LISBON
SCHOOL OF
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UNIVERSIDADE DE LISBOA

MASTER IN
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MASTER'S FINAL WORK
PROJECT

THE LEAN STARTUP APPROACH IN THE IMPLEMENTATION OF A CHILDREN LOCATION DEVICE

ANA RITA GRANJO DE AZEVEDO VIEIRA PITA

OCTOBER-2019

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SUPERVISION:

MANUEL DUARTE MENDES MONTEIRO LARANJA

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ABSTRACT

In this master thesis, The Lean Startup methodology is used to develop a business solution of a wearable device that is able to track children.

Every day, all around the world, children go missing. In 2018 Missing Children Europe organization stated that in Europe 250,000 children are reported missing every year, 1 child every 2 minutes. As their motto: "One Missing Child Is One Too Many" it's urgent to assist parents to track their children. But even though many children tracking systems have been proposed, there are high costs and energy limitation of locators as well as wearability problems. A way to address this challenge is to design a wearable children tracking system that traces the child position and sends it to the parents without using a subscriber identity module (SIM) card reducing adoption costs and with a much higher range than a Bluetooth system.

Applying The Lean Startup methodology to the Business Model Canvas will allow us to discuss possible business models because, at the early stage of new product development, it is imperative to create validated knowledge. The main objective is to take advantage of Lean Startup (TLS) principles, such as entrepreneurship, validated learning; innovation accounting; the build-measure-learn cycle so that in the future it is possible to develop a business plan for a new child traceability product and thus maximize the chances of success for the startup. Using this approach a solution was created and tested, and customer feedback was used in the initial development process, streamlining and restructuring the business model.

Key words: Lean Startup; traceability; problem testing; solution testing

RESUMO

Nesta dissertação de mestrado, a metodologia Lean Startup é usada para desenvolver uma solução comercial de um dispositivo vestível capaz de rastrear crianças. Todos os dias, em todo o mundo, crianças desaparecem. A organização europeia para crianças desaparecidas afirma que na Europa são relatadas 250.000 crianças desaparecidas a cada ano, uma criança a cada 2 minutos e, como eles afirmam,: "Um criança desaparecida é demais". Porém existem altos custos e limitação de energia nos localizadores, além de outros problemas. Para enfrentar esse desafio, projetou-se um sistema de rastreamento de crianças que rastreia a posição da criança e a envia aos pais sem a necessidade de usar um cartão SIM, reduzindo custos mensais, com um alcance muito maior que o sistema Bluetooth e de fácil utilização pela criança.

A aplicação da metodologia Lean Startup permitirá debater possíveis modelos de negócios uma vez que, no estágio inicial de desenvolvimento de novos produtos, é imperativo criar conhecimento validado. O principal objetivo neste tipo de abordagem é tirar proveito dos princípios do The Lean Startup (TLS), como Validated Learning; Innovation Accounting; ciclo Build-Measure-Learn por forma a no futuro poder desenvolver um plano de negócios para um produto de rastreabilidade de crianças e maximizar as chances de sucesso desta startup. Usando essa abordagem, uma solução foi criada e testada e o feedback do cliente foi usado no processo de desenvolvimento inicial, simplificando e reestruturando o modelo de negócios.

Palavras-Chave: Lean Startup; rastreabilidade; teste ao problema; teste à solução

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BML – Build-Measure-Learn (feedback loop).

LoRa – Long Range

MVP – Minimum viable product

PCB – Printed Circuit Board

PWD – Portuguese Water Dog

TLS – The Lean Startup

CES - Consumer Electronics Show

1. Introduction

According to Ries (2011) the author of The Lean Startup (TLS) methodology, "there are more entrepreneurs operating today than at any previous time in history" but, as shown by a Harvard Business School research, 75% of all start-ups fail (Ghezzi et al 2015). In fact, the restless entrepreneurs take the "just do it" approach avoiding all forms of management, process and discipline as if it was a shortcut towards their vision. And, by not taking enough time to analyze the strategy, the impatient and eager entrepreneurs, suffering from overconfidence bias and overestimating their knowledge, rush to product development with just a few preliminary customer conversations (Ries, 2011), So, the problem is not strategic but rather working with inaccurate and invalid business assumptions as product development guidelines (Ries, 2011).

The proposed contribution of this thesis is to address an idea for a tracking device using The Lean Startup (TLS) principles. These principles are validated knowledge through hypothesis testing as well as running incremental product iterations backed up by customers insights (Ries, 2011). In order to maximize the chances of success it's necessary to mitigate the product-market fit risks by attending three criteria: customers' willingness to pay for the product, customer aquisition is less expensive than the price of the product and finally that there's sufficient evidence that the market is large enough to support the business (Cooper et al., 2013). An objective of this work is to describe and evaluate the process of developing a startup model using The Lean Startup methodology (TLS), identifying and analyzing the steps and tools to reach the final business proposal.

The thesis is divided in three parts: literature review, execution of the lean startup methodology and its results and conclusion. In the first part, the literature review, the data collection was mostly from classical literature, such as books and academic journals on entrepreneurship and on Lean Startup. The data collection for the execution of the lean startup approach was primarily quantitative in the form of an online survey with 114 valid answers but secondly, and more important, was qualitative in the form of interviews with potential customers that could be used to reject or validate the defined hypothesis. Although the restricted time to deliver this master thesis, the results of the Lean Startup approach were critical and allowed to go through the Build-Measure-Learn loop two times pivoting the initial idea to a completely new concept and product. What started as the vision of a swimwear collection that could trace a child has pivoted to a pin with the firm logo plus a receiver that can be put in a keychain. Finally the conclusion states all the learnings and different outcomes that the application of The Lean Startup methodology allowed and also the further work to be developed.

2. Literature Review

2.1. Entrepreneurship, Opportunities and Startups

The Global Entrepreneurship Monitor defines entrepreneurship as "any attempt at new business or new venture creation, such as self-employment, a new business organization or the expansion of an existing business, by an individual, a team of individuals, or an established business" (GEM, https://www.gemconsortium.org/). Although this definition of entrepreneurship can take a broad view, it recognizes new business activity, as not being restricted to newly registered businesses (Bosma, 2012). Stevenson, Roberts, and

Grousbeck (1989, p. 23) define entrepreneurship as "a process by which individuals, either on their own or inside organizations, pursue opportunities without regard to the resources they currently control" . Entrepreneurship can then be understood as the creation of new, growth oriented firms that bring together the resources necessary to exploit an opportunity in order to create value. Later, Zimmerer and Scarborough (2008) mention that entrepreneurship is the creation of new businesses in conditions of uncertainty and risk in order to make a profit by applying innovation and creativity to the opportunities and needs in the market, in a systematic and disciplined process.

According to Dees (1998, p.4), entrepreneurship is "the pursuit of opportunity without regard to resources currently controlled". This definition accentuates the shortage of resources that all entrepreneurs face, such as financial capital, human capital, intellectual property and access to distributors (Collins, 2016). For Johnson (2001, p. 137) an entrepreneur can be seen as "an individual who takes agency and initiative; who assumes responsibility and ownership for making things happen; is both open to and able to create novelty; who manages the risks attached to the process; and who has the persistence to see things through to some identified end-point, even when faced with obstacles and difficulties".

For Ries (2011), the author of the Lean Startup (TLS) entrepreneurs are everywhere and entrepreneurship is the management of a human institution designed to create new products and services under conditions of extreme uncertainty (Ries, 2011). People usually find ingenious ways to solve their problems, however, not every opportunity is a business opportunity worth engaging since only solutions that touch a sizeable customer segment can be qualified as business opportunities. Successful entrepreneurs need to recognize

problems that afflict an exploitable group of people as well as take into consideration the opportunity cost of doing it (Ries, 2011).

On the other side of the benefits and opportunities of entrepreneurship, there is failure (Wapshott and Mallett 2018). In fact, in order to exploit successfully an entrepreneurial opportunity there has to be a translation of that opportunity into a viable business model (Amit and Zott, 2001). Nowadays we live in an era of unprecedented worldwide entrepreneurial renaissance, but this opportunity hides many perils since for every success there are far too many failures (Ries, 2011). For Ries (2011), who introduced TLS approach, the problem with most entrepreneurs is not strategic but rather working with invalid and inaccurate business assumptions as guidelines for product development. The liberal implementation of startup management principles is then still to be standardized to a comprehensive and thorough methodology from which startups could draw substantial value (Maurya, 2012).

The most common entrepreneurial enterprises, are the new ventures we designate as startups. In a startup, the key variables an entrepreneur should take into consideration are the search for the best opportunities and how to approach the environment of extreme uncertainty. This inherent uncertainty in the entrepreneurial activities makes opportunity costs harder to perceive, therefore deceiving entrepreneurs to take greater risks on the new ventures (Holcombe, 2003). Ries (2011, p.8) defines startups as being "human institutions designed to create a new product or service under conditions of extreme uncertainty". Another definition of a startup comes from Blank (2007, p.27) and he defines a startup as "an organization that seeks a repeatable and scalable business model". We can describe startups combining this two definitions as an organization that operates

in a scenario filled with unknown variables, that seeks for a business model that is scalable, repeatable and most of all profitable.

Increasingly, startups seek to improve and modernize their business development processes in order to make them efficient and effective. However, classic management methods for large companies are not suitable for early stage ventures (Blank, 2007) because startups are not smaller-scale versions of large companies, and don't operate in well-known markets (Blank & Dorf, 2014). From this context, emerged the Lean Startup methodology that aims to present to the entrepreneurs a process to minimize the market risks, and to assist them in finding a solution and a suitable market for the business.

