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MOBILE INNOVATION AND SERVICE DISRUPTION ON HEALTHCARE: THE STARTUP´S ENTREPRENEUR PERSPECTIVE

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Paulo Roberto Pereira Pinto Filho

Mobile Innovation and Service Disruption on Healthcare: The startup´s entrepreneur perspective.

Master's dissertation presented to Instituto Coppead de Administração, Universidade Federal do Rio de Janeiro, as part of the mandatory requirements to obtain the degree of Master in Business Administration (M.Sc.).

Supervisor: Eduardo Raupp de Vargas, Ph.D.

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ABSTRACT

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Innovation and healthcare are closely connected as new drug, equipment, disease treatment and service delivery are developed and adopted to bring value to stakeholders. Still, in the last decades, there is a concern about the constant increase of healthcare costs, being one of the main factors the adoption of the same technologies that were supposed to improve patient conditions. Being the innovation inaccessible, it is not bringing real value for patients. On the other hand, mobile technologies are allowing the creation of service platforms that link both technology and service innovation to provide high availability and lower costs in primary care. Can this trend disrupt the health care industry? In order to answer these questions, it was advanced a service innovation definition, which was articulated with disruptive innovation and innovation system insights. Thenceforth, it was made a revision of the literature of the last 10 years on healthcare mobile innovation to identify what the technology tendencies are. Healthcare based startup companies were chosen due to its innovative profile. A structured criterion was used to choose relevant from relevant startups. Their founders were interviewed and the information was submitted to the proposed theoretical framework. It is concluded that health care has the potential to be disrupted by mobile technology innovations, once they bring distinctive characteristics and competences, low costs, high availability, structured business models and immersed into the healthcare innovation ecosystem. The difficulties on determining potentiality to impact are related to the dynamicity of the startup environment, the lack of information sources and level of maturity of these companies are limitation for a more conclusive argument.

Keywords: Healthcare, Primary Care, Service Innovation, Disruptive Innovation, eHealth, mHealth, Telehealth, Electronic Health Records, Smartphone, Internet of Things, Mobility.

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LIST OF ABREVIATIONS

AHIMA	American Health Information Management Association
C3N	Collaborative Chronic Care Network
CPOE	Computerized Provider Order Entry
DSP	Dried Blood Spot
EHR	Electronic Health Records
EMR	Electronic Medical Records
EPR	Electronic Patient Records
ESF	Estratégia de Saúde da Família
FAPERJ	Fundação de Amparo à Pesquisa do Rio de Janeiro
FP	Foundational Premises
GDP	Gross Domestic Product
GSM	Global System for Mobile
HCAHPS	Hospital Consumer Assessment of Healthcare Providers and Systems
HIS	Healthcare Innovation System
HIV	Human Immunodeficiency Virus
ICT	Information And Communication Technology
IoT	Internet of Things
IT	Information Technology
MIS	Management Information Systems
OECD	Organization for Economic Co-operation and Development
PCMH	Patient-Centered Medical Home
PDA	Personal Digital assistant
PHI	Personal Health Information
PHR	Personal Health Records
POM	Production and Operations Management
PPI	Procurement of Innovation
PSF	Programa Saúde da Família
R&D	Research and Development
RFID	Radio Frequency Identification

SDL	Service-Dominant Logic
SEBRAE	Serviço Brasileiro de Apoio às Micro e Pequenas Empresas
SENAC	Serviço Nacional de Aprendizagem Comercial
SESI-RJ	Serviço Social da Indústria do Rio de Janeiro
SME	Small And Medium Enterprises
SMS	Short Message Service
SUS	Sistema Único de Saúde
UBS	Unidade Básica de Saúde
VBS	Value-Based Purchasing
WHO	World Health Organization

CONTENT

1 INTRODUCTION

Every new development on medicine and health care has brought improved results to patients' health conditions and life span. On the other hand, the same treatments are mostly inaccessible for most of the population, due to high costs and low availability. Governments and private institutions have been struggling to find solutions to make healthcare more accessible and more affordable for both institutions and patients. On every other industry, innovation such as mobile technology leads to increased overall efficiency. Startup companies are changing whole sectors with simpler, cheaper and smarter solutions. Therefore, how the paradigm of medicine innovations leading to increased costs instead of improving population well-being could be challenged? Will new technologies be a factor for increased costs and lack of access, or will they be a platform for service innovation delivery? Can health care industry be disrupted by mobile innovations? How innovative companies have been facing the challenges and opportunity to invest on healthcare?

Analyzing the current situation for innovations on healthcare, it is frequently reported that new developments and products are responsible for the most important share of the increasing costs. According to the World Health Statistics 2017, a World Health Organization (WHO) report, "new health technologies, such as medicines, vaccines and diagnostics, are also becoming increasingly expensive" (World Health Organization, p. 19, 2017). This bucks the trend of what happens in other industries, where innovation is synonym to increased efficiency, lower costs, higher customer-value, higher availability, clear and comparable product specifications, strong product/company competition, and so on (DIXON, 2010; PEARL, 2014).

Innovations in health care are usually represented as a new drug, equipment, procedure or treatment, or a new service offering. They all require high investments in research, development, experimentation, testing, approval from government agencies and medical associations. They must be taught to medicine students, and eventually, their benefits proven to health organizations so they can be adopted. For drugs and equipment, there is necessity to involve the whole manufacturing supply chain. At this point, the solution must be registered at government agencies and approved for reimbursement. Still, if the innovation cannot be proven profitable for private healthcare organizations (both big as hospital conglomerates and small as the independent physicians), it will face rejection. Public health policies may

interfere at this point if the innovation has impact on social or regional health care. Government can implement several strategies to assure population access, such as incentives for commercialization, patent rights revocation, public purchase or public fabrication – as it happens with some vaccines in Brazil. Lastly, even if everything goes as expected, there are several barriers for the adoption of the novelty among patients and physicians, a subject that can be found intensively discussed in the literature (such as the technology acceptance model theory, among others).

Due to all the steps above mentioned, patients are having problems finding better treatments at lower costs. Competitiveness is restrained due to several barriers: time barriers - government agencies and medical associations take too long to approve new techniques, knowledge barriers - new physicians are unaware of new developments since academia does not update their curricula, adoption barriers - health organizations are risk averse and prefer to keep up with traditional, well-known, listed for reimbursement and profitable practices, and physicians, nurses and other healthcare professionals are neither presented nor trained to use the new technology or even are not convinced of its benefits, among other restrictions.

Some innovations, on the other hand, are proving that even in restricted high barriers industries, there is room for smart solutions that can bring benefit for all stakeholders. They will present relevant common aspects: they are mostly not just a physical product nor only a service, but a combination of both; some bring practices common to other areas of appliance; others are user-centered, focused on value; they are based on the easiness of communication and data exchange made available by the internet and connected devices; and ultimately, they are applying later academic research rapidly into day-by-day practice, leading to cutting-edge solutions that bring great competitive advantage, even allow the opening of the company to new markets.

One example of this kind of innovation is the mobile technology and the services associated to the digital platforms. An historic overview on smartphones shows how it impacted the desktop computer and laptop markets in the 2010s. Its popularization made possible for an enormous share of the world population to have access to internet and to digital platforms, allowing them to have as much connectivity and information access as a regular desktop equipment could provide, but bringing the distinct advantages of having lower costs and being portable anywhere, anytime (ISLAM, ISLAM, MAZUMBER, 2010).

As a matter of fact, the smartphones started as limited devices, quite expensive, but in a few years - as predicted by Moore's Law of Electronics - it tended to cost much less and provided much more capabilities, such as quick communication, time saving and productivity increase, IT infrastructure improvement, considerable cost saving, entertainment (ISLAM, ISLAM, MAZUMBER, 2010). Thus, a massive number of new mobile applications are being launched, each one providing different possibilities for users to entertain themselves with games, access news content, listen to music, watch movies, search for places, plan their schedule, check for new restaurants and bars, contact their friends and family, acquire products and services, and much more services. This possibility greatly impacted communication, entertainment, education, retail, transportation and travel companies, among many others. Hence, more than just a product, a smartphone is a platform that allows users to have access to all kinds of services (ISLAM, ISLAM, MAZUMBER, 2010).

If mobile technology is deeply impacting several industries, it seems reasonable to conclude that it would have the same impact on health care. Notwithstanding, analyzing health care necessities involves more than just drugs, devices and treatment; it is also about providing a personalized, individual care, interlinked with the necessity of an specialized knowledge, only available for medical teams, and on health facilities such as medical offices, clinics, laboratories and hospitals.

The report mHealth App Developer Economics 2016 was published on website Research2Guidance.com about data on healthcare apps. From 2015 to 2016, the number of mHealth apps increased from 20% (of all published apps) to about 55%. From all the published apps, about 43% are achieving the expected success. Also, 56% of mHealth apps are targeting chronically ill people. An interview showed that diabetes is expected to be a potential market (by 73% of the interviewed), followed by obesity (40%), hypertension (29%), depression (27%) and coronary heart disease (16%).

The website Statistica.com provides a web report with the percentage of mobile medical application used by U.S. adults in 2017: 44% use apps to track fitness; 42% use apps for diet and nutrition tracking; 35% use apps for self-diagnosis; 26% is "Apps to measure other health metrics (e.g., pulse and blood pressure, body heat, blood glucose, etc.); 25% for fitness instructions, such as exercise lists; 23% use apps to relieve stress/promote inner peace, through meditation, light yoga exercises, or similar activities; 21% to track illness and

medication administration; 17% for emergency situations; and 7% use apps to help quit smoking.

