1,350.90
TOTAL GASTOS COM PESSOAL	€ 86,625	€ 86,625	€ 86,625	€ 86,625	€ 104,990	€ 106,039	€ 160,650	€ 162,256	€ 163,879	€ 165,518	€ 167,173

Appendix G.4.4-Personnel Withholding Taxes

Table 43 - Financial Plan - Withholding Taxes

Withholding Taxes		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Withholding Taxes Social Security:												
Administration	11.00%	€ 1,540	€ 1,540	€ 1,540	€ 1,540	€ 1,555	€ 1,571	€ 1,587	€ 1,603	€ 1,619	€ 1,635	€ 1,651
Other Personnel	11.00%	€ 6,160	€ 6,160	€ 6,160	€ 6,160	€ 7,777	€ 7,855	€ 12,693	€ 12,820	€ 12,948	€ 13,078	€ 13,209
Personnel IRS withholding	15.00%	€ 10,500	€ 10,500	€ 10,500	€ 10,500	€ 12,726	€ 12,853	€ 19,473	€ 19,667	€ 19,864	€ 20,063	€ 20,263
TOTAL withholdings		€ 18,200	€ 18,200	€ 18,200	€ 18,200	€ 22,058	€ 22,279	€ 33,753	€ 34,090	€ 34,431	€ 34,775	€ 35,123

Appendix G.5 - Operating Fund

Table 46 - Financial Plan - Operational Fund

Oper.Fund	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Clients		€ 851	€ 4,028	€ 9,533	€ 17,278	€ 26,269	€ 35,658	€ 47,020	€ 64,452	€ 85,093	€ 105,994
Inventory		€ 126	€ 638	€ 1,534	€ 3,165	€ 5,080	€ 6,964	€ 9,350	€ 12,969	€ 17,526	€ 22,871
State											
TOTAL		€ 977	€ 4,666	€ 11,067	€ 20,443	€ 31,349	€ 42,622	€ 56,370	€ 77,421	€ 102,619	€ 128,865
Sources of Working Capital											
Suppliers	€ 860	€ 1,171	€ 3,659	€ 5,865	€ 8,458	€ 12,903	€ 17,314	€ 22,839	€ 31,231	€ 41,673	€ 53,637
State	€ 2,488	€ 2,791	€ 3,177	€ 5,028	€ 8,445	€ 11,025	€ 15,386	€ 18,707	€ 23,825	€ 29,593	€ 34,654
TOTAL	€ 3,348	€ 3,961	€ 6,836	€ 10,892	€ 16,903	€ 23,929	€ 32,700	€ 41,546	€ 55,055	€ 71,266	€ 88,291
Necessary Cash Reserves	-€ 3,348	-€ 2,984	-€ 2,170	€ 175	€ 3,540	€ 7,420	€ 9,922	€ 14,824	€ 22,365	€ 31,353	€ 40,574
Investment in Working Capital	-€ 3,348	€ 363	€ 814	€ 2,345	€ 3,365	€ 3,880	€ 2,502	€ 4,902	€ 7,541	€ 8,988	€ 9,221
STATE:	€ 2,488	€ 2,791	€ 3,177	€ 5,028	€ 8,445	€ 11,025	€ 15,386	€ 18,707	€ 23,825	€ 29,593	€ 34,654
Social Security (SS)	€ 1,738	€ 1,738	€ 1,738	€ 1,738	€ 2,106	€ 2,127	€ 3,222	€ 3,254	€ 3,287	€ 3,320	€ 3,353
Income Tax (IRS)	€ 750	€ 750	€ 750	€ 750	€ 909	€ 918	€ 1,391	€ 1,405	€ 1,419	€ 1,433	€ 1,447
VAT (IVA)	€ 0	€ 303	€ 690	€ 2,540	€ 5,430	€ 7,980	€ 10,773	€ 14,047	€ 19,119	€ 24,840	€ 29,853

Appendix G.6-Financing

Table 49 - Financial Plan - Financing

Financing	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Investment	-€ 3,348	€ 363	€ 4,902	€ 7,541	€ 8,988	€ 9,221	€ 0	€ 0	€ 0	€ 0	€ 0
Safety Margin											
Funding Needs	-€ 3,300	€ 400	€ 4,900	€ 7,500	€ 9,000	€ 9,200	€ 0	€ 0	€ 0	€ 0	€ 0
Sources of Finance	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Cash Flow Generation						€ 16,823	€ 12,289	€ 53,793	€ 118,726	€ 192,125	€ 256,272
Capital	€ 375,000										
Other equity instruments (+/-)											
Shareholder Loans											
Bank Financing											
Subsidies											
TOTAL	€ 375,000					€ 16,823	€ 12,289	€ 53,793	€ 118,726	€ 192,125	€ 256,272