2.2. The Lean Startup

Lean Startup comes from Lean Thinking, which was the management approach applied in Toyota's factory production system that made it rise to its prominence. Taiichi Ohno was an industrial engineer and manager at Toyota Motor Corporation that rose up to the executive level, and is considered to be the father of the Toyota production system, which became the foundation of Lean Manufacturing in the United States. When confronted with the western production systems inefficiencies, he diagnosed several production flaws such as high inventory levels which consumed precious storage space, and high production defect rates which disrupted assembly line fluency, as well as limited consumers' variety of choice due to the Holweg (2007, p.422) "inability to accommodate consumer preferences for product diversity. The lean production system evolution resulted in philosophies and methodologies that companies should seek to follow in order to maximize their performance such as specifying what customers truly perceive as value and identifying which steps of the value stream

aren't adding value to the product from the customer's perspective. But also, establishing a production pull system, making value flow from the beginning to end of production as well as a vision of striving for perfection (Womack and Jones, 2003). Some of these Toyota Production System principles were then transcribed to be applied in startups development resulting in The Lean Startup methodology with three central principles: the goal of minimizing waste, the culture of continuous improvement and the importance of measuring the big picture (Ries, 2011). TLS methodology should theoretically help companies maximize their chances of success combining customer development approach (Blank, 2007) with software development techniques and lean management practices (Womack & Jones, 2003).

According to Ries (2011), all this startup failures are a waste of our civilization's time, passion, and people's skill. The introduction of new products or innovative business models in the market is subjected to high levels of risk and generally overconfidence bias on the success (kahnemano, 2000). Coupled with these are the additional problems of rushing to product development and the overestimating of knowledge, abilities and accuracy of customer feedback which exceeds all forms of management, process and discipline, and leads to failure (Ries, 2011). The Lean Startup (TLS) movement, dedicated to preventing these failures appear, in the entrepreneurial context, to promote a guide line to help entrepreneurs have greater chances of success (Ghorashi, 2015). TLS reconceives the startups' effort to design scientific experiments that test its strategy assumptions and help understand which aspects are plausible and which are erroneous (Ries, 2011).

The Lean Startup methodology has it's foundations in five tools: validated learning, minimal viable product, build-measure-learn loop, preserve or pivot and innovation accounting that will be addressed in the following points.

2.2.1. Validated Learning

Influenced by the lean production theory, Ries (2011) purposes hypotheses about the business model that are to be tested via continuous experiments, promoting in this way minimal waste in terms of time and money and building capital-efficient companies. The validated learning is the type of learning methodology that is acquired through hypothesis testing and is the pillar to all startups development as they should be engineered to create knowledge in order to build sustainable and profitable businesses.

According to Ries (2011), there are two important hypotheses: the value hypothesis and the growth hypothesis. He defines the value hypothesis as being a (Ries, 2011, p. 67) "test whether a product or service really delivers value to the customer once they are using it" and the growth hypothesis to the "test how new customers will discover a product or service" (Ries, 2011, p. 68).

Balser (2015) refers that in order to translate assumptions into hypothesis the person has to understand what a hypothesis really is. As Osterwalder (2014, https://www.strategyzer.com/blog/posts/2014/9/29/value-proposition-design) states a business hypothesis definition could be: "Something that needs to be true for your idea to work partially or fully but that hasn`t been validated yet. So, for a hypothesis to be a falsifiable hypothesis, it has to be a statement that can be proven wrong".

2.2.2. The Minimum Viable Product

Frank Robinson, in 2001, coined the term "Minimum Viable Product" (MVP) as an unique product with the least risk or effort and the highest return on investment for the supplier and the customer. The MVP is a fundamental concept of TLS methodology. Ries (2011, p.82) defines MVP as "a version of a new product, which allows a team to collect the maximum amount of validated learning about customers with the least effort".

The MVP evolves from the stages between product conception and product-market fit. Ries (2011) stresses that fundamentally a lean startup is a series of MVP's, each designed to answer specific questions (hypothesis) to generate validated learning. For Copper et al (2013) when learning, is more important to build experiments that can contain different features instead of just building features over features in a new product.

So, the MVP is an early product prototype with the purpose of assessing early adopters' reactions and collect truthful feedback to proceed with the product development process (Frederiksen et al, 2017). By letting customers get in contact with the product sooner rather than later this will prevent the startup from spending unnecessary resources on developing features that might not add any value to the customer, and thus could reduce potential waste (Ries, 2011).

Building a MVP, that is an early version of the product with a smallest set of features, enables the entrepreneur to learn customers' requirements before investing a lot of money in building a product that no one wants. Therefore releasing small versions of the product allows to test results and diagnose problems near the early adopters that are willing to buy the first version of the product even if it doesn't have all the "nice to have" features (Eisenmann et al, 2012).

2.2.3. The Build – Measure – Learn Loop

One of the fundamental concepts of the lean business model is the Build-Measure-Learn (BML) feedback loop. The final goal of the Build-Measure-Learn cycle is learning (Ries, 2011) and it includes three stages: building the idea, measuring customer satisfaction and learning. The "Build Stage" represents essentially turning the initial idea, into an early prototype to test some key business model hypothesis with the least amount of effort and resources. By gathering the feedback from costumers, new features might appear as well some could disappear. In the "Measure Stage", it's necessary to identify which are the key performance indicators that measure customer satisfaction towards the product development incremental changes, and if those improvements deliver more value in the customers' perspective. Finally, the "Learn Stage" reports what path to take which can be to either persist with the current direction or adjust the course of action. For Ries (2011), entrepreneurs must treat the BML as a scientist and therefore apply the scientific method formulating falsifiable hypotheses and run multiple experiments, to prove them validated or rejected. Only focusing on minimizing the total time it takes to go through the entire loop can the entrepreneur eliminate the unnecessary waste of resources (Ries, 2011). Therefore the build-measure-learn starts with the learning goal (theory or hypothesis) and ends with an experiment (prototype) to test the hypothesis.

2.2.4. Persevere or Pivot

Following the Build-Measure-Learn feedback loop the company will conclude if it should pivot its business strategy: make a turn and steer the strategy into a different direction than before or if it should persevere in the current direction (Ries 2011). In the persevere situation entrepreneurs can either keep validating

hypotheses or if all hypotheses are validated prepare to scale (Eisenmann et al, 2013). Ries (2011, p.169) defines a pivot as a major shift, a strategic course correction "designed to test a new fundamental hypothesis about the product, business model, and engine of growth".

For Ries (2011), there are three types of Engines of Growth: the "Sticky Engine of Growth" that is related to the number of customers engaged with the product or retention rate of customers; the "Paid Engine of Growth" that is related to the number of new customers and the "Viral Engine of Growth" that can be defined as the number of new customers signing up as a result of one new customer reflection of the word of mouth.

If a company tests the hypotheses and analyzes the results it will be able to understand if it is reaching its customers and adding value. But if instead they are not actually adding value as revealed by the experiments it is time to pivot and start over with testing new hypotheses. In this way the company avoids unnecessary waste of time and money and realizes in an early stage if there is a need for change (Ries, 2011). The entrepreneurs may decide to pursue alternative courses of actions, pivoting, if the MVP rejects the business model hypothesis or the customer feedback directs entrepreneurs to other advantageous possibilities, (Eisenmann et al 2013). So, pivot is an essential concept in the entrepreneurial world as learning more about their customers and their changes the elements of the customer-problem-solution hypothesis and eventually the business model (Cooper et al., 2013).

As Ries (2011) asserts, successful pivots put entrepreneurs on the right track toward growing a sustainable business and that pivoting when faced with failed

hypothesis lead entrepreneurs to head into new directions keeping all previous and useful validated learning.

2.2.5. Innovation accounting

The key indicator on how the product development is actually leading the firm to progress is the measure of the performance of the MVP in the experiments. For that, Ries promotes a method called "Innovation Accounting", a quantitative method aiming to show if the company is working in the right direction.

Innovation accounting is a specific metric that allows entrepreneurs to maximize outcomes and to plan milestones. It gives the indication on where to prioritize and what are the calculated risks making sure the right signals are being fed back into the build-measure-learn loop that validates or rejects hypotheses (Ries 2011).

The "Innovation Accounting" consists of three steps or "learning milestones". First the company needs to map its current situation by establishing its baseline, measuring data generated from the MVP. Secondly the "tuning the engine" means to make micro changes and optimizations of the baseline product until reaching the desired ideal. Finally the "decision point" determines whether to pivot or persevere the current business strategy (Ries, 2011).

3. Methodology

This master thesis purpose is to develop a product for an idea that is at an early stage using The Lean Startup methodology. But, although it is important to choose an organization scheme that best fits the specifications and needs of the business to be created, there is no conceptual need to follow a pre-determined model as long as it indicates what is the critical information to be included (Wheelen et al, 2010). The lean startup methodology doesn't focus

on one research philosophy of epistemology, ontology or axiology but rather takes a pragmatist philosophical position focusing on the research question. The method for research depends on the question itself and both qualitative and quantitative research are used.

The final aim of this study is to develop and launch a product using TLS methodology the original vision will be defined according to the problem and its potential solution will follow the entrepreneurs' assumptions leading to falsifiable business model hypotheses that can be rejected or accepted through decisive experiments. (Maurya, 2012). These experiments will primarily take the form of interviews to potential customers, designed in such a way qualitative metrics are used for validation. The decision to reject or validate a hypothesis should rely upon real feedback from the interview's outcomes. Since the product to be developed is a children tracking device, interviews must take place in kindergarten schools as well as parks in Lisbon in order to reach the targeted customer segment, the parents.

In the process of evaluating the hypothesis, getting in touch with the persons can be challenging. In this thesis the snowball sampling technique was used (Balser, 2015). In this technique the founder wrote down three names of friends that share the same characteristics and contacted them for the interview as well as to ask if they could enable introductions to other people, which share the same characteristics. The answers from friends were handled with more care, since those might be biased by familiarity with the idea and sympathy for the entrepeneur. The problem interview structure used a compilation of ready to use questions that can be customized to the problem in hands, as presented in Balser (2015) and incorporated in Appendix 1. and the number of interviews should be

within the range of ten to twenty interviews for each round of interviews (Blank, 2013a; Maurya, 2010; Wilcox, 2014). One important aspect to be taken into account is that the original template of the interview cannot be static so the script may suffer changes to accommodate for the encountered behavior.