At first, several of the mentioned services could only be provided by nurses and physicians using medical equipment on health facilities such as hospital and clinics. Even the knowledge to do so remained far from the patients themselves. Along the years, newer, smaller and less expensive devices are being developed, allowing patients to check health conditions at home. Smart devices and apps are giving the possibilities of easier, anywhere and anytime checkups, resulting on more frequent measurements, capacity of storing more data, informing both user and health provider about their own body conditions, allowing physicians and other health care professionals to rapidly assist the patient. In terms of market potential, remote monitoring, diagnostic, medical condition management, remote consultation and electronic health records (EHR) are presented as the market choice for app types (mHealth App Developer Economics, 2016).

Most of these technologies are immediately available and at lower costs. The communication revolution, made possible by the internet, is still changing how people access services - including health ones. Tracking devices commonly used by manufacturing industry, management software that measure, control and register performance data, teleconference, secure email and social networks are already known technologies that are finding new application on healthcare, with impressive results to patient-value.

Startup companies are one of the main responsible for fostering the innovations ecosystem, thus fomenting usage of new technologies, such as mobile. Startups are attracting funding, new sources of employment and economic growth on cities (MULAS, MINGES, APPLEBAUM, 2015). Their competitiveness is opposes the incumbent companies that lack the flexibility of the younger competitors, which can risk into bringing new technologies that challenge the currently available offerings. Their competitive advantages are providing solutions that are much simpler and cheaper, focused on the user, receptive to feedback and to continuous improvement.

Henceforth, it is important to take a close look at startups to understand the last innovation tendencies. But there are some difficulties to find information on them: the startups environment is very dynamic - the lack of resources force them adapt fast; they operate in a

lean structure - few employees; and their products are new to the market – lacking secondary documents and history. So, to better understand how mobile devices and platforms can impact healthcare services provisioning, the best – and sometimes the only – source of information are the founders themselves. Entrepreneurs are deeply involved in the industry, aware of new possibilities and challenges, and willing to make their company to prosper. Despite of the biases, they are the most complete source of information on how startups are viewing the healthcare industry and how they are reacting to it.

1.1 RESEARCH QUESTION

The research question to be answered is: "Does mobile technology have the potential to impact healthcare services by decreasing costs and improving availability, under a theoretical analysis of information acquired from startups' entrepreneurs?"

One may wonder the difficulties on analyzing the potential of mobile innovations to disrupt health care. Since several concepts are involved, it was important to explain three main innovation concepts related to the question: the service innovation, the disruptive innovation and the health care innovation, and how these three topics are related.

This essay will start by a theoretic revision discussing well-known theories on service innovation. The theories of Service-Dominant Logic (SDL) by Ordanini and Parasuraman (2010) and, mainly, the characteristics-based representation of the product, along with the integrative or synthesizing approach for service innovation by Gallouj and Savona (2008), are used to define and frame service innovation. Subsequently, the disruptive innovation theory proposed by Professor Clayton Christensen is described in their healthcare analysis, based on the article by Christensen, Raynor, McDonald (2015). This theory gives a guideline for determining if an innovation – that can be a service or a physical product – is or has the potential to be disruptive, based on the characteristics of the proposed product, the product positioning on the market and the business model. Finally, the last part of the theoretical review is based on health care system innovation, the stakeholders of the health care ecosystem responsible for innovation, how it occurs in this industry, what are the barriers and the perceptions when innovating on health care. The idea is to provide an overview on the difficulties and on where it is most possible to find innovation along the health care value-

chain. Then, a guideline for analyzing potential service innovation on health care is proposed at the end of this chapter.

The systematic literature review on mobile health care innovations was based on defining trends on health care innovation, focusing on mobile technology and service innovation terms. The most cited technologies were grouped into four topics: telemedicine, EHR, e-learning and social networks, and were used as base to select which companies where aligned to these tendencies.

The reasoning behind choosing startup companies is that nowadays, the most well-known cases of disruptive innovation are coming from these companies. To select the most relevant ones, the 100OpenStartups ranking was chosen, due to its structured evaluation criteria. From the ranking, only startups that provided a health care service to patients and followed one of more of the trends resultant from the systematic literature review were chosen. From 16 healthcare startups, only four were selected: Guepardo Sistemas (telemedicine - using high compression software for images and a modem for low speed internet transmission); Oxiot (telemedicine - remote monitoring of oxygen flow on home cylinders), HelpBell (telemedicine – a internet connected drug box for drug administration monitoring and emergency button), and VivaBem (EHR and telemedicine – a platform for employers and employees to monitor health indicators and promote health)

The method of data gathering was a semi-structured interview with the founders or the CEOs of the selected companies. An in depth interview method was used, so relevant points concerning the research were discussed – such as innovation, the business model, the strategic positioning of the product and the company, the plans for the future, among other information. Because the companies are still new to the market and relatively small, secondary information was not available. Still, the information provided gave enough parameters for the theoretical framework to be applied and a conclusion be taken.

From four interviewed startups, only two showed evidence of potential to disrupt the healthcare industry, despite all the innovation-driven selection criteria. It is showed that mobile technologies have the potential to impact the health care industry by providing distinctive solutions, where the low costs and high availability of the offering improves the

access of patients to health care services. Thus, the paradox of innovation in healthcare being responsible for increasing costs can be challenged by these solutions.

The proposed framework can only be fully attested by monitoring the potentially disruptive startups growth and long-term sustainability. Also, the level of maturity of the startup companies will impact the framework analysis, since only present information are being provided. The dynamicity of the startup environment and the lack of information sources act as limitations to the study. Future research propositions are related to follow up the researched companies to attest for disruptiveness and the application of the theoretical framework in other industries.

In the next sub topic, the research objective will be defined. A set of specific objectives will follow and will be dividing the main objective into topics for a more precise view of how the research method will be build.

1.2 OBJECTIVES

The main objective of this essay is to verify if mobile technologies have the potential to disrupt health care industry through service innovations which increase access to low cost and high quality health care services. Thus, challenging the paradox of medical new solutions providing enhanced patient treatment value, but being expensive and with low availability.

A specific objective is the development of a theoretical framework, based on well-known and proven theories on service, service innovation, disruptive innovation and innovation systems that could allow the analysis of disruptive potential of service innovation on health care.

Another specific objective is to determine trends on health care service innovation using mobile devices and platforms, and use this information to select startups that are more likely to present innovations with the potential to disrupt the health care industry.

Yet, another specific objective is to address entrepreneur from selected, relevant startups to analyze the potential of their solutions to disrupt the health care industry under the information provided, according to the framework developed from relevant theory on disruptive service innovation.

After presenting the objectives, the next subtopic will discuss the limitations on the study. Some definitions on key terms will also be provided.

1.3 STUDY DELIMITATIONS

Since the research question is about challenging the traditional health innovations – namely, drugs, treatments, equipment –the study will focus on providing insights on service innovations. This term definitions and theories around the topic will be presented at chapter 2. The companies' offering, the product, will follow the definitions of the SLD as a set of characteristics and competences, not solely as a good or a service (ORDANINI, PARASURAMAN, 2010). Thus, startups and their proposed innovations will be chosen and analyzed as they provide a service component.

Service innovation definition will follow the characteristics-based representation of the product (GALLOUJ, SAVONA, 2008), where the innovation must provide distinct characteristics or competences from other offerings to be considered an innovation. They must also be focused on bringing value to the patient, in terms of low costs and high availability. Solutions that aim at a single aspect – such as algorithm-based applications or enhanced laboratory procedures for examples – will not be chosen for analysis. Terms like patient value, job-centered, patient-centered are some of the terms which will be used for literature review, in an effort to filter and channel publication material.

Mobile innovation will be defined at chapter 3. It is related to all technology that is capable of communicating wirelessly with the internet. The devices must be portable, and able to acquiring, storing and transmitting information. They are electronic and digital-based equipment.

Another relevant point is about startup companies. A definition will be provided at chapter 4. Startup definition relates to a company deeply involved into creating an enormous impact by the application of innovative solutions (ABREU AND CAMPOS, 2016). Startup companies will be chosen regardless the size or the current maturity stage. Since the study is focusing on health care, only companies that offer health care services will be chosen. A structured criteria for selecting startups will be presented also at chapter 4.

Finally, the main information sources will be relevant publications on healthcare innovations based on mobile technologies (see chapter 3 for details) and interviews with startup founders, the entrepreneurs. The entrepreneurs are a primary source of information. Most of these companies are small and new to the market; secondary information on them is practically nonexistent. The founders, on the other hand, are deeply involved into the market and are willing to discuss their products, their companies, their plans and opinions on the health care market.

In the next subtopic is presented a landscape on Brazilian health care system. The health care companies and services are inserted at this ecosystem and its particularities will heavily influence business plans, since this industry is quite sensible to governmental incentives, partnerships, supply chain development, target markets, regulatory agencies, national public health plan – the Single Health System, and reimbursement policies.

1.4 BRAZILIAN HEALTH CARE LANDSCAPE

The Brazilian national health system is based on the Single Health System, or SUS (*Sistema Único de Saúde*), being the objective to provide health care services access for every citizen. The Brazilian Government is the main supporter of the SUS, both through policies and funding. The Union is responsible for 50% of funding and developing national plans for health care, and the States and the municipalities provide the other half of investments and must follow and comply with the policies. The States must grant at least 12% of tax income to health care funding, and municipalities must grant at least 15%. Finally, according to an institutional reform entitled Healthcare Pact (*Pacto pela Saúde*), it was determined that federal government will provide funding to States and municipalities through five gateways: 1 - Basic (Primary) Care, 2 -Medium and High Complexity Care, 3 - Health Surveillance, 4 - Pharmaceutical Assistance, and 5 - SUS Management (STRAUSS, 2006).