Appendix G.7-Critical Point

Table 50 - Financial Plan - Critical Point

Critical Point	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Sales and Services Rendered		€ 8,300	€ 39,300	€ 93,000	€ 170,400	€ 260,700	€ 354,500	€ 468,700	€ 643,750	€ 852,630	€ 1,068,100
Changes in inventories and cost of raw materials		€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Costs of Goods Sold		€ 3,030	€ 15,305	€ 36,825	€ 75,960	€ 121,910	€ 167,145	€ 224,400	€ 311,250	€ 420,626	€ 548,910
Third party supplies and services		€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Gross Contribution Margin		€ 5,270	€ 23,995	€ 56,175	€ 94,440	€ 138,790	€ 187,355	€ 244,300	€ 332,500	€ 432,004	€ 519,190
Break-even point		€ 153,786	€ 179,581	€ 181,522	€ 209,586	€ 220,176	€ 325,953	€ 333,609	€ 339,828	€ 349,684	€ 367,926

Appendix G.8-Profits and Losses

Table 53 - Financial Plan - Profits and Losses

Profit Loss Account	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Sales and Services Rendered	€ 0	€ 8,300	€ 39,300	€ 93,000	€ 170,400	€ 260,700	€ 354,500	€ 468,700	€ 643,750	€ 852,630	€ 1,068,100
Costs of Goods Sold	€ 0	€ 3,030	€ 15,305	€ 36,825	€ 75,960	€ 121,910	€ 167,145	€ 224,400	€ 311,250	€ 420,626	€ 548,910
Third party supplies and services	€ 10,320	€ 10,320	€ 22,320	€ 22,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320	€ 10,320
Personnel Costs	€ 87,325	€ 87,325	€ 87,325	€ 87,325	€ 105,838	€ 106,896	€ 161,948	€ 163,567	€ 165,203	€ 166,855	€ 168,524
EBITDA (earnings before interest, taxes, depreciation, and amortization)	-€ 97,645	-€ 92,375	-€ 85,650	-€ 53,470	-€ 21,718	€ 21,574	€ 15,087	€ 70,413	€ 156,977	€ 254,829	€ 340,346
EBIT (earnings before interest and taxes)	-€ 97,645	-€ 92,375	-€ 85,650	-€ 53,470	-€ 21,718	€ 21,574	€ 15,087	€ 70,413	€ 156,977	€ 254,829	€ 340,346
Intrest and similar earnings	€ 5,729	€ 3,953	€ 2,269	€ 1,176	€ 688	€ 1,063	€ 1,227	€ 2,505	€ 5,234	€ 10,358	€ 16,492
EARNINGS BEFORE TAXES	-€ 91,916	-€ 88,422	-€ 83,381	-€ 52,294	-€ 21,030	€ 22,637	€ 16,314	€ 72,919	€ 162,211	€ 265,187	€ 356,838
Income Tax						€ 5,659	€ 4,078	€ 18,230	€ 40,537	€ 66,270	€ 89,209
NET INCOME	-€ 91,916	-€ 88,422	-€ 83,381	-€ 52,294	-€ 21,030	€ 16,978	€ 12,235	€ 54,689	€ 121,675	€ 198,917	€ 267,628