4. Analysis of the Market

4.1. Need, Problem, Solution

As stated in the introduction, in Europe alone, an estimated 250.000 children are reported missing each year, 1 child every 2 minutes. In the United States, a child goes missing every 40 seconds, which comes to 765.000 children a year (https://www.fbi.gov). These are surprising and impressive numbers, and make voice for the parent's worst fears which is to lose their child. Parents have an intrinsic need to always know that their kids are safe thus ensuring peace of mind for themselves. Also, if the child has special needs and requires special attention tracking them will help parents to keep them out of potential trouble or danger.

This business idea came about because 2 of my 4 kids are elopers, they runaway whenever they see a chance or wander away and most frequently in less confined spaces like the outdoors (e.g. the beach). Going in line with this preoccupation, the Portuguese police initiated in 2016 the program "Estou Aqui" that consists on tagging the child with a number on a bracelet. If the child would get lost, the contacts of their parents could be provided in any police station from the bracelet identification. This is clearly insufficient to prevent problems and assay fears. This strategy depends on strangers encountering a lost child and for them to take the child to safety or to the nearest police station. Even if the child is found, during the child disappearance it could have been in risk of traffic, abduction and malfeasance. It is clear that there are many instances where the bracelet would

be useless. Many of the parents and caregivers feel the need to know and have easy access to the current location of their children.

There are a lot of ways for parents to track their young children: wristbands, belts, watches and even smartphones enable the tracking of older children with features such as iPhone's "Find my friends". But all of these (currently available in the market) either require a monthly fee (e.g. via a SIM card) are either cumbersome or if small and light (carried as a pendant) have a very small range (i.e. inferior to 30m due to Bluetooth limitations). So, there was a need to track children in the outdoors (e.g. beaches, woods, lakeshores) with no monthly fee, no dependency on internet/mobile coverage and with a comfortable range (hundreds to thousands of metres). The solution was a location device embedded in a bathing suit or a piece of clothing. After attending the CES Conference in Las Vegas in January 2019, I discovered that the range would be possible by using LoRa[1] radio technology (short for LOng RAnge). LoRa is a long range, low power wireless platform, that uses a spread spectrum modulation technique operating in the ISM[2] (Industrial, Scientific and Medical free band) and has become the de-facto technology for Internet of Things (IoT) networks worldwide.

This technology breakthrough, together with the idea to use wearable PCBs (Printed Circuit Boards) and flexible shaped batteries would allow the building of a device that can communicate without the need of a digital cellular network infrastructure. These technologies combined, add differentiation to the already existent products, via product design because the tracking device would be embedded in the children bathing suit with no need for a monthly fee or contract

[1] https://www.semtech.com/lora/what-is-lora
[2] https://www.techopedia.com/definition/27785/industrial-scientific-and-medical-radio-band-ism-band

and available or "strong" mobile/internet connection which is another differentiator aspect.

4.1. Analysis of the consumer customer

In order to identify and assess our customer profile we conducted an online survey that we got 114 answers and the results are described in APPENDIX 2. Our prospective consumer is then of both genders (64% female and 36% male), with main age segment being older adults (41-50 years: 47%, 31-40 years: 30%). They identify the beach and the mall as main places where is easy to loose a child, 64% had already thought of having a device to locate their child and 78% would like to have a real time location in their smartphone. Around 60% are interested in helping to test this device and gave us their personal contacts. Regarding the price, the average price identified in the survey was 76€.

4.2. Competitor analysis

In the location devices, consumers are searching for the most effective product at the lowest possible price and emphasizing on ease of use with reliability. An online research showed that all current competitors with similar products require internet connection to actually locate the missing person, while incurring monthly fees ranging from €5 - €30 per month due to necessity of a mobile connection with a SIM card. In essence, their systems dictate that the users must be located at their internet-accessible place in order to use the competitors' systems. On the other side there are the devices that don't need internet connection online because they use Bluetooth connection to locate the child which limits the range to 300m or less. The most significant difference is that the PWD system is not reliant on being in an area where cellular towers exist with the range 100x

superior to Bluetooth and by simply wearing it. This important difference of wearabilty and safety translates into peace of mind to the caregivers. On the other hand, the analysis of the 5 competitive forces of Porter reaffirms that the competitors are low in terms of competitive rivalry since it wasn't found any competitor with the same features. The threat of new entrant is medium since the copycat will lead to the birth of new competitors and for last, the biggest threat is the supplier power, due to commercial relations with Chinese suppliers that can shift regardless of contracts and agreements. To mitigate this risk, it's indispensable to patent this location device as well as "start early and run faster" in order to gain market share.

4.3. Trends

The wearable tracking device industry is fairly new in the consumer market, but it is the beginning of a new industry that as the potential for explosive growth due to the rapidly decreasing technology cost,. The primary target market include, but are not limited to, the family consumer namely children. But this system will also appeal strongly to families concerned about the safety of their loved ones. Sadly, child abduction is on the rise globally and PWD device will help to reduce these figures, while potentially saving lives. In order to connect with family tech-savvy consumers the focus should be on the brand image that is also the product added by the online presence with the accessibility of a mobile site. Digital marketing strategies and tools in order to connect to the family shoppers and provide an excellent buying experience and launching and targeted marketing campaigns as tracking devices are more often purchased in holidays season. Finally, engage with consumers via personalized digital marketing campaigns by focusing on offer alerts, special promotions and direct customer marketing

4.3.1. Definition of the relevant market

To define the TAM – Total Addressable Market it was considered that there are about 7.7 billion people alive today(1) and that everyone, either male or female, has a mom. The potential users of this device are children with less than 14 years, that round 1.958 billion in the world. In Worldometers, on average every couple has 2.36 children (in Wikipedia), so the number of potential mother/parents will be 0,821 our Total Addressable Market.

For the SAM – Served Addressable Market it was taken into account the fact only the parents with internet access can be aware and buy PWD product, since it will only be available in an online sale channel. Estimates from International Telecommunications Union state that 48% of the world population are internet users so our TAM reduces to 394 Million. Additionally, according to the online survey(Appendix 2, 114 answers), the number of parents that are afraid of loosing their child is 81%. So, our SAM shall be 319 Million parents.

For the Target Market we took into account the estimate from survey (Appendix 2, 114 answers) of the number of potential customers that had already thought of having some device that would give them the real location of their child (64%), and would like to have a real time location of their child in a smartphone (79%) which combined represent a target market of 161 Million of "potential" parent customers for our product with children with the age <14).

5. The Lean Startup Approach

Before using The Lean Startup approach to test the problem and the solution, a quantitative method in the form of a survey was launched to test if parents:

- Were indeed afraid of losing their children
- Felt the need for a tracking device for their children.

The objective of this survey was to effectively quantify attitudes and behavior of parents instead of hitting a dead end in the following qualitative methods: problem/solution interviews. The survey was diffused via email and social media such as Facebook, timed just under 3 minutes and was active for almost two months (from May 9, 2019 to June 25, 2019) closing with 114 valid and complete responses. The results that are presented in the Appendix 2, show that 80% of the inquired parents are in fact very afraid of losing their children (Question n.º 5, where 43% answered panic about it) and 80% of the parents would like to have the localization of their child in their smartphones (Question n.º 12).

5.1. The Problem Interview

The problem interview with potential customers are defined to be the first interviews a startup should conduct, because it will provide an understanding of underlying opinions, motivations and reasons, behind the stated behavior. This will validate whether the identified problem is relevant enough and also develop ideas and hypotheses for further potential qualitative research in the solution interview. Without this approach, the project could turn into a faith-based passion endeavor without a systematic roadmap. This was the correct point in the project evolution to understand customers' perception with proper testing of hypotheses and assumptions.

The first critical step in this approach is to write down the initial vision and sharing it with other people : "Children get lost every time, especially in the beach and because of that parents urge for a tracking device for children within the swimwear they wear and with high range and no monthly fee (no SIM card)". Both acquaintances, colleagues and other parents were interviewed in the Jamor park – an outdoor area that serves to evoque the problem. The problem interview was

conducted with ten inquired possible customers. The customers segment can be described as adults, from thirty to fifty years, who take care of one or more children and are afraid of losing their child.

In order to validate the problem three main hypotheses were formulated:

a. A tracking device in children swimwear as kids get more lost in the beach
b. It's important the range, the precision, and the no monthly fee.
c. The tracking device should be imbibed in the clothes.

To solve these problems a prototype started to be developed as a first step to the final product, to test usability and interest with the prospective customers and to understand the technological and business obstacles to the realization of the full product and solution.

5.1.1. The Problem Interview Results Analysis

Due to time limitations there was only one round of 10 interviews regarding the hypotheses stated in 4.2. All 10 interviews were taken in the park of National Stadium of Portugal, face-to-face and were held between the first of July 2019 to the first of August of 2019 (Appendix 3)

In total, there were 8 mothers and 2 fathers, with one or two kids, totalizing 7 boys and 8 girls with mean ages of 5,6 years and 4,8 years respectively. The problem interview script revealed itself to produce a clear and direct data collection but also flexible enough to allow unexpected interviewees comments and opinions. No script changes were made during the whole interview process.

After retrieving the insights it was necessary to categorize qualitative answers, using the technique of "Cutting and Sorting" to validate or invalidate the hypotheses, and to compare the previously stated hypotheses with the actual outcome of the interviews (Wilcox, 2013). Due to the limitation of time for this

thesis and the reduced number of interviews the technique of cutting and sorting will validate hypothesis if at least three people mention what kind of tracking device and what characteristic they seek (see Appendix 4).