The municipalities are the main responsible for their population health services. If there is some service that the city is not able to provide, it must look for partners, like in the private sector, ONGs, philanthropic institutions or even other cities (STRAUSS, 2006). In the case of private institutions, the reimbursement follows a very similar procedure to the US Health Care System, where a list of procedures is approved to receive as fee-for-service.

According to the SUS program statements, the entry point for health care should be through primary care, like UBS (described in details below), health centers, clinics, and so on, and only if necessary the patient will be directed to a more complex institution, like a hospital or a specialty center (STRAUSS, 2006).

The Basic Health Units (or UBS - *Unidade Básica de Saúde*) are described at the National Primary Health Care Policy, from 2012. They are composed of a physician office, dentist office, multi-discipline professional attendance office, administrative office, collective room for primary care professionals, reception, archive, vaccine office, public pharmacy and medicament storage, inhalation room, procedure room, and ambulatory. This policy also states a continuous education program for UBS health professionals, the size of the unit according to the public it attends, how it will manage the population under their jurisdiction, health professional attributions, and so on. The same document also describes the UBS support to the Family Health (*Saúde da Família*) initiative, where family doctors are responsible for managing a list of families around a territory normally lacking basic health care structure.

The article from Arantes, Shimizu and Merchán-Hammann, from 2015, entitled "The Benefits and Challenges of the Family Health Strategy in Brazilian Primary Healthcare: a literature review", analyze the Brazilian primary care landscape. According to the article, the first attempts to organize a national primary care delivery program at Brazil started at the 1920's. An important event was the creation of the PSF (*Programa Saúde da Família*), or Family Health Program, that later changed to ESF (*Estratégia de Saúde da Família*), or Family Health Strategy. The ESF aimed the organization of the whole healthcare delivery in Brazil, focusing mainly on the development of healthcare practice, patient and family-centrism, individual assistance, assurance of healthcare delivery; healthcare institutions network coordination, social participation and inter-sectoral actuation.

On the other hand, several difficulties imposed barriers to the program. Lack of funding from the government, lack of health professionals aligned with the primary care provisioning, lack of health professional career plan, lack of intra-sector coordination and mutual support (ARANTES; SHIMIZU; MERCHÁN-HAMMANN, 2015). The physicians and other professionals are the main points of contact between the patient, the treatment and the improvement of the health conditions. The medical staff is also responsible for patient

treatment supervising, impacting treatment adherence and increasing chances of recovering. It is very important to keep these professionals trained and motivated.

Other related challenges were lack of access to some services, such as teenager health, HIV patients, drug addicts, obese patients, and mental patients; also ESF integration to the already established health care, thus missing to assign the system primary care units as entry point to health care system (ARANTES; SHIMIZU; MERCHÁN-HAMMANN, 2015). The several conditions must be addressed to prevent patients to appeal to much expensive tertiary care, such as specialists and hospitals, especially at chronic diseases, where the treatment is well-established ad follow-up can be done by primary care professionals.

According to the DataSUS web site, the SUS portal for statistics and data on national health care, in 2012 approximately 4,2% of the Federal budget was spent on health care, or 1,86% of the GDP (IDB, 2012). The main spending institutions are the hospitals that, despite all efforts from the Brazilian government, became the entry point to health care services, due to the insufficiency of primary care system access (difficulties/challenges discusses above). About 70% of emergency care is provided by hospitals, along with 27% of ambulatory services (LA FORGIA; COUTTOLENC, 2009).

There is lack of basic items, such as basic drugs (for example, in the UBS from Rio de Janeiro, from 175 listed items, 118 are missing, such as antiseptic alcohol, painkillers, antibiotics, anti-inflammatory) (RODRIGUES, 2017), exam supplies (such as glucose test strip at São Paulo, Santa Catarina and Minas Gerais) (ALENCAR, 2017; SALMO, 2017; G1, 2016), and even building maintenance (FERRAZ, 2017).

Thus, even though patients seek for primary health care services in public sector, they are not always available. The private sector also presents barriers to access, such as long waiting time or high costs. Therefore, emergency rooms become a shortcut to visit a physician as quickly as possible, even for chronic diseases treatment (LA FORGIA; COUTTOLENC, 2009). Despite the fact that private hospitals account for 70% of all beds, most of the funding is through SUS reimbursement.

This hospital-centric trend is responsible for major inefficiencies and inequalities. Instead of focusing on primary care, doctors are studying to become specialists. A survey on Organization for Economic Co-operation and Development (OECD) countries showed that

from 1990 to 2005, the growth of 35% in the number of physicians was driven by a 50% growth on specialists and only a 20% increase on general practitioners (LERBERGHE, EVANS, RASANATHAN, MECHBAL, 2008). For example, according to the website Salary.com, generalist doctor annual base salary in United States is in average below USD 200k, while ophthalmologists and neurologists earn more than USD 225k and surgeons and gastroenterologists over USD 350k. Health care provision becomes punctual, acute, driven by immediacy instead of focusing on preventive care, promotion of good habits, general health care attendance, regular and more frequent visits to physicians, even in the case of diagnosed chronic diseases.

Therefore, the Brazilian government - Federal, State and Municipality - struggle to provide access to public health care, since hospital services are much more expensive than initiatives like the UBS and the Family Doctors. There are ongoing initiatives to enhance primary care efficiency. One of them is an update on Primary Health Care Policy to increase funding to UBS from 17,3 billion reais to 19,1 billion reais, an investment to be spent at capacitation of professionals (including to instruct community agents to measure blood pressure and perform basic wound care), expansion of services (prenatal, hypertensive and diabetes care, small surgeries and vaccines), and purchase of medical equipment (mobile oral care units for remote municipalities and X-rays for oral surgery) (FRASAO, 2017). Also, until December/2018, all UBS must be fully equipped and trained to use electronic health records (more than 64% - 27330 units - do not have access to EHR) (BERALDO, 2017). Some municipalities are even investing on their own to enhance primary care access, like the Municipality of São Paulo, that launched a mobile app to schedule visits and exams on UBS (G1, 2017).

There is enough evidence to show that investments in services that increased population access to health care services can benefit the entire healthcare system. Mobile services provides patients with relevant information, immediate contact with health professionals, remote assistance, among other functionalities that – as it will be showed – costs much less expensive than current solutions like the ones found in hospitals, having less equipment and staff, but have the basic structure to provide initial and periodic care.

2 THEORETICAL REVIEW

Mobile platforms are increasing user access to many services at client's early convenience. At first, patients could only access medical services by physically reaching a health professional, most of the times at a proper installation, such as the doctor's office, a laboratory or an emergency room. But mobile devices are allowing users to acquire physical conditions information and share them with medical teams. It is about changing the way services are provided.

In this sense, to measure the impact of innovating on health care, it is fundamental to define what service innovation is. Relevant and widely accepted concepts on this topic come from SDL (VARGO; LUSCH, 2004), and characteristic-based representation of product (GALLOUJ; SAVONA, 2008). These approaches are relevant because they bring the intangible service component and the tangible good (device) component as relevant for innovating in service provision, what matches the mobile platform as a channel to service provisioning.

But these theories do not mention how an innovation can impact an industry, as mobile technology has impacted several industries. On that, the theory of disrupt innovation from Professor Christensen (CHRISTENSEN; RAYNOR; MCDONALD, 2015) tackles the event of new entrants disrupting an industry by positioning their products characteristics on markets that are not being supplied by incumbent companies. The theory has four main points: the first one is if that disruption is a process, not a point in time or a single product; the second one is related to the business model adopted; the third is that not every disruptive innovation succeeds; and the fourth states that an incumbent company, which market is being disrupted, does not necessarily need to change its entire structure to remain competitive.

Following, the theoretical review will discuss health care innovation in general terms. Innovation occurs under specific ways according to the type of industry. More traditional industries, like heavy or assembly industry (oil and gas, metallurgy, automakers, construction) rely on very formal and linear pathway of planning, budget, development, trial, approval and application. Despite having some similarities to pharmaceutical and medical equipment developments, health care innovation have some particularities linked to the practice of

medicine that allows innovations to be created in a daily basis, in spontaneous serendipities, like in the moment the patient is being examined, what is characteristic of the service industry.

Thus, it is important to contextualize the referred theories under the health care innovation scenario and after that build a framework that allow us to analyze how the entrepreneurs are dealing with mobile innovations over health care particularities.

2.1 SERVICE INNOVATION

One of the difficulties to improve services, according to Gallouj and Savona (2008) is that "service" is not well defined. Thus, it is hard to measure its output and how to improve it.

Service is a process, a sequence of operations, a formula, a protocol, and a problem solution, none physically countable nor quantifiable or storable. It is better understood as a "transaction" than a "manufactured good" (GALLOUJ; SAVONA, 2008), where specialized competence – application of knowledge - is applied through any processes for the benefit of another or itself (VARGO; LUSCH, 2004).

The discussion brought by SDL goes even further, by moving economy from a goods-dominant view – where the transaction of tangible artifacts are at the center of the economy, to a service-dominant one, where the intangible aspect comes to be central, such as exchange of processes, knowledge and relationships run the economic activities (VARGO; LUSCH, 2004). The argument is that behind the exchange of tangible goods, there is an exchange of specific competences, required to create (or to assemble, or to obtain, or to gather and so on) that good. The SDL is based on eight foundational premises (FPs), listed below (VARGO; LUSCH, 2004):

FP1: The Application of Specialized Skills and Knowledge is the Fundamental Unit of Exchange;

FP2: Indirect Exchange Masks the Fundamental Unit of Exchange;

FP3: Goods are Distribution Mechanisms for Service Provision;

FP4: Knowledge is the Fundamental Source of Competitive Advantage;

FP5: All Economies are Service Economies;

FP6: The Customer is Always Coproducer;

FP7: The Enterprise can only make Value Propositions;

FP8: A Service-Centered View is Customer Oriented and Relational.