Appendix G.9-Cash Flow

Table 56 - Financial Plan - Cash Flow

Cash flow	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Project Cash Flow Generation											
Operating Results (EBIT) x (1-IRC)	-€ 73,234	-€ 69,281	-€ 64,238	-€ 40,103	-€ 16,288	€ 16,180	€ 11,315	€ 52,810	€ 117,733	€ 191,122	€ 255,259
Depreciation and Amortization	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Provisions	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
	-€ 73,234	-€ 69,281	-€ 64,238	-€ 40,103	-€ 16,288	€ 16,180	€ 11,315	€ 52,810	€ 117,733	€ 191,122	€ 255,259
Invest./Uninv Oper.Fund											
Operating Fund	€ 3,348	-€ 363	-€ 814	-€ 2,345	-€ 3,365	-€ 3,880	-€ 2,502	-€ 4,902	-€ 7,541	-€ 8,988	-€ 9,221
Operational Cash Flow	-€ 69,886	-€ 69,645	-€ 65,052	-€ 42,447	-€ 19,654	€ 12,300	€ 8,813	€ 47,908	€ 110,192	€ 182,134	€ 246,038
Investim./Desinvest. em Capital Fixo											
Fixed Capital	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Free cash-flow	-€ 69,886	-€ 69,645	-€ 65,052	-€ 42,447	-€ 19,654	€ 12,300	€ 8,813	€ 47,908	€ 110,192	€ 182,134	€ 246,038
Accumulated Cash Flow	-€ 69,886	-€ 139,531	-€ 204,582	-€ 247,030	-€ 266,683	-€ 254,383	-€ 245,570	-€ 197,662	-€ 87,470	€ 94,663	€ 340,702

Appendix G.10 - Financial Plan

Table 59 - Financial Plan -Financial Plan

Financial Plan	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
FUNDS SOURCE											
Cash Flow Generation	-€ 97,645	-€ 92,375	-€ 85,650	-€ 53,470	-€ 21,718	€ 21,574	€ 15,087	€ 70,413	€ 156,977	€ 254,829	€ 340,346
Equity Capital	€ 375,000	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other capital instruments	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Obtained Loans	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Divestment in Equity Capital											
Divestment in Operational Cash Flow	€ 3,348	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Financial Gains	€ 5,729	€ 3,953	€ 2,269	€ 1,176	€ 688	€ 1,063	€ 1,227	€ 2,505	€ 5,234	€ 10,358	€ 16,492
Total Funds Provided	€ 286,431	-€ 88,422	-€ 83,381	-€ 52,294	-€ 21,030	€ 22,637	€ 16,314	€ 72,919	€ 162,211	€ 265,187	€ 356,838
APLICAÇÕES DE FUNDOS											
Investment of Equity Capital	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Investment of Operational Cash Flow	€ 0	€ 363	€ 814	€ 2,345	€ 3,365	€ 3,880	€ 2,502	€ 4,902	€ 7,541	€ 8,988	€ 9,221
Profit Tax		€ 0	€ 0	€ 0	€ 0	€ 0	€ 5,659	€ 4,078	€ 18,230	€ 40,537	€ 66,270
Payment of Dividends											
Repayment of Loans	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Financial Charges	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Total sum of investments	€ 0	€ 363	€ 814	€ 2,345	€ 3,365	€ 3,880	€ 8,161	€ 8,980	€ 25,771	€ 49,525	€ 75,491
Cash Balance	€ 286,431	-€ 88,785	-€ 84,195	-€ 54,639	-€ 24,395	€ 18,757	€ 8,152	€ 63,938	€ 136,440	€ 215,663	€ 281,346
Accumulated cash balance	€ 286,431	€ 197,646	€ 113,451	€ 58,812	€ 34,417	€ 53,174	€ 61,327	€ 125,265	€ 261,705	€ 477,368	€ 758,714
Short Term Investments	€ 286,431	€ 277,181	€ 195,324	€ 143,070	€ 121,261	€ 142,664	€ 153,293	€ 219,645	€ 358,547	€ 618,087	€ 924,770

Appendix G.11-Financial Statement

Table 62 - Financial Plan - Financial Statement - Assets

ASSETS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Current assets	€ 286,431	€ 198,623	€ 118,117	€ 69,879	€ 54,860	€ 84,523	€ 103,949	€ 181,635	€ 339,126	€ 620,524	€ 953,466
Inventories	€ 0	€ 126	€ 638	€ 1,534	€ 3,165	€ 5,080	€ 6,964	€ 9,350	€ 12,969	€ 17,526	€ 22,871
Clients	€ 0	€ 851	€ 4,028	€ 9,533	€ 17,278	€ 26,269	€ 35,658	€ 47,020	€ 64,452	€ 85,093	€ 105,994
Governing bodies											
Partners											
Accounts receivable											
Deferrals											
Cash and cash equivalents	€ 286,431	€ 197,646	€ 113,451	€ 58,812	€ 34,417	€ 53,174	€ 61,327	€ 125,265	€ 261,705	€ 517,904	€ 824,601
TOTAL ASSETS	€ 286,431	€ 198,623	€ 118,117	€ 69,879	€ 54,860	€ 84,523	€ 103,949	€ 181,635	€ 339,126	€ 620,524	€ 953,466