Regarding the hypotheses a (Ha) "a tracking device in children swimwear as kids get more lost in the beach" 60% of the inquiries responded option t-shirt and most of all the only two mothers that answered swimwear were thinking about underwear. In fact 8 out of the 10 parents interviewed, answered they preferred the location device to be embedded in the clothes of the children and not specifically and only in swimwear. The reasons were stated in the second question of the interview and mentioned: "easy to wear", "more versatile than a bathing suit", "can be worn in more places than the beach". This overwhelming proportion of answers, invalidated the Ha hypothesis and leads us to the first pivot for this startup. The product should allow to be used in more places than the beach (parks, and other gatherings) and even used as underwear. In addition to this, in the question "Do you think it's missing any additional resource?" 4 parents responded that the device should be in other types of clothes and not just t-shirts. The aim was that the product should be more versatile than a t-shirt but not a bracelet , which although versatile enough, is easily recognized as well as a token to be taken away by the children (see answers at question 1 in Appendix 2). Thus, the product imagined to be a swimsuit changed dramatically to clothes adding also variety. A set of multiple different ideas were then gathered with the interviewed for the solution interview: "*in the brand logo*", "*sewed in the clothes*", or even in "*the tag of the clothes*". But in all these iterations, one feature remained unaccomplished: "Versatility". The solution came further ahead after the solution interviews, when showing the prototype and testing it with real users with the APP

that displays the child location with a pin. After some considerations this aspect brainstormed into the new idea of having the location device put inside of a pin (in Portuguese we also say pin) that could be placed anywhere in the children clothes. This first pivot changed everything in the product features so as to be much more directly aligned to the customers' needs but also removing the business problem of having to produce clothing which is not the core business of this firm. This pivot had many implications such as for example removing the need for new designs and collections every year and the necessity of a inventory of clothing apparel in many shapes and sizes.

Regarding the hypotheses b (Hb) "It's important the range, the precision, and the no monthly fee." and after using the technique of "Cutting and Sorting" in question 7: "Imagine yourself in the decision process of buying such an article, what were the elements you take into account?" the answers clearly validate this hypotheses as they were stated by at least six parents.

Finally regarding the hypotheses c (Hc) "the tracking device should be impregnated in the clothes", this allusion to the discretion (i.e. camouflaging) of the device was clearly identified in the interviews, question 1c) "What is the indispensable characteristic?" when 5 parents said "discretion" validating Hc.

The following Figure 1 clarifies the cutting and sorting technique used to validate or invalidate the problem hypotheses

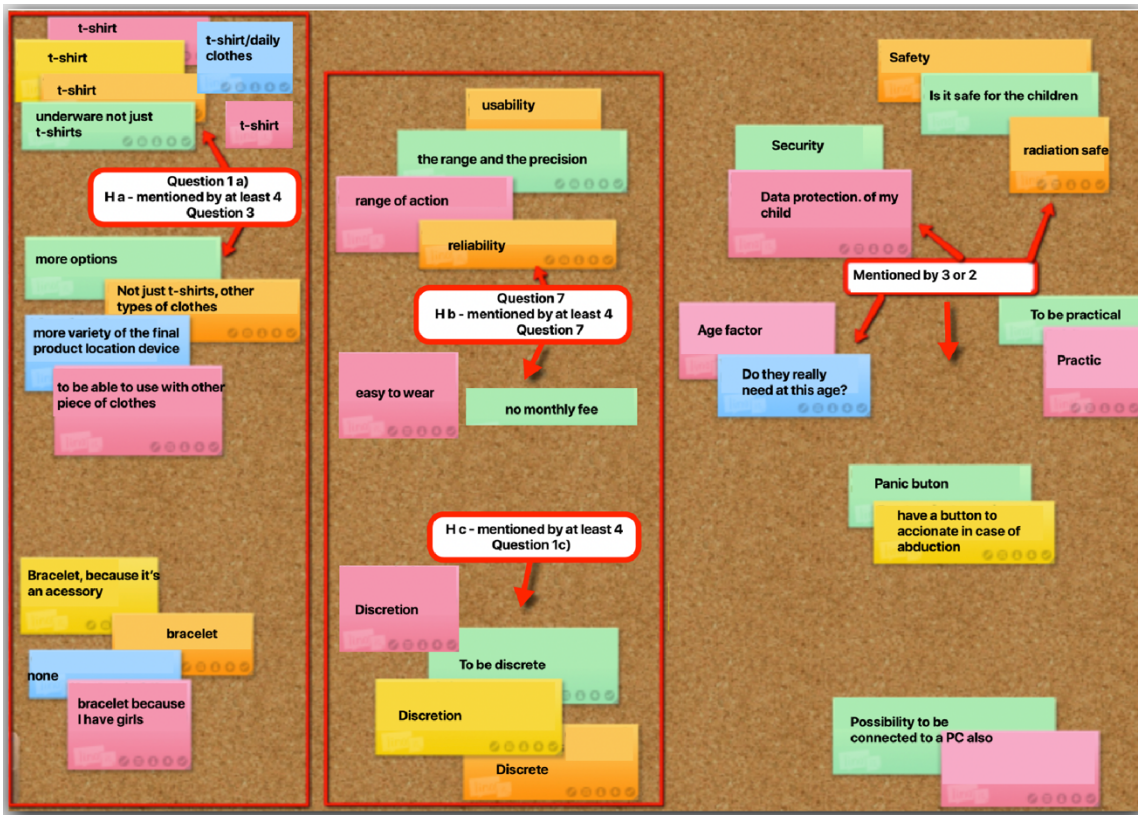

Figure 1 - Qualitative analysis – Cutting and Sorting

Finally, and although this kind of information didn't contribute to the validation of the hypotheses it's important to refer that in the interview, 90% of the interviewees said they would be prone to wear this kind of location device immediately (Question 4 in Appendix 2) and an overwhelming 80% was willing to pay 70€ for it (Question 6 in Appendix 2). In summary, given the interview data, two of the three problem hypothesis were confirmed and one invalidated the first one that stated the type of product imagined. All of interviewees resonated with the problem statements and showed interest to help and to in knowing more about what was going to be developed.

5.2. Prototype

The PWD name stands for Portuguese Water Dog, a Portuguese dog breed that it's known for its capability to carry messages from ship to ship or ship to shore

and retrieve lost tackles, broken nets and even fisherman from the sea. The PWD product is an electronic waterproof remote personal locator in the form of pin. It uses unassisted GPS/GSM technology-called LoRa that operates in a frequency which is not reliant on cellular tower to relay data.

In order to collect the maximum amount of validated learning about the solution a prototype was build according to the specifications in Appendix 5. It is composed of 2 devices, a sender and a receiver as the Figure 2.

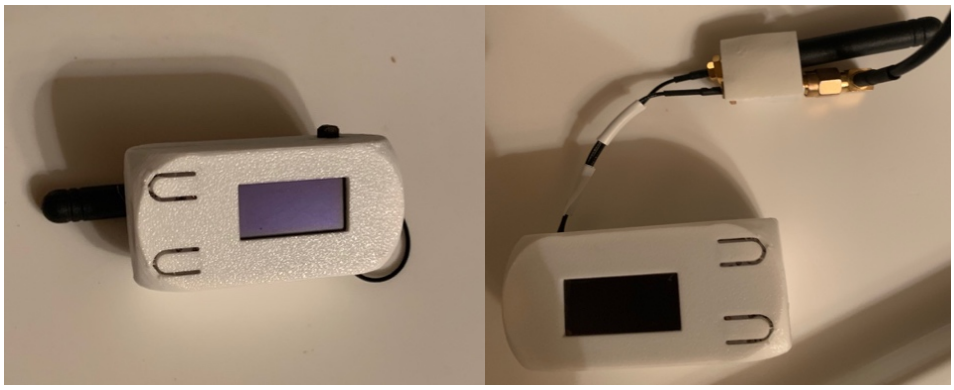

Figure 2 – Receiver and Sender prototypes

Although the prototypes present normal cumbersome radio antennas and a large size (6cmx3cm), it is recognized that these are solvable problems using more integrated circuitry and in-circuit printed LoRa and GPS antennas.

The sender device must have a very reduced size in order to be imbibed in the wearable clothes, is GPS connected, and sends it's location to the receiver using a LoRa transceiver and an antenna. It also needs of course to have a battery and the functionality is implemented by a PCB circuit that connects all systems (including the processing unit). All the components of the PWD sender are to be waterproofed by immersion in nano particles liquid protection from nanoflowX[3]. The IP Code, International Protection Marking, classifies and rates the degree of

[3] the V3 solution: https://www.nanoflowx.com/v3/

protection provided by mechanical casings and electrical enclosures against intrusion, dust, accidental contact, and water and is published by the International Electrotechnical Commission (IEC[4]). By submerging all the locator components in the V3 solution they will have a dust tight protection plus and immersion to 1 m or more depth protection (IP 68[5]).

The receiver doesn't have the same size restrictions as it can be attached to the case of the cell phone or just putted in a key chain and it's not mandatory to be water proof (although it can be) as its made to be carried by the caregivers. The receiver receives the LoRa packets from the sender and connects to the phone using Bluetooth ot WiFi technology. The location information can be served from the receiver as it either sets up a webserver with google maps or by having a dedicated iOS or Android App that will present a map and location. When activated from anywhere in the world (with regional changes to the LoRa frequency) it instantaneously pinpoints in the cell phone the wearer's location, accurate to within 3 meters in real-time as shown in figure 3.