An example of the foundational premises, when a doctor prescribes a medication to the patient, the pharmaceutical company is delivering services related to years of research, tests and approval, the physician is delivering several years of study and medical experience and the drugstore is delivering logistics and distribution to the patient (FP1, FP3). The patient is paying cash, but behind the money there is another enormous service-exchange chain that results basically in receiving a salary for delivering some kind of services (FP2). If the patient presents some adverse reaction, or a new use for the medication, the pharmaceutical company can use this information to improve their product and get even better results (FP6, FP4). The information about the drug adverse reaction can come from patients, if there is a developed relationship with them, or from physicians, or even from the government regulatory agencies (FP8).

The definition of resource is also under questioning: what is a resource for "building" a service? A resource cannot be limited to raw material, assembling machines and even human resources. The SDL joins the concepts of good and service into a single definition. Vargo and Lusch (2004) define the concepts of operand resources and operant resources. The operant resources are the means to act on the operand resources. So, the operant resources produce an effect over the operand resources, creating value. A fish in a pound is an operand resource, and fishing activity is an operant resource. The fish will only have any value if captured, and still only a value proposition (see FP7), since if the customer is not hungry, it won't have value for her at all.

Still at the fishing example, it is important to point out that what is being traded actually is the competence of fishing – the practice, the equipment, the knowledge, the location – a set of intangible assets that gives the fisherman a competitive advantage. As described by Vargo and Lusch (2004), these intangible assets can also be defined as core competences – the collective, internal, specific knowledge acquire from learning, characterized in many ways, such as how

to coordinate diverse production skills (such as fishing), and integrate multiple streams of technology (PRAHALAD; HAMEL, 1990), or managing the waiting room of a hospital emergency service.

Some definitions to service follow “assimilation” or “demarcation” approaches, as innovation drivers are the same for goods and service; service is merely defined as an intangible variation of a good. The assimilation approach is excessively focused on technology and dismisses the service particularities, such as intangibility and coproduction, and tends to explain service innovation under traditional manufacturing-context innovation drives, such as research and development (R&D) investment and patents. Demarcation approach, on the other hand, greatly emphasizes peculiarities of service, but still classifying service as a special type of product. Instead of proposing a broader view as proposed by SDL, it restricts the innovation model by reassessing and modifying tangible products models (ORDANINI; PARASURAMAN, 2011).

A broader view on services and service innovation is proposed by SDL and the work of Gallouj and Savona, 2008, which follows the SDL proposal on addressing service as a group of competences (knowledge and skills), structuring them within a characteristic-based definition of product, once “boundaries between goods and services are becoming more blurred”.

The Lancasterian characteristic-based representation of a product model organizes characteristics and competences into vectors, such as service characteristics vector, technical characteristics vector, process vector (both technological and non-technological), supplier vector and the customer-user vector (GALLOUJ; SAVONA, 2008). The product is not a good or a service, but a set of characteristics or competences, what is called integrative approach to innovation in services (GALLOUJ; SAVONA, 2008).

Other cited approaches are the technologist or assimilation approach, where the role of the technology is mandatory on innovating in services. Using the example of the iPhone from Introduction chapter, one would argue that the service provision of mobile media was only made possible by the embedded technology inside the manufactured device itself; and the service-oriented or differentiation approach, where the process of provisioning the service itself is the sole responsible for the innovation. Making use of the iPhone example, to contact

media producers and make them available anywhere, anytime for customers is the big deal. The device itself would be just a mean to provide it. The integrative or synthesizing approach merges manufactured goods and services, as both have their share of importance. The iPhone device would be a platform for service delivery. Both aspects (smartphone and media provision) are equally important, and the "platform" concept blurs the previous distinctive approaches.

Figure 2 is a graphical representation of the concept, focusing at the competences of each vector, as following: vector [C] represents the competences of the provider or the supplier; the vector [C'] represents the competences of the client or the user; the vector [T] represents the technical characteristics of the product (both tangible or intangible) that are used to produce vector [Y], therefore [T] is a process; and the vector [Y] represents the final or service characteristics, what defines the value to the client. The simultaneous employment of [T], [C] and [C'] lead to the delivery of a service [Y] (GALLOUJ; SAVONA, 2008).

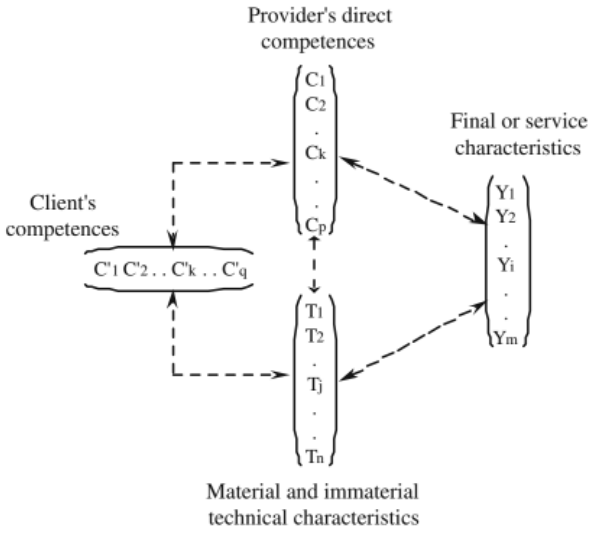

Figure 1 - Characteristics-based representation of the product (GALLOUJ; SAVONA, 2008).

From this representation, innovation in service is a result of changing elements or even entire sets of vectors; a minor change in one of the vectors will consequently lead to a smaller improvement to the final product, and several changes in one or many vectors will have a greater impact on service delivery. The diversity of change possibilities leads to the following classifications on innovation:

Radical innovation: creation of new sets of vectors [C'*], [C*], [T*], and [Y*] when the service to be delivered is completely new, or [Y], when the changes lead to the same service to be provided, but with different process (for example, high speed railroads replacing air traffic between two cities, offering lower prices and improved luggage space, but keeping the same service characteristics for the client, such as transportation, comfort and speed);

Improvement innovation: sets of characteristics [T] and [Y] are kept the same, but the single competences value are enhanced, due to firm learning and knowledge building (such as better understanding of how some drugs affect the human body);

Incremental innovation: addition, elimination or substitution of one or more elements, without changing the whole set of vectors (as when alcohol was used to clean patient skin before injections and now the practice was abandoned due to inefficiency to sterilize);

Ad hoc innovation: typical from high knowledge intensity activities, when the [C] vector and the immaterial characteristics of the [T] vector are dramatically changed, leading to a new solution for the client [Y*], varying even the nature of the solution (such as changes in nutrition habits to cure from a condition instead of having a surgery);

Recombination innovation: different association of service and technical vectors, creating a new product with the combination of one of more products or the dissociation of the characteristics of a pre-existing product (as when three different vaccines are combined into a single one, or when a laptop was stripped from its keyboard and other functionalities, giving birth to the simpler, cheaper and more portable tablet);

Formalization innovation: it's the standardization of characteristic elements from [T], mostly material ones, and related to process (as if in a general hospital reception, a single questionnaire was given to a waiting patient on check-in with basic questions about his health conditions to make medical trial easier and faster).

As it can be seen, innovation can come from any vector. This classification encompasses and explains other theories on service innovation. For example, the job-centric approach (BETTENCOURT; BROWN; SIRIANNI, 2012) is based on figuring out which jobs (problems, needs, activities) the customers want to get done. The traditional approach would

be to analyze customer experience, customer satisfaction and service quality - some of the metrics companies usually relates to measure current service. When the company shifts attention toward the customer needs, it allows the identification of opportunities for service innovations that are not constrained by currently available solutions (BETTENCOURT; BROWN; SIRIANNI, 2012).

Using the characteristics-based representation of the product, the job-centric approach could be framed as gathering a new set of service characteristics, based on customer jobs to get done and changing competences or technical characteristics to achieve them. This approach does not allow the analysis of every service innovation since it misses the possibilities of delivering products that customers don't know they would appreciate: the creation of necessities on the market, which has been the strategy of many companies worldwide - such as what happened with the telecommunication and smartphone companies and our intense need to stay connected on the internet all the time, when on late 2000's it was not a reality. On the other hand, the characteristic-based definition of a product allows the analysis of job-centric innovation as a particular case of updating [Y] vector with client needs and looking to [C], [C'] and [T] for solutions.

Möller, Rajala and Weterlund (2008) address the service innovation by the customer-provider interaction, where the main objective is to co-create and capture value. The client will perceive value from the service provided through their own competences ([C'] vector); the provider must then, attend to the client's resources and capabilities to understand how value is created and capture it using the provider's own capabilities ([C] vector) and incorporate them into innovating their products.

Three service innovation strategies are proposed - Established Services, Incremental Service Innovation and Radical Service Innovation, depending if the company is well-established with a well-defined and stable value production logic, as operational efficiency leads to competitive advantage; if the company develops new services accordingly to addition of value, investments and adaptions, keeping ahead of competition by providing improved and effective solutions for the clients; and if the company is driven by creating completely new concepts and offerings as a mean to value creation (MÖLLER; RAJALA; WETERLUND, 2008).

The proposed classifications fall under the Gallouj and Savona (2008), as established services strategy is equivalent of the improvement or formalization innovation (acting at [T] vector), the incremental service innovation being similar to incremental innovation (adding new characteristics to the product) and the radical service innovation being similar to the radical innovation (where whole sets of vectors are changed to create new services).