Table 65 - Financial Plan - Financial Statement - Equity

EQUITY	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Paid-up Capital	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000	€ 375,000
Stocks											
Other capital instruments	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Capital Reserves		-€ 91,916	-€ 180,338	-€ 263,719	-€ 316,013	-€ 337,043	-€ 320,065	-€ 307,829	-€ 253,141	-€ 90,929	€ 133,338
Resultado liquido do periodo	-€ 91,916	-€ 88,422	-€ 83,381	-€ 52,294	-€ 21,030	€ 16,978	€ 12,235	€ 54,689	€ 162,211	€ 224,267	€ 267,628
TOTAL EQUITY	€ 283,084	€ 194,662	€ 111,281	€ 58,987	€ 37,957	€ 54,935	€ 67,171	€ 121,859	€ 284,071	€ 508,338	€ 775,966

Appendix G.11.1-Financial Statement(Cont.)

Table 68 - Financial Plan - Financial Statement - Liabilities

LIABILITIES	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Current Liabilities.	€ 3,348	€ 3,961	€ 6,836	€ 10,892	€ 16,903	€ 29,588	€ 36,778	€ 59,776	€ 95,593	€ 137,536	€ 177,500
Suppliers	€ 860	€ 1,171	€ 3,659	€ 5,865	€ 8,458	€ 12,903	€ 17,314	€ 22,839	€ 31,231	€ 41,673	€ 53,637
Governing Bodies	€ 2,488	€ 2,791	€ 3,177	€ 5,028	€ 8,445	€ 16,685	€ 19,465	€ 36,936	€ 64,362	€ 95,863	€ 123,863
Partners	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Obtained Loans	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0	€ 0
Other Accounts Payable											
TOTAL LIABILITIES	€ 3,348	€ 3,961	€ 6,836	€ 10,892	€ 16,903	€ 29,588	€ 36,778	€ 59,776	€ 95,593	€ 137,536	€ 177,500
TOTAL LIABILITIES + EQUITY	€ 286,431	€ 198,623	€ 118,117	€ 69,879	€ 54,860	€ 84,523	€ 103,949	€ 181,635	€ 379,663	€ 645,874	€ 953,466

Appendix G.12 - Main Indicators

Table 71 - Financial Plan - Main Indicators

MAIN INDICATORS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
ECONOMIC INDICATORS											
Growth Rate			373%	137%	83%	53%	36%	32%	37%	32%	25%
Profitability on sales		-	-	-56%	-12%	7%	3%	12%	18%	23%	25%
		1065.33%	212.17%								
FINANCIAL-ECONOM. INDICATORS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Return on Investment (ROI)	-32.09%	-45%	-71%	-75%	-38%	20%	12%	30%	48%	36%	28%
Asset Profitability	-34.09%	-47%	-73%	-77%	-40%	26%	15%	39%	46%	41%	36%
Asset Turnover	0.00%	4%	33%	133%	311%	308%	341%	258%	190%	137%	112%
Return on Equity (ROE)	-32.47%	-45%	-75%	-89%	-55%	31%	18%	45%	57%	44%	34%
FINANCIAL INDICATORS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Financial Autonomy	98.83%	98%	94%	84%	69%	65%	65%	67%	84%	82%	81%
Overall Solvency	8556.57%	5014%	1728%	642%	325%	286%	283%	304%	616%	553%	537%
Coertura dos Encargos Financeiros											
LIQUIDITY INDICATORS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Current Liquidity	85.57	50.14	17.28	6.42	3.25	2.86	2.83	3.04	6.16	5.53	5.37
Low Liquidity	85.57	50.11	17.19	6.27	3.06	2.68	2.64	2.88	5.92	5.37	5.24
RISK INDICATORS	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
Gross Margin	-10,320	-5,050	1,675	33,855	84,120	128,470	177,035	233,980	322,180	421,684	508,870
Operational Leverage	10.57%	5%	-2%	-63%	-387%	595%	1173%	332%	205%	165%	150%
Corporate financial leverage	106.23%	104%	103%	102%	103%	95%	92%	97%	97%	96%	95%