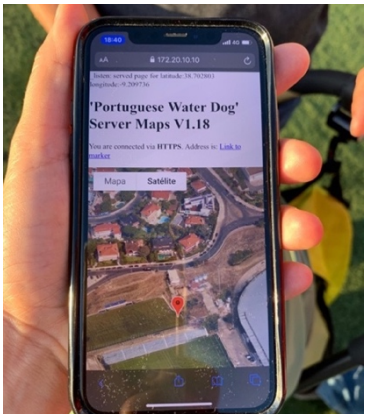

Figure 3 - PWD prototype tracking application

5.3. The Solution Interview

[4] https://archive.org/details/gov.in.is.iec.60529.2001/page/n3
[5] https://en.wikipedia.org/wiki/IP_Code

After the problem hypothesis validation, an interactive solution questionnaire was developed to test solution hypothesis using the prototype described in 4.3. Because the solution interviews could only start after the prototypes had been crafted it was only possible to make them at the beginning of August. This delay was due to all the work inherent in creating and testing the prototypes and the phone application. The questionnaire intended to test these two main hypotheses:

H1: "I want a tracking device to prevent loosing my children

H2: "The solution presented is viable to customer: sender + receiver + app", to solve the problem stated in the first hypothesis.

All interviews were performed face-to-face and in a semi-structured method and were held between the first of 20th of August 2018 to the first of October 2019 (the earliest time the prototype was ready for operation). In total, five customers were "problem interviewed": 3 men and 3 women, all with children at their care. The problem interview script revealed itself sturdy to ensure smooth data collection but also flexible enough to allow unexpected interviewees comments and opinions. No script changes were made during the whole interview process.

5.3.1. The Solution Interview Results Analysis

The prototype is an early product prototype with the purpose of measuring early adopters' reactions and collect truthful feedback to proceed to loop the product development process. Regarding the first hypothesis (H1) "I'm afraid of losing my kids and want a tracking device for them" All of the interviewees responded promptly "Yes", although opinions poured everywhere about how it should look.

Validating this answers were some of the affirmations " thank God this exists, I am going mad about going following them around all days". The most important feature that it was appointed was the current size of the prototype, as it was too big and not practical. "How will children wear it?" and "It will be discrete?" "Think about us dads that carry everything in our pockets". This issue took so much interest on part of the solution interviewed that stated the importance of downsizing the sender to the size of a pin and the receiver to a comfortable size. Regarding the hypothesis number two (H2) "The solution presented is viable to customers: sender + receiver + app" it was also validated with the solution interviews but some features where incorporated after listening to the potential costumers. As a grandmother commented "it's fantastic to be able to see where they are, when I'm not seeing them" , "I have been waiting forever for this type of product". It was rewarding to see the reaction of the interviewees to the prototype presented functionality and taking also into account the results from the questionnaire in question 17 (Appendix 2) 63% of the inquires claimed they wanted to help test it, even proposing to supply their personal contacts) as in their mindset the final product would deliver real value. However some features were appointed as being poor and not viable. The first one was the fact that as the location appears in a webpage in the internet the operator would have to be refreshing all the time to see the pin move. This is not a problem since this was only a quirk of the temporary solution of the prototype and could easily be corrected with an app. Additionally it was found important for the parents the speed of the pin tracking update. Another important point is to have both the pins of the parent (receiver) and the child/target (sender). The reason is that some people have limited sense of orientation, and as the sender pin becomes far from

the parent with the receiver starts being anxious not knowing exactly where he is and how to trace the easiest path to the child. This seems to indicate that an important feature would be for the App to track a path from the parent (receiver) to the target (sender). This has already been added to a new released version of the prototype webserver.

6. Conclusion

The thesis main purpose was to use TLS methodology in the develop and launch of a new product: a device for tracking children that can operate anywhere in the world and without the obligation to be linked to a mobile network (3G/4G/5G) because it establishes a LoRa point to point connection. Firstly, the TLS principles were researched for appropriate application via the literature review focusing on the methodologies that could further the actual benefits and improvement in startups. Indeed as indicated by the literature review, it was through customer interactions that both the need and the problem were tested and value hypothesis and grow hypothesis were established to validate learning. In fact, it is a learned conclusion of this work that before taking some real product development steps it's critical to first consider customer's inputs to validate the problem to find the proper solution. Nevertheless the development of a prototype was essential in order to test the solution thought solution interviews. This incipient product was very useful to better understand the technology limitations, get costumers insights about the necessity and the features of the final product.

The TLS methodology requires great emotional intelligence in order to deal with unexpected and frequently contradictory customer feedback, development hurdles and product functionality. An example of this is a purely rational approach about the problem statement "it has to be downsized to the size of a 2€ coin" –

understanding of the desired form and size factor, or "underwear, think of underwear instead" – understanding of the product usability, was clearly validated via learning. What started as the vision of a swimwear collection that could trace a child anywhere in the world has pivoted to a pin with the firm logo plus a receiver that can be put in a keychain. This progress from summer collections to a product that can be worn every season and everywhere was critical. That said, as stated by the parents in the solution interview, it's very important to target the downsize from the prototype to the final product. Because of this challenge it became obvious that there was lack of know-how in the team to advance further in the PCB miniaturization aspect and as such an PCB electronic specialist is now with the task to make a centimeter sized MVP to be tested by the customers. Due to the short window of time given to elaborate this thesis it was not possible to go further and follow-up hardware and software development until the Minimum Viable Product, however the prototypes are already a major step forward. It is understood that many business assumptions are still to be validated such as customer relations, sales channels and markets and these are scheduled to the first trimester of 2020.

This thesis, besides describing theoretically the lean methodology, takes a step forward applying it in a real case and demonstrating what it can contribute in terms of learning and improving project requirements. The process was performed by listening to the prospects clients and trying to meet their needs of reassurance and efficiency as well as following the trends of wearable technology while adapting it to children use cases. Wearable and radio technologies in this case are being used to make trackability more dynamic and efficient while being guided by the TLS approach to better understand the future customers. The next

step will be, using lean product development, to launch a MVP so that the startup tests not only the consumers but also the other marketing dimensions aiming that in a near future it can launch a successful product.

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8. APPENDIX
APPENDIX 1

Problem Interview Questions : In the following a list of questions, considered to be good questions, as well as bad questions will be presented. Bad questions are dangerous, because they might lead to a false positive outcome, which means it is concluded that the customer has a problem, when in reality he has none (Osterwalder et al., 2014). A good question is characterized by being open ended, tied to a specific event in the past and about the life of the customer and not about one's solution. Bad questions on the other hand can be characterized by being yes/no questions, future and hypothetical questions formed with will or would you.

Good Questions:
Do you find yourself doing X?
Do you find process X painful?
Take me through the last time you had this problem? What happened? What was the hardest part? And why?
How do you currently solve this problem?
What do you like/dislike about the current solution?
What is the impact of the pain?
What do you wish you could do, that is currently not possible?
How much money does this problem cost you?
Is there a budget for this?
Who else has this problem? Can you refer me?
If I would not have called on you personally, how could I reach you? 5 why´s method (if appropriate)

Bad Questions:
- Would you use this product?
- Do you think it is a good idea?
- Do you want feature X? (Most likely answer: yes)
- How much would you pay for this?
- If we built a product that solved Problem X, would you use it? - How would you pay for something that did X?
- Would you like your existing solution better, if it did X?
- Would you want an app that does X?

On the other hand there are not just bad questions, but also bad answers that have no value and do not offer any learning.

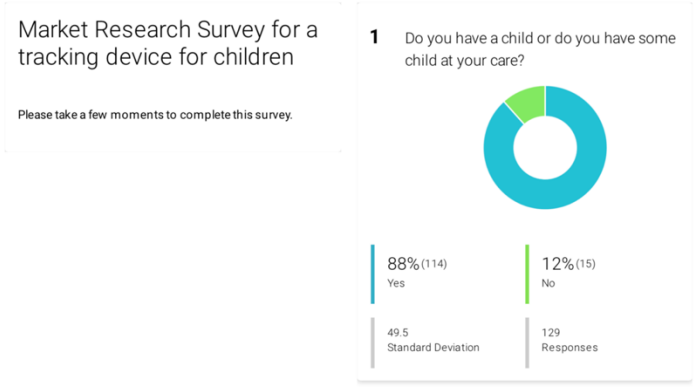
Solution Interview Questions : In terms of characteristics, the questions of the solution interview meet the same requirements as the problem interview

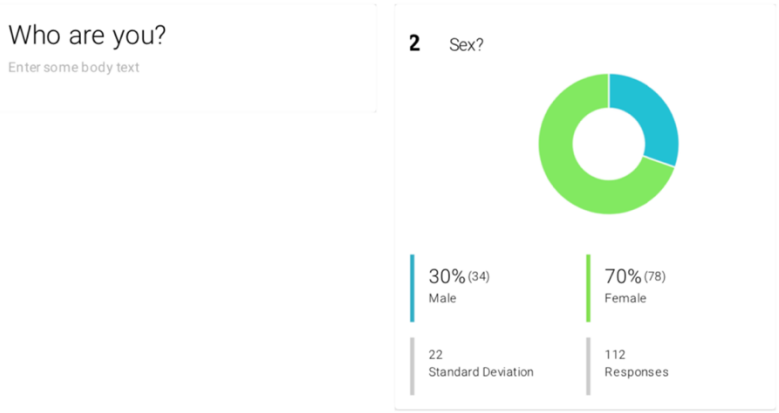
questions. The questions of the solution interviews aim specifically at testing the responses of customers to the proposed solution.