The theories presented are mainly concerned about characterizing what service is, and moreover, to show that any offering can be understood as a service, and the definition of product is more than just a single good or a service, but an integration of both. The set of competences and characteristics that comprises the now defined product allows us to explain and classify innovation, according to the amount of modifications made at the elements – with the modification coming from all parts involved in the process – client, providers, technology or service description.

With the SLD and the characteristic-based definition of product defining service and service innovation, now it is needed a theory that helps to indicate if a given innovation, despite being radical, incremental, ad hoc, and so on, has the potential to deeply impact a traditional industry, such as health care. The disruptive innovation theory of Professor Christensen will be presented and discussed to fill this void.

2.2 DISRUPTIVE INNOVATION

The disruptive innovation theory was developed by Prof. Clayton M. Christensen and introduced in 1995 and reassessed by its creator, by Michael Raynor, and Roy McDonald in the article “What Is Disruptive Innovation?” from December, 2015.

Despite many may think, not every ground-shaking, innovative, highly competitive products are necessarily disruptive. Formally, a disruptive innovation comes from a new-entry, small company. The products are launched in a market that is already dominated by incumbents, with a high range of options, many of them filled with functionalities, with the latest technologies, high competition, and consequently, higher prices (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

The disruptive innovation, according to Prof. Christensen theory, is much simpler, cheaper and less featured, but focused on most of the basic consumer needs, or [Y] vector elements.

They are more accessible, aiming the jobs the customers want to get done, and not necessarily the range of functionalities the incumbents' products are offering.

The figure 2 on next page is a graphical representation of the disruptive innovation theory. The vertical axis represents the product performance, features, functionalities, embedded technologies, provided services; and the horizontal axis the market maturation. The first arrow line represents the incumbent strategy, targeting high-end markets with expensive products with high margins and neglecting the eager-to-consume mainstream and the less resourceful low end markets.

The entrant company's solution arrow line is presented right below the first one, being launched some time before the incumbent product. As it can be seen, at any point in time, their product will present much lower performance and features, but also lower prices, and still matching the vector [Y] essential elements, reasonably fulfilling the client needs. The product will be inserted on a market niche that incumbents are overlooking (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

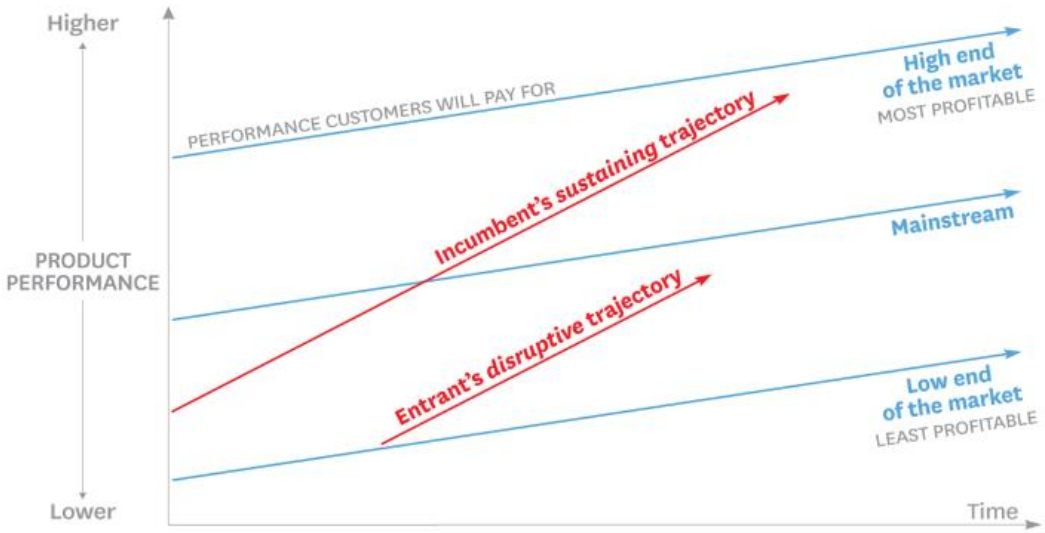

Figure 2 - The Disruptive Innovation Model (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

These new entry products are not as profitable as the top notch ones that incumbents are focusing on. They are targeting high-end market consumers that are able to afford high prices for premium functionalities, most of the time neglecting low-end and mainstream markets. The disruptive innovations focus at low-end, new market footholds, therefore using an

upmarket strategy to reach mainstream, starting by delivering a more-suitable performance at an accessible price and earning customer awareness, than engagement, thus increased selling volume (CHRISTENSEN; RAYNOR; MCDONALD, 2015). This strategy allows small companies to be competitive in markets supposedly dominated by incumbents.

To explain the new entrant's successful trajectory, four relevant points on disruptive innovations are presented. The first one is if that disruption is a process, not a point in time or a single product. It should start as an experiment, with market trials, from small to large scale, i.e., getting mature over time. In the beginning, it will be simple, with lesser features than competitors, but still fulfilling niche market needs. The second one is related to the business model adopted. Usually, disruptive innovations business models diverge from incumbent business models (CHRISTENSEN; RAYNOR; MCDONALD, 2015). Since the offering is different, and sometimes less profitable, entrants must think strategically which customers they are targeting, how they will attract and captivate the customers, what the value propositions are, and so on. A innovation that is not sustainable won't be disruptive. The third is that not every successful innovation is disruptive. In other terms, a successful new-entry tech company can present incrementally developed product that are well accepted but won't impact the industry. The fourth point states that an incumbent company which market is being disrupted does not necessarily need to change its whole structure to remain competitive (CHRISTENSEN; RAYNOR; MCDONALD, 2015). If the incumbent is not focusing on a less profitable market, it can build up barriers to the dominant markets (such as the high end customers) to prevent the entrants from getting access to them. Incumbents can decrease costs, launch new products, expand their product range, specialize even more, negotiate with suppliers, strengthen their brand, and acquire the new entrant company, among other strategies. Incumbents have plenty of resources and market knowledge to deal with the treat. But they need to act quickly, nevertheless.

In order to have the potential to disrupt an industry, a product must have the essential features required by the clients, which are to be much simpler and cheaper than the incumbent solutions, attend to a market segment that is not being targeted by incumbent companies, and have an innovative business model that allows the company to keep growing and improving their product offering.

Finally, it is important to position the presented theories into the health care industry context. They were disclosed in generic terms so they could be fitted in most contexts. But health care have several particularities that requires understanding. The next topic will shed a light over the health care innovation pathways and gateways.

2.3 HEALTHCARE INNOVATION SYSTEM

The analysis of innovation in health care requires an examination of the health care ecosystem. The industrial-medical complex (ALBUQUERQUE; CASSIOLATO, 2002), comprises medical supply manufacturers, composed by pharmaceutical (including vaccines and diagnosis reagents), medical and diagnostic equipment companies; research institutions that are biotech companies, universities, technical schools and research centers; hospitals, classifies as general, specialized and teaching; diagnosis institutions, such as clinics and laboratories; other smaller institutions composed by independent physician offices and home care institutions; Government agencies, responsible for regulation, incentive and control of new substances, for procedures reimbursement and policies; health insurance companies, an important part of the ecosystem that links health service providers and service takers, such as employees and companies; regional and national boards of medicine (and other classes), responsible for approving practices, discussing professional ethics, work licenses, and so on; and health professionals (physicians, nurses, technicians, professors), academic and professional scientists, and patients (CONSOLI; MINA, 2009; GARDELHA; QUENTAL; FIALHO, 2003; HAVIGHUST, 2008).

All of these players have the potential to contribute with innovation in health care (CONSOLI; MINA, 2009). Hospitals are intensive medical practice institutions, where feedback from existing, approved treatments and procedures, from both patients and health staff can give input to new products. At research hospitals, devices and drugs, procedures and treatments will be implemented and taught; the research teams will closely observe new observations and reports. Also, tacit knowledge will migrate to explicit, and current treatments will be improved, leading to incremental innovations (CONSOLI; MINA, 2009). The same can be said about clinics and diagnosis centers. Not only the intensive use of diagnosis equipment (ultrasound image, hemogram, hemodialysis, etc.) and the direct contact between physician and patient allows the observation of procedures and immediate feedback, what could lead to new procedures or equipment improvement (CONSOLI; MINA, 2009).

As academia and research institutions contribute with a constant flow of scientific and technologic information, Government agencies and professional boards act as filters to new developments for both industry and academia. These institutions have a central role on selecting new treatments, drugs and equipment, putting apart a commercial, profit-based point-of-view. Public and private medical assistance put innovations into practice (ALBUQUERQUE; CASSIOLATO, 2002).

The production of medicaments is composed of four main stages: research and development – acquisition - new substances, clinical trials and approval by regulatory agencies; formulation and final medicament processing; industrial production of the drug; and finally commercialization and distribution by drugstores and other retail stores (GARDELHA; QUENTAL; FIALHO, 2003). Therefore, pharmaceutical companies are highly dependable on research, both internal and external and invariably very expensive, as a new drug represents competitive advantage. Sources of external research are academic, research institutes and biotechnical companies (ALBUQUERQUE; CASSIOLATO, 2002). Pharmaceutical companies are responsible for an important share of investments on research and development, thus relevant contributors to innovation on health care.

Several biotechnology companies started as spin off of university research laboratories. They are deeply involved with research and development of new technologies to produce synthetic substances, such as insulin. Big pharmaceutical companies have great interest on them due to their innovative profile, and in biotechnical companies enjoy the partnership to take their products to the market, since pharmaceutical companies have advanced production capabilities, resources for clinical tests and improved commercial and marketing departments. (ALBUQUERQUE; CASSIOLATO, 2002).

Medical and diagnosis equipment companies are also important technology developers. They can be both dedicated companies, of branches of mechanical and electrical companies (like GE, Siemens, Phillips, HP, etc.). Their importance is also related to the interdisciplinary content of their products, and the development of technologies and scientific research in other industries (such as aerospace, metallurgy and material, electronics and computer science) greatly impacts their product development agenda and inserts non-medical knowledge to health care (ALBUQUERQUE; CASSIOLATO, 2002).

Health insurance companies can either benefit a specific innovation by incentivizing adoption through better payment or dismiss it by withdrawing the procedure from the authorized payment list. The same will happen with government reimbursement list – if a procedure is not listed, hospitals will chose not to implement the practice and prefer to continue with more profitable ones.

Consoli and Mina (2009), state that health care innovation ecosystem is configured as a dynamic division of knowledge, where labor – research, testing, promotion, selling, adoption, incentives, and control – is distributed across technological fields and organizational units. During the innovation process in health care, the cited units can take part in two stages: the development of the technology, and the diffusion into the medical practice. The individual units are called gateways and the relationship between them is called pathways.

It is through the pathways that information flows among gateways. The information is composed of feedback from medical practice to innovation developers and happens systematically and through collective knowledge accumulation. Relevant sources of information are the physician-patient interaction, and research hospitals. On the other side, the scientific community – research institutions, academia, and product development departments – use information for further developments that will have to cross regulatory procedures to reach practice again (CONSOLI; MINA, 2009). This system is defined by the authors as “the building blocks (gateways) and the nexus of interactions and feedbacks (pathways) that characterizes a modern health system”.

Under the view of this modern and dynamic health innovation system, how to access prominent innovations, from a very particular segment – mobile technology – and somehow measure the potential to be disruptive? In the next section, we present a tentative framework based on this literature review. This framework will be the lens for our literature review and, especially, for our case studies analyses.

2.4 DISRUPTIVENESS POTENTIAL ON SERVICE INNOVATION FRAMEWORK

A framework to test the potential for a health care innovation to be disruptive is presented below. It is based on a three-step guide that will use the previous theories to analyze the innovation and check its potential to impact health care industry.

From the SDL, it is possible to create a single basis for analyzing and comparing goods, services or a combination of both. The characteristics-based representation of the product goes deep into the innovation features, offering a broader and clearer view over the innovation by dividing the product features into user, provider, technical and service sets of elements.

By comparing the sets of elements with a competitor – a product from an incumbent company that is already in the market, it is possible to emphasize how distinct or not is the proposed solution, allowing the measurement of novelty.

Thus, the Step 1 – Distinct Competences and Characteristics, is about describing the innovation and the competitor offering in terms of user [C'] and provider [C] competences, technical [T] and service [Y] characteristics. Once the products are segregated into competences and characteristics, it does not matter if it is a good, a service or a combination of both. This allows the innovation to be compared with competitors, regardless how they are classified (good, service, combination) (VARGO; LUSCH, 2004; GALLOUJ; SAVONA, 2008). The comparison must be made in terms of changes to the elements of the vectors.

If there are not enough elements that differ from the competitor, the innovation is just another regular competitor (such as two pediatrician clinics providing the same services at the same neighborhood).

For an innovation to impact an industry, the theory of disruptive innovation was accessed, as the theory will link the differential aspects of the product with the business plan strategy to entry the market: if the product is focusing on an unattended market, if it is competitive by being simpler and cheaper, if the business model is also innovative, along with others (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

Therefore, since it has been proved that the innovation differentiate itself from a current product, in the Step 2 – Disruptiveness Indicators, it will be to attest if the solution follows the disruptive innovation indicators. A potentially disruptive solution must be simpler and cheaper than competitors (namely, a recombination innovation would be ideal, since the solution would have fewer characteristics than competitor and still present a new product), it must target a market that is not being attended by incumbent companies, its business model must not follow the regular industry business practices, and there must be any indication of scalability (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

Besides competitors and target-markets, it is also important to position the company and the product into the health care innovation system – the gateways and the pathways (CONSOLI; MINA, 2009). A positioning strategy will provide information and resources for further developments, such as partnership with suppliers and health institutions; channels for client feedback; relationship with research centers, universities, and other companies; government agencies support and other sources of investment are fundamental for any companies – especially small, entry companies - to have means to quickly respond to the market forces.

So, on the Step 3 – Innovation Ecosystem, the innovation and the startup gateways and pathways of the health care system innovation. The ecosystem positioning and relationships are very important to foster new partnerships, essential resources and information sources and flow to sustain the company on the long-term (CONSOLI; MINA, 2009).

Thus, a framework, designed to verify the potential for a service innovation to be disruptive and self-sustaining, is presented below. It is a 3-step guide that will use the previous theories to analyze the innovation and check its potential to impact health care industry.

After the application of the framework, a final analysis will be provided and the results will be discussed. If the innovation follows mostly of the service and disruptive innovation assumptions, we will have reasons to believe that the solution has the potential to impact the health care industry.

The figure 3 on the next page presents the framework analysis:

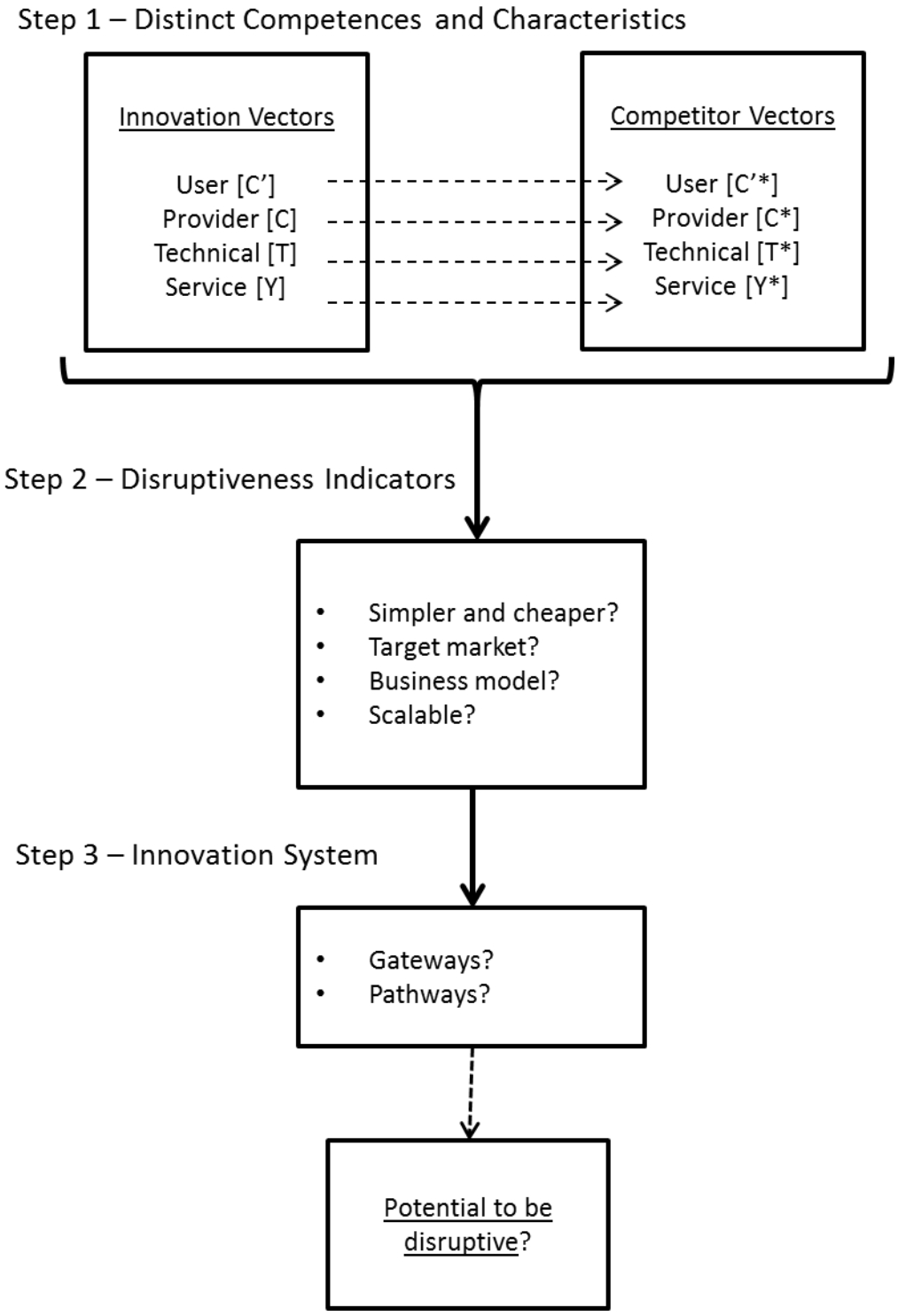

Figure 3 - Visual representation of the Disruptiveness Potential on Service Innovation Framework.

3 SYSTEMATIC LITERATURE REVIEW ON MOBILE HEALTH CARE INNOVATIONS

This chapter will present a systematic literature review on mobile health care innovations. The purpose is to draw a map of the technology trends related to the mobile technology application on health care provisioning globally, and later filter Brazilian solutions according to the determined trends.

Searching for references on health care innovation usually lead us to new medical treatments, to new drugs, to new medical equipment, new studies on patient behavior, studies on patient response to one or some of the new innovations mentioned, and so on.