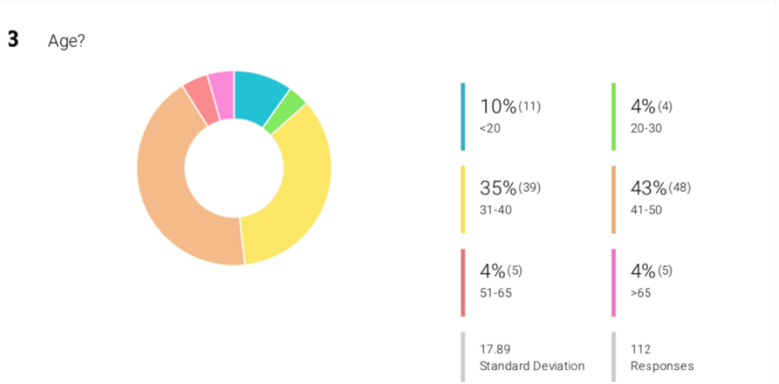
Good Questions:

- Does this product solve your problem?
- Which screenshot resonates most with you? Which could you live without?
- Is there any additional feature you think you are missing?
- If you could use this product right away, would you use it? How?
- What does prevent you from using it?
- What <*product category*> do you buy now? Why? How long?
- If this product would be available today and free, would you implement/use it immediately? If no, why?
- If the product would cost (100 times the planned price) per year, would you be willing to implement it/use it immediately?
- How do you or your company buy products like this?
- How does the approval process look like? Could you walk me through the process? Who else is involved?

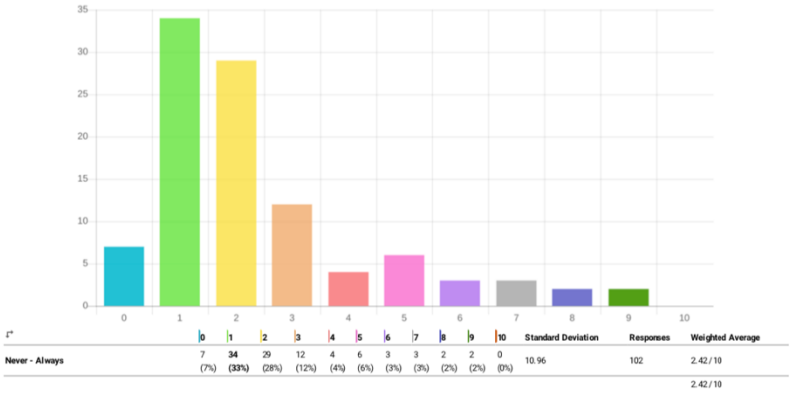
APPENDIX 2





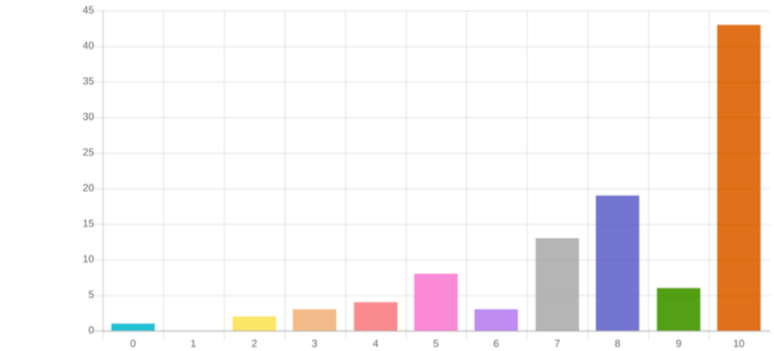


4 How regularly have you lost sight of your/a child? (even for that 1 minute that seems to last forever...)



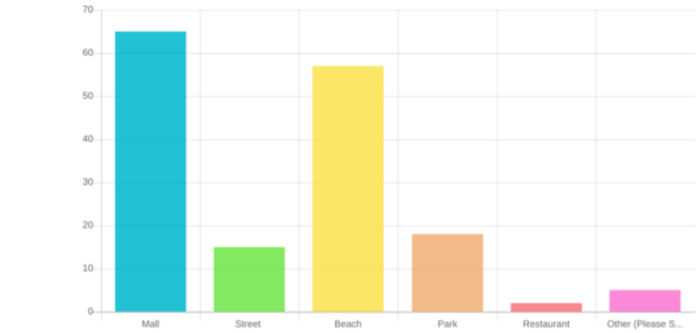
	0	1	2	3	4	5	6	7	8	9	10	Standard Deviation	Responses	Weighted Average
Never - Always	7 (7%)	34 (33%)	29 (28%)	12 (12%)	4 (4%)	6 (6%)	3 (3%)	3 (3%)	2 (2%)	2 (2%)	0 (0%)	10.96	102	2.42 / 10
														2.42 / 10

5 How much are you afraid of loosing sight of a child?



	0	1	2	3	4	5	6	7	8	9	10	Standard Deviation	Responses	Weighted Average
Not afraid - Panic!	1 (1%)	0 (0%)	2 (2%)	3 (3%)	4 (4%)	8 (8%)	3 (3%)	13 (13%)	19 (19%)	6 (6%)	43 (42%)	11.96	102	7.98 / 10

6 Where do you think is more easy to loose sight of a child?



63% (65) Mall

15% (15) Street

55% (57) Beach

17% (18) Park

2% (2) Restaurant

5% (5) Other (Please Specify)

162 Responses

Any place

Any of these places or even others

Airport (travelling)

Airport

In every place

7 Do you have a tracking device for your child?

4% (4) Yes

96% (98) No

47 Standard Deviation

102 Responses

Location, location, location

Enter some body text

11 Have you ever thought of having some device that would give you the real location of your child?

64% (60) Yes	36% (34) No
13 Standard Deviation	94 Responses

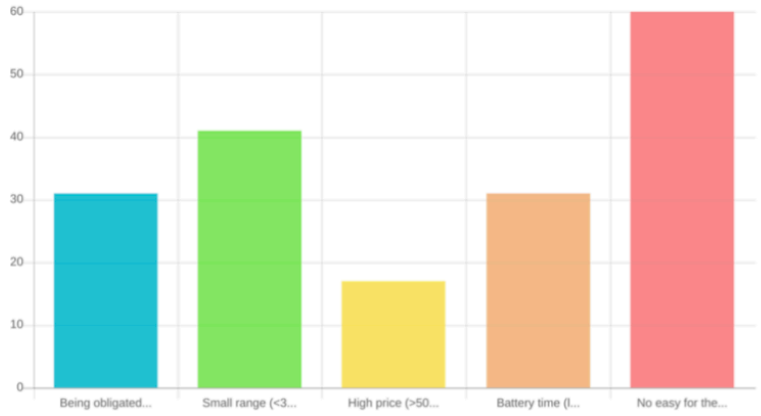
12 Would you like to have a real time location of your child in your smartphone?

80% (75) Yes	20% (19) No
28 Standard Deviation	94 Responses

13 If the tracking device was a wearable, where would you prefer to have it placed in your child?

16% (15) watch	**12%** (11) t-shirt
2% (2) bathing suit	**17%** (16) shoes
12% (11) necklace	**39%** (37) bracelet
2% (2) Other (Please Specify)	
10.94 Standard Deviation	94 Responses

14 Which of theses features would make you NOT WANT TO BUY/HAVE a tracking device for your child?



33% (31)
Being obligated to a monthly fee dued to the SIM CARD incorporated in the device

43% (41)
Small range (<300m)

18% (17)
High price (>50€)

33% (31)
Battery time (less than 8 hours)

63% (60)
No easy for the child to wear/use

180
Responses

17 Would you like to help test this wearable tracking system?

63% (60)
Yes

37% (35)
No

12.5
Standard Deviation

95
Responses

APPENDIX 3

Raquel C. (2 meninas, 7 e 4 anos) (1)

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.

1 - Olhando para as imagens qual seria a sua primeira opção? (A?) B? ou C?

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

Escolhi pulseira pelo facto de ser um acessório logo mais versátil e menos limitativo do que a B ou a C e também por ter 2 meninas e o uso de pulseiras ser habitual.

b) Que características têm mais a ver consigo ou são-lhe mais apelativas? Pulseira – acessório e é discreto

c) Dessas características qual seria a imprescindível?
Discreto.

3- Acha que está em falta algum recurso adicional?
Não.

4- Se pudesse, utilizaria este produto imediatamente?
Sim.

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Sim

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70? → Provavelmente não e pensaria muitas vezes antes de comprar
→ SIM, DE IMEDIATO

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

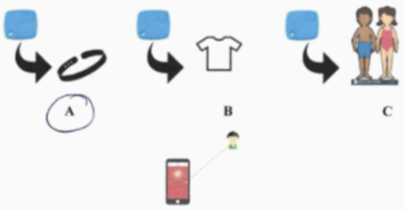
O valor do produto tem de ser equilibrado para o produto ser encaixável. Produto + caro pensaria logo e o GPS funciona? Qual o prazo de ação? E robustez? Para várias idades? Até lá escola?

Muito obrigada

Milka - Broonlevo - (1 ♂ 8 anos - 1 ♀ 4 anos) (2)

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.



1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C? (A)

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

Pensei no meu menino (lola) por ser um acessório de uso comum, que não levantaria suspeitas para o rapto. E que estará sempre com ele e evitaria desconforto por parte da dona

b) Que características têm mais a ver consigo ou são-lhe mais apelativas?
Discreto e versatilidade.

c) Dessas características qual seria a imprescindível?
Discreto

3- Acha que está em falta algum recurso adicional?
Botão para acionar em caso de perigo.

4- Se pudesse, utilizaria este produto imediatamente?
Sim, usaria

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Com certeza que sim.

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70? Não e não. Só usaria se fosse gratuito pois a minha preocupação é ele estar fora do meu alcance, a + 3 km (escola, pessoas etc)

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

· Mt imp. ser desactivado somente pelo responsável em caso de rapto
· Durabilidade → muito importante a bateria, o alcance a precisão do GPS
· Discreto para não levantar suspeitas
· Preço vs benefícios.

Muito obrigada

Sérgio H. (1♀, 5anos) ③

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.

1 - Olhando para as imagens qual seria a sua primeira opção? ~~A?~~ (B?) ~~ou C?~~

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

Discreto e fácil de usar.

b) Que características têm mais a ver consigo ou são-lhe mais apelativas? Facilidade de uso, [illegible], facilidade de usar com o telefone. [illegible]

c) Dessas características qual seria a imprescindível?

Ligação ao telefone

3- Acha que está em falta algum recurso adicional?

[illegible]

4- Se pudesse, utilizaria este produto imediatamente?

Sim, mas só em determinadas alturas. [illegible] etc.

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? yes.

6- E se o produto custasse ~~€ 700~~, você estaria disposto a usá-lo imediatamente? E se fosse € 70?

→ sim.

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

· Preço vs benefícios.

· [illegible] de uso. [illegible] etc.

Muito obrigada

Laura Jorge (1♀ 5anos; 1♂ 2anos) ④

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.

1 - Olhando para as imagens qual seria a sua primeira opção? (A?) ~~B? ou C?~~

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

Fácil de usar e de colocar às crianças

b) Que características têm mais a ver consigo ou são-lhe mais apelativas? Usabilidade, [illegible] anda sempre com eles.

c) Dessas características qual seria a imprescindível?

Usabilidade.

3- Acha que está em falta algum recurso adicional? Não

4- Se pudesse, utilizaria este produto imediatamente? Sim

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Sim

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70?

Não Sim

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

· O Alcance → mt importante

· Ter 1 carro e [illegible] para ver ele está fora do alcance [illegible].

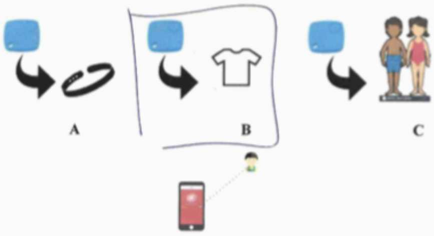
· Fiabilidade e a usabilidade quer do dispositivo quer da aplicação

· Preço.

Muito obrigada

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.



1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C?

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

b) Que características têm mais a ver consigo ou são-lhe mais apelativas?

c) Dessas características qual seria a imprescindível?

3- Acha que está em falta algum recurso adicional?

4- Se pudesse, utilizaria este produto imediatamente? Sim

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Sim.

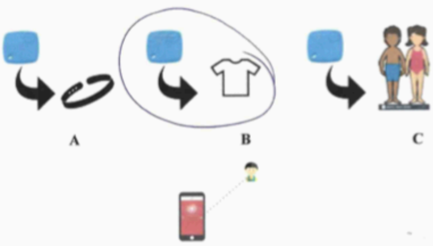
6- E se o produto custasse € 100, você estaria disposto a usá-lo imediatamente? E se fosse € 70? Sim.

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

Muito obrigada

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.



1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C?

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

b) Que características têm mais a ver consigo ou são-lhe mais apelativas?

c) Dessas características qual seria a imprescindível?

3- Acha que está em falta algum recurso adicional?

4- Se pudesse, utilizaria este produto imediatamente?

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Sim

6- E se o produto custasse € 100, você estaria disposto a usá-lo imediatamente? E se fosse € 70?

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

Muito obrigada

(7)

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.

1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C?

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

b) Que características têm mais a ver consigo ou são-lhe mais apelativas?

c) Dessas características qual seria a imprescindível?

3- Acha que está em falta algum recurso adicional?

4- Se pudesse, utilizaria este produto imediatamente?

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê?

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70?

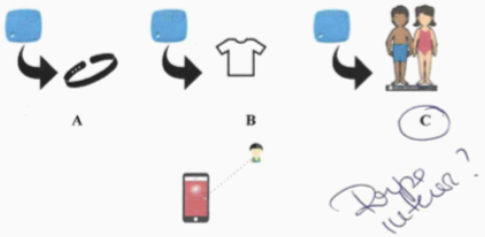
7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

Muito obrigada

(8)

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.



1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C?

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

b) Que características têm mais a ver consigo ou são-lhe mais apelativas?

c) Dessas características qual seria a imprescindível?

3- Acha que está em falta algum recurso adicional?

4- Se pudesse, utilizaria este produto imediatamente?

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê?

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70?

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

Muito obrigada

Sofia S. (1 menino ; 4 anos) (10)

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.

1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C?

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

Parece amiga à vista, ser mais prático. Roupa interior!

b) Que características têm mais a ver consigo ou são-lhe mais apelativas? Algo que imperceptível e que não tirem tendência a tirar

c) Dessas características qual seria a imprescindível? Não conseguir tirar.

3- Acha que está em falta algum recurso adicional? não

4- Se pudesse, utilizaria este produto imediatamente? Sim em festas, feiras, sítios com muita pessoa

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Sim mas tal como no 4

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70? → de acordo com o 4 [illegible]

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

Preço, conforto, ser muito discreto

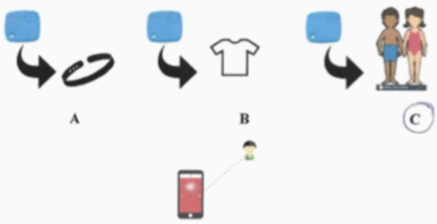
Muito obrigada

A verdade algo pouco me preocupei muito com isso. Algo que pensar melhor.

Vando P. (1 ♂ 9 anos ; 1 ♀ 3 anos) (9)

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.



1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C? Roupa interior.

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

Se o C for roupa interior em vez de fato de banho. Podiam todos [illegible]

b) Que características têm mais a ver consigo ou são-lhe mais apelativas? Confortável mas não perceptível

c) Dessas características qual seria a imprescindível? = b.

3- Acha que está em falta algum recurso adicional? X

4- Se pudesse, utilizaria este produto imediatamente? Sim, só em sítios públicos

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê? Sim, mas

6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70? Julgo que sim.

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

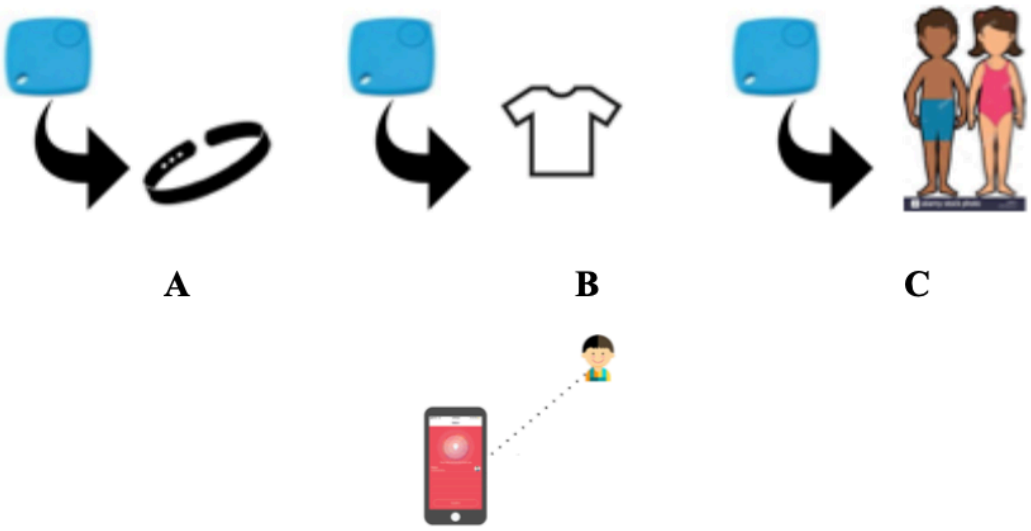
Pequeno relógio, pulseira e pulseira, mas são perceptíveis e fáceis de tirar. Por isso aquilo que disse atrás. a)

Muito obrigada

APPENDIX 4

Obrigada por participar neste questionário sobre localizadores de crianças.

Apresentamos de seguida algumas das soluções que imaginámos para os localizadores de crianças. Nas 3 opções o localizador encontra-se embebido no produto final e envia para a app no telefone, a localização da criança. Este produto tem um alcance de pelo menos 3 km, não tem qualquer fee mensal e é recarregável por indução.



1 - Olhando para as imagens qual seria a sua primeira opção? A? B? ou C?

- SERGIO (1 menina, 5 anos)→ B → T-SHIRT
- Vera L (2 meninos de 5 e 3 anos) → B → T-shirt
- Rita A (1 menino 4 anos) → B → T-shirt/roupa do dia a dia
- Marisa L (1 menina 6 anos) → B → Roupa
- Vanda P (1 menino 9 anos, 1 menina 3 anos) → B? → Roupa interior
- Sofia S (1 menina 4 anos) → B? → Roupa interior

2- Tendo em mente a sua resposta anterior:

a) o que lhe levou a escolher essa opção?

- Fácil de utilizar e colocar às crianças
- Dá para usar em mais situações (não só na praia ou piscina) e
- É mais fácil e versátil
- Logo é mais fácil na roupa.

- Mais prático

b) Que características têm mais a ver consigo ou são-lhe mais apelativas?
   - Discreto.
   - Descrição e versatilidade
   - Usabilidade
   - Ser versátil,
   - Versatilidade, discreto
   - Discreto
   - Não percetível
   - Impercetível

c) Dessas características qual seria a imprescindível?
   - Discreto.
   - Descrição
   - Discreto
   - Discreto
   - Não percetível
   - Impercetível

3- Acha que está em falta algum recurso adicional?
- Poder usar noutras peças de roupa, em vez de ser só t-shirt. Mais variedade
- A variedade de produtos finais onde se podem aplicar o localizador
- Pelo que disse é só em t-shirts, deveria ser em qualquer peça de roupa
- Confortável mas não percetível
- Impercetível
- Deveria ter a opção roupa interior

4- Se pudesse, utilizaria este produto imediatamente?
- Sim
- Sim, utilizaria.
- Sim
- utilizaria, mas somente em determinadas alturas, por exemplo em eventos onde há muitas pessoas, praia, etc.
- Sim
- Sim
- Sim
- Sim, mas só em situações pontuais como por exemplo visitas de estudo ou saídas sem os pais
- Sim, em sítios com muita gente tipo feiras, festivais, festas etc.

5- Se este produto estivesse disponível hoje e gratuitamente, utilizaria-o? Se não, por quê?