The idea was to focus on health care services, the middle ground between the patient and the doctor, or between the medical procedure and the patient, or even between the patient and the direct treatment. In order to be more specific, the health care service innovation must also follow the integrative approach by Gallouj and Savona (2008), meaning that the solutions must be comprised from both technology and service. A solution based solely on an algorithm, for example, which would use patient physical data to propose a treatment, without the participation of a physician, would be discarded. On the other hand, if the same algorithm was used for a first triage and then, a health professional would provide personalized treatment, it would be a match.

Another aspect was the use of mobile technology. The Cambridge Dictionary defines “mobile technology” as electronic equipment such as a mobile phones or small computers that you can use in different places, and the technology connected with them. So, it is understood all kind of technology that is possible to be carried by the patient on their regular routine, such as smartphones, smartwatches, electronic tags, sensors and other small devices. The device must exchange information through a remote network, which could be an intranet (a private network inside a hospital, for example) or the internet (the World Wide Web). The information to be exchanged can be obtained through sensors or by the user input.

The database used for the research was the Business Source Complete database, from the EBSCOhost Company. EBSCOhost is an online reference system that offers a variety of

proprietary full text databases and popular databases from leading information providers, such as CINAHL, Inspec, MEDLINE, PsycINFO, which range from general reference collections to specially designed, subject-specific databases for public, academic, medical, corporate and school libraries. The variety of databases included within EBSCOhost was an important differential, since the disciplines related to health care and mobile technology come from very distinct areas of knowledge.

The Business Source Complete database is composed by more than 1200 relevant business magazines, financial information, books, dissertations, conferences, case studies, industry and market reports and company profiles, among others. The database covers the main business disciplines, such as marketing, management, Management Information Systems (MIS), Production and Operations Management (POM), accounting, finances, strategy and economy.

The following databases within Business Source Complete where chosen: Academic Search Premier, CINAHL with Full Text, Dentistry and Oral Sciences Source, Information Science and Technology Abstract (ISTA), RILM Abstracts of Music Literature (1967 to Present only), SocINDEX with Full Text, SPORTDiscus with Full Text, eBook Collection (EBSCOhost), Computers & Applied Sciences Complete, and MEDLINE Complete. The diversity of databases contributed by bringing several different subjects to the research, since the topic has a strong multidisciplinary aspect, once technology application may come from distinct industries.

Both medicine and technology articles on innovation tend to bring product specificities instead of a broader view of the impact on society. Thus, it was chosen to use a business-based database, where the focus would be on the application of the solutions on institutions, markets, regions, business, allowing a humanistic overview rather than a technical one.

Hence, first, it was made a preliminary search, with some keywords that were related to the topic, such as “health care”, “innovation”, “service”, “mobile”, and so on. The results were greatly broad, but allowed to find some other keywords that could bring more relevant findings.

Following the preliminary search, research strategy was build: (SU Healthcare OR SU health OR SU "health care") AND (SU innovation) AND (AB service OR AB "value based" OR AB value-based OR AB "co creation" OR AB "co-creation" OR AB delivery) AND ((AB human

OR AB user OR AB patient OR AB client) AND (AB centered OR AB based OR AB experience)).

The SU code means that the entry will be searched at subject field. The general entries, related to a broader area of knowledge, received the SU code. The AB code refers to abstract. The abstract has the main points of the publication, where usually the authors choose the words that best capture the essence of the article to captivate the reader.

As it can be seen, other service innovation concepts were used, such as user-centered, value-based, co-creation and so on. This search was executed on August, 22nd, 2017. The figure 5 below presents the research and the number of results per year, as a mean of comparison:

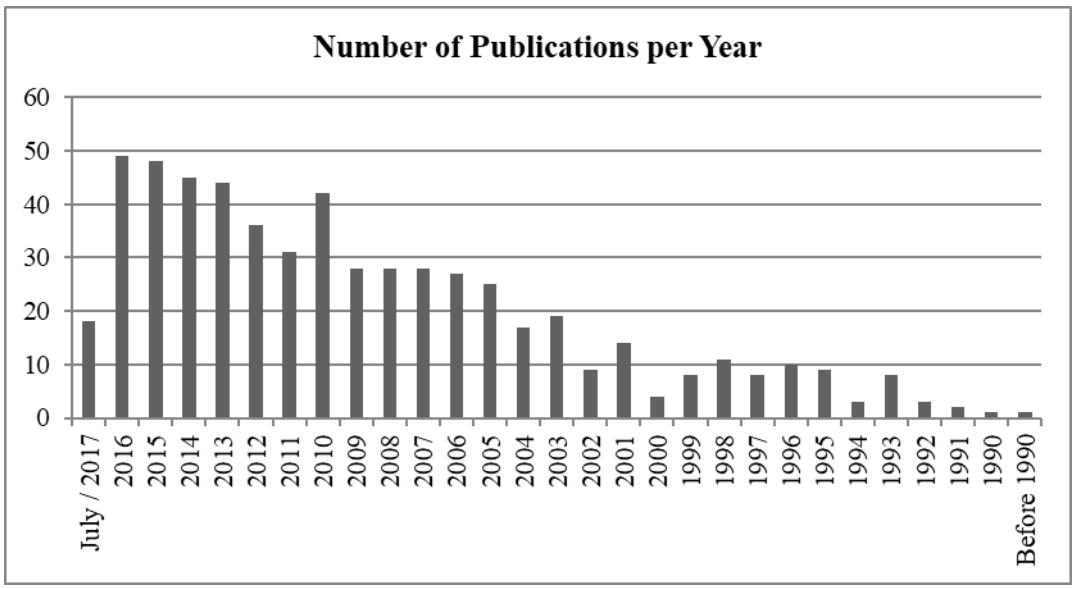

Figure 4 - Graphical representation of the number of publications per year.

The whole amount corresponded to 632 publications. From 2000 to 2017, the number of publications increased steadily. From 1990 to 2000, the number of publications per year averaged 6.1. From 2001 to 2006, the number of publications averaged 18.6 per year. In the chosen 10 years period – from 2007 to July, 2017 – the sum of publications reached 397 and the average publications per year reached 35.65.

The reasons behind the choice of the period are based on the mobile technology timeline. 2007 was an emblematic year, since it was the year when the first capacitive touch screen smartphones were launched - the LG Prada and the Apple iPhone. Despite having other

mobile devices with touch screens – such as Personal Digital Assistant (PDAs) and some tablets, they were mainly destined to professional use. Moreover, before 2007, mobile internet communication was still very restricting, since 3G was still expensive and only available at few telecommunication companies. It was also in 2007 that 3G became mainstreamed along with the smartphones.

The 397 papers are classified into academic journals (384), journals (300), magazines (7), and others (3). Most of the articles were classified both as academic journals and journals.

The texts were widely spread over 51 different publications. The main ones were Health Affairs, accounting for 20 articles, the International Journal of Integrated Care (IJIC) with 19 articles, the BMC Health Services Research with 15 articles, and the Health Affairs Project HOPE with 13 articles. The others accounted for less than 10 articles each.

On thesaurus terms, the first 15 most cited were diffusion of innovations, medical innovations, medical care, technological innovations, integrated delivery of health care, health services accessibility, quality assurance, quality control of medical care, health insurance reimbursement, medical care costs, primary health care, health care reform, health care teams, public health, and cost control.

The 397 articles were filtered by withdrawing duplicated publications (12), then by presenting or not a full-text for detailed analysis (169). The next step was to read every title and abstract and select publications that related to mobile technology being used as service. The number of publications dropped to 56 articles.

The chart below presents a visual representation of the systematic literature review.

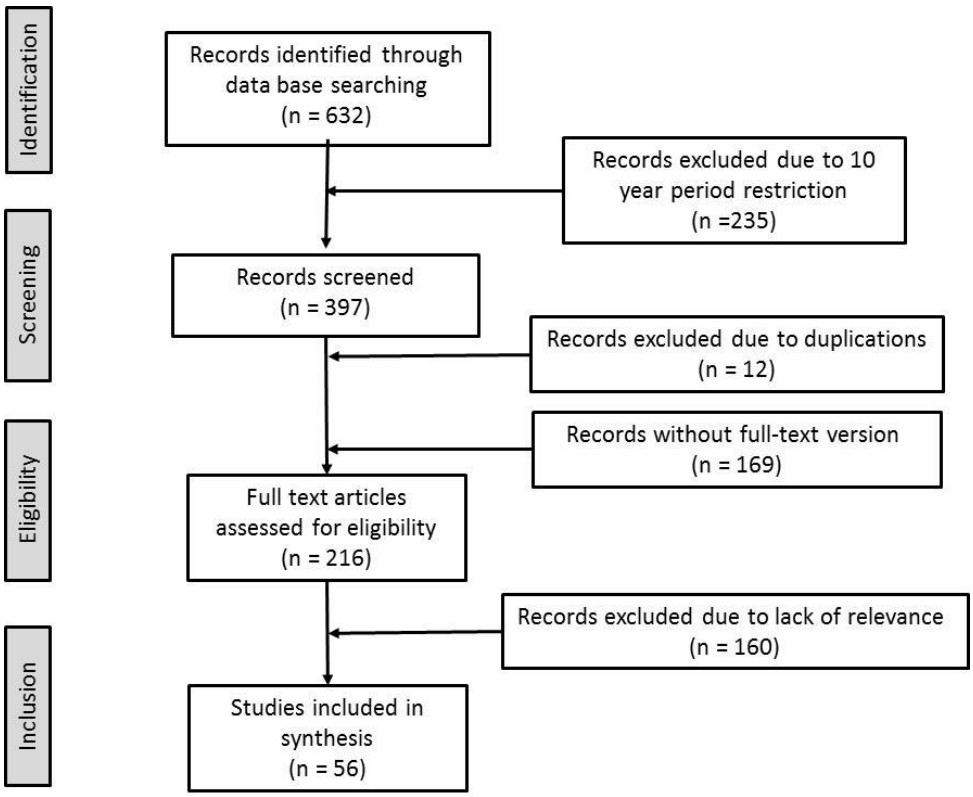

Figure 5 - Visual representation of the systematic literature review.