- Sim
- Utilizaria com certeza.
- Sim
- Sim
- Sim
- Sim
- Sim
- Sim
- Sim

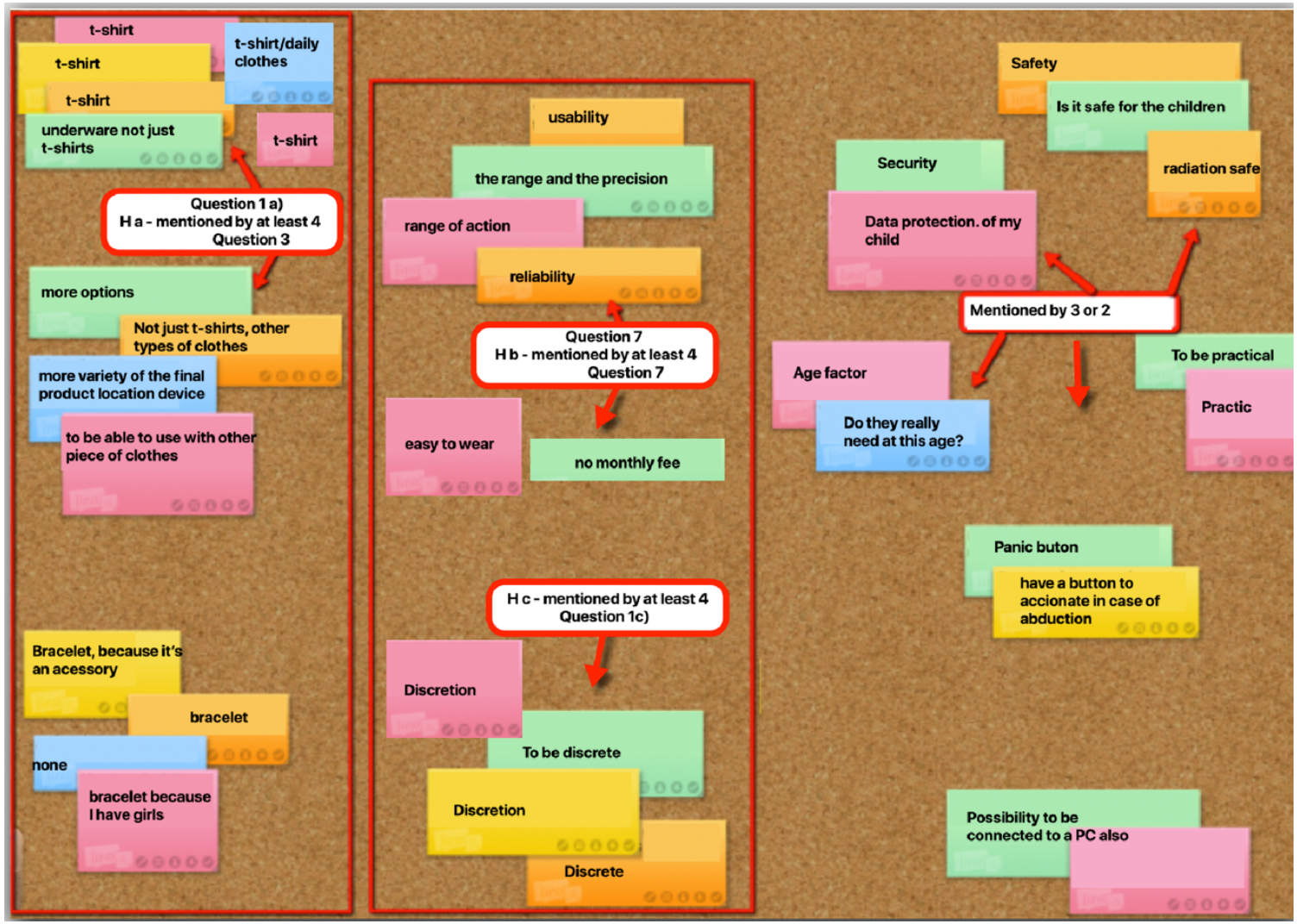
6- E se o produto custasse € 700, você estaria disposto a usá-lo imediatamente? E se fosse € 70?

- Se custasse 70 €, compraria de imediato.
- Sim
- Mas 70 euros sim
- 70 sim
- 70 parece razoável
- Só 70
- 70 sim

7- Imagine que estaria no processo de decisão de compra de um localizador de crianças. Pode descrever um pouco os elementos que pesaria na sua escolha?

- Este GPS funciona mesmo? Qual o raio de ação?
- Alcance e precisão do geolocalizador.
- A fiabilidade e depois a usabilidade quer do dispositivo quer da aplicação.
- É o alcance e a funcionalidade do equipamento também teria que ver.
- Pratico e de fácil utilização
- Ser eficaz
- O valor do produto tem que ser suficientemente equilibrado
- O preço versus beneficio
- O preço.
- E o preço.
- Custo beneficio de que falámos.
- A usabilidade do produto e o alcance.
- Pratico.

The following is a summary board of the interviews results.



APPENDIX 5

Technical Requirements for PWD wearable tracker

Sender requirements

The sender is embedded in the logo tag of the clothes so it has a very reduced size, is composed of:

- GPS + MCU chip + LoRa transceiver and antenna (all in PCB) → SIP package
- Battery – (round or possibly flexible form factor), of long shelf life (>1 year) with 1000mAh capacity or allow induction charging.

Receiver requirements

The receiver can be attached to the case of the cell phone or just put in a key chain it does not have same size restriction and is composed of:

- Bluetooth + Antenna
- Battery – induction charging - >2000mAh
- Display to indicate information on sender activation and reception

Possible solutions

Two possible SIP solutions:

- S76G/S78G from ACSIP
- ATSAMR35J16BT from Microchip

Other notes:

- Must have waterproofing rated as IP68: No ingress of dust/ Immersion, 1 m up to 3m: https://en.wikipedia.org/wiki/IP_Code
- Must respect the limits on LoRa radio power emitted as: https://stackoverflow.com/questions/50395087/lora-point-to-point-limitations
- May reuse the LoraWAN besides the Point to Point connection: https://lora-alliance.org/resource-hub/lorawanr-specification-v11

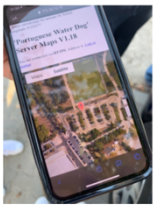
APPENDIX 6

The following are some reports of the interviews and testing of prototypes.

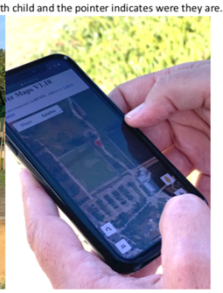
INTERVIEWS WITH THE MVP

INTERVIEW1 - GRAND PARENTS WITH A CHILD OF 5 YEARS

a) Meeting and preparation of the PWD



b) Testing - Grandfather walks away with child and the pointer indicates were they are.



c) Grandfather walks further away with the child and now the grandmother follows the pointer in the application and gives us feedback

"Isto é fantástico, eu já não os vejo mas sei onde estão. Eu morro de medo de os perder. Que bom que estão a desenvolver isto" Ana 72 anos

i) Qual a característica que mais gosta: *"poder ver onde eles estão, mesmo que eu não os veja"*

ii) Qual a característica que menos gosta: *"não saber onde eu estou no mapa. Deveria ter um pin onde eu estou. E se pudesse ter o caminho melhor ainda"*

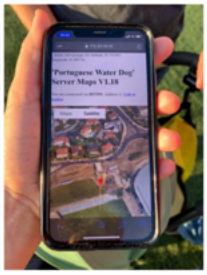
iii) O que gostaria de ver melhorado: *"No produto: o tamanho, está muito grande e ninguém gosta de andar carregado. Na aplicação o ter de andar a fazer sempre refresh para ver o pin andar de sitio e deveria ter algo a marcar onde estamos. Eu pelo menos já não sabia onde estava..."*

iv) Alguma questão: *"Pelo que percebi temos de ter 2 coisas. Uma que esta com a criança e outra que fica comigo. Se me esquecer de levar a minha coisa não funciona?* Não. O que permite a ligação com o pin da criança é o seu dispositivo que emparelha por bluethooth com o telefone. *Hummm, então deveria ser algo que andasse sempre comigo: ou no telemóvel ou nas chaves" E se a criança apanhar chuva? O gps dela é à prova de chuva?* Sim é . *Boa!"*

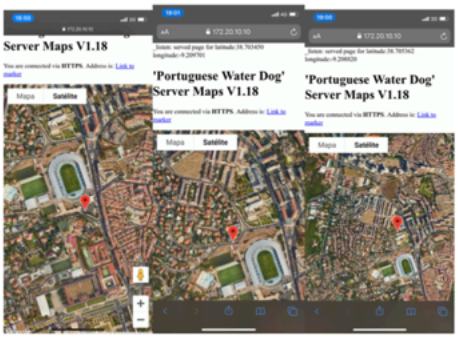
Conclusion: Put a pin where the sender is as well as where the receiver is as shown below

INTERVIEW1 – TEENAGER (17 YEARS)

a) Meeting and preparation of the PWD



B) Path taken by A. and marked with a Pin.



"Uau, não pensei que fosse possível. Qual a tecnologia por detrás. Funciona mesmo?"

i) Qual a característica que mais gosta: *"poder ver onde e"*

ii) Qual a característica que menos gosta: *"é muito grande. É um calhamaço para andar connosco. E a antena tão grande que tem sempre de estar bem ligada e fora"*

iii) O que gostaria de ver melhorado: *"O tamanho porque está muito grande e ninguém gosta de andar carregado. Até mesmo o receiver tem de ser pequeno. Nós homens apenas andamos com a carteira no bolso ou então os porta-chaves. Teria de ser algo que não ocupasse kilos de espaço nos nossos bolsos"*

iv) Alguma questão: *"É à prova de chuva ou água?* Sim é .