The United States accounted for half of the articles selected - 28, followed by Canada and Australia – 6 each. Other countries presented less than 4 articles – China, Germany, India, New Zealand, South Africa, Spain, Sweden, Tanzania, The Netherlands and UK. Brazil unfortunately did not appear at the final set. The USA presented a very relevant importance in this research, even though other countries were also represented.

Every article was read and the main points highlighted. The next step was to identify mobile technology trends on health care. The results are presented below, starting with the definition of eHealth and following that, the trends.

3.1 E-HEALTH

Since many of the publications refer to eHealth, it was important to define the term.

eHealth can be defined as “not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve

healthcare locally, regionally, and worldwide by using information and communication technology" (WOZNEY ET AL, 2017).

Several technologies are related to eHealth, including cell phones, smartphones, interactive voice response, text messages, e-mails, clinic-based interactive video, home-based web-cams, mobile smartphone two-way cameras, personal monitoring devices, kiosks, dashboards, personal health records, web-based portals, social networking sites, secure chat rooms, on-line forums (FORTNEY ET AL, 2011), and other devices that enhance communication, data acquisition, and data transfer. These technologies can be used for the development of several solutions with the potential to drastically diminish the geographical, temporal, cultural and digital health access problems faced by the population (FORTNEY ET AL, 2011).

Fortney et al (2011) suggests four types of virtual healthcare utilization: synchronous digital patient-to-provider encounters (where information is sent and received at the same time, such as in telecommunications), asynchronous digital patient-to-provider communication (like secure email messaging, where there is a time delay between sending a question to a physician and receiving an answer), digital peer-to-peer communication (such as patient social networks for pregnant women and cell phone-based communication between community health agents in Africa), and synchronous digital interactions between patients and computer health applications (as smartphone applications that collect personal physical data and allow the users to take different actions - such as a self-algorithm-based diagnosis, or a proposed set of physical exercises, or even send the sensor acquired information to health institutions).

Although more and more patients have broadband internet access and are using smartphones, the digital divide may create connectivity barriers for low income, minority, rural, and older adult patients (FORTNEY ET AL, 2011).

3.2 DESCRIPTION OF TECHNICAL AND SERVICE INNOVATIONS TRENDS

Technology is an essential element for enabling disruptive innovation on health care. Despite up-to-date technological innovations in medicine have increased costs; other solutions have the potential to increase access to primary care service, improving patient-experience and value. Danking et al (2014), presents the following argument on the topic:

> We argue that if complex programs of technology-enabled service innovation are understood in terms of their contribution to patient care and supported by participative, capability-building evaluation methodologies, conditions are created for practitioners and patients to realize the potential of technologies and make substantive contributions to the evidence base underpinning health innovation programs (DANKING ET AL, 2014).

In general, the technology resources that are mostly cited by references are internet, databanks, wireless networks, computers, portable electronic devices - mostly smartphones, but also tablets, PDAs, cellphones, wireless sensors, video, Radio Frequency Identification (RFID), Global System for Mobile (GSM) and mobile applications, being the internet the basic resource for almost every solution found in literature.

On solutions, there are the EHR, e-learning, social networks, telehealth (comprising variations such as telemedicine, teleradiology), Patient-Centered Medical Home (PCMH), and other specific platforms and devices.

In the following paragraphs, the articles will be discussed under the same theme, as indicated by the sub-title. Sometimes, the articles are far broad and they will relate to several technologies; even in that case, it was selected the main technology being described and then the article was classified under a single theme.

3.2.1 Telehealth

Telehealth - and its variations such as telemedicine, telepractice, and teletherapy - can be defined as provisioning of healthcare services using remote communication systems. Telehealth is also about the improvement of health care conditions in the affected communities by exchanging medical information between different places (TAYLOR, 2013).

Thus, most of the solutions on telehealth are focused on shortening the physical distance between patients and doctors from remote locations to specialists. The specialists can be specialized physicians, like oncologists (MURPHY ET AL, 2015), radiologists (CHAR ET AL, 2010), and owners of any other field of knowledge not available at the location, like mental health, speech-language pathology, and wound care (DESILVA, 2014; THEODOROS, 2012; BARRET ET AL, 2009). Difficulties in implementing are usually related to lack of infrastructure, such as reliable internet connection (CHAR ET AL, 2010),

appropriate software and computers (BARRET ET AL, 2009; CHAR ET AL, 2010); and adoption by physicians and institutions (BARRET ET AL, 2009; TAYLOR, 2013; MURPHY ET AL, 2015).

Most of the used technologies are, in short, based on any online or technology-based device or set of devices which provides auditory and visual signals that are replicated and transmitted at a distance. Examples of enabling technologies enclosing telehealth are telephone services, internet and web-access services, enough bandwidth transmission, videophones, mobile phones, PDAs, computers, software - remote access, multimedia (video and sound), image viewing, compressing, archiving, and customized multimedia video conferencing systems (CHAR ET AL, 2010; THEODOROS, 2012).

Rural areas are keener to receive this kind of innovation, especially due to lack of technical, IT and medical resources. Even if the region has some qualified specialists, the workload could be too much for the local staff to handle (CHAR ET AL, 2010). This remote area also suffers from social and economic disadvantages in comparison to metropolitan areas - and in some regions, ethnic inequality, later physical health condition diagnosis and consequently late starter and poorer treatment (MURPHY, 2015). However, even in metropolitan areas, the scenario is the same when the patient has some kind of disability, needing a carrier to assist them, and, sometimes, specialized transport. Even when the disabled patient is able to arrive at the medical installation - clinic, hospital, and laboratory - the person may be in a less than optimal physical, cognitive, and emotional state to be treated (THEODOROS, 2012).

Telehealth is a solution that, despite using usual, available, well-known technologies, is being applied to new medical specialties and treatments. Barret ET AL (2009) describes a chronic wound care treatment for the countryside of Australia, using telehealth systems installed at chosen clinics. Another example is the speech-language pathology, also in Australia, to treat remotely conditions like aphasia, dysarthria, and apraxia of speech (THEODOROS, 2012).

Another aspect of telehealth is to use communication network not only for distant multimedia consultation but providing relevant information that promotes healthcare service. Despite the widespread employment of smartphones, several regions - especially underdeveloped countries - still use GSM network through cell phones. This simple, outdated technology (on developed countries standards) has a huge potential to promote better health care services just

by providing communication. The GSM networks allow information transmission through Short Message Service (SMS). Some articles point that SMS can impact health care service delivery in underdevelopment countries in terms of data transfer availability, management of patient's treatment, medical intervention complexity reduction and positively influencing equities in service delivery. A problem might be scaling up the solution (NOORDAM ET AL, 2015).

For instance, in India, a solution based on cell phones and GSM network allows health professionals to receive a list of patients to visit, access to education through training modules, and fast, direct contact to other health professionals (ROPER, 2013).

SMS can provide surveillance over contracting and spreading of infectious diseases. With support from data analysis systems, it has the possibility to increase the monitoring of diseases in broad, distant, rural areas of developing countries. The solution presented by Mwabukusi et al (2014), is based on a server-client model: collaborators use cellphones to send SMS about the conditions of the local area; the data is collected, then aggregated, and finally visualized and managed, i.e., forecast disease expansion, allowing preventive actions or at least supportive actions for the population.

Another use for SMS was in support for infant nutrition surveillance in Malawi and early HIV infant diagnosis in Malawi and Zambia. In both cases, it was implemented an SMS platform entitled RapidSMS, "a free and open source framework for dynamic data collection, logistics coordination, and communication, with maternal, newborn, and child health interventions" (NOORDAM ET AL, 2015). In the case of early HIV infant diagnosis, although the dried blood spot (DSP) test was safe enough to be collected and transported, problems were related to lack of laboratory installations, capacitated staff to perform the exams, lack of means to allow adequate care management and even couriers to transport DSP samples and test results, and a discontinued government HIV care policy. The main benefits of the application of the RapidSMS were the possibility to keep track of DBS tests, reducing transport needs and allowing faster communication of test results, facilitating community health workers to contact mothers caretakers by phone, instructing them to visit the local clinic for test results and orientation (NOORDAM ET AL, 2015).

On infant nutrition surveillance, the problems were very similar: lack of capacitated health workers - resulting in deficit supervision and technical skills for family nourishment data gathering, survey tools based on paper forms - demanding logistical systems and increasing complexity for data analysis, difficulty in raising community awareness on nutrition surveillance and on patient (mother and children) monitoring. With the implementation of the RapidSMS system, it was able to reduce complexity in communication and transportation of survey data, reducing the delay in data transmission, improving data quality and data analysis (NOORDAM ET AL, 2015). It is important to notice that not all difficulties were tacked by the implementation of SMS tools, such as training and capacitation of health workers - but as it was seen on previous examples, the GSM network is capable of delivering educational solutions to community workers, although the article from Noordam ET AL (2015), doesn't mention any initiative for a project like this.

Fowler (2016) performed a systematic literature review on the efficiency of using mobile technology on adult alcohol abuse treatment. It has been noticed that traditional interventions (like in-person counseling, brief motivational intervention) require substantial time and money as well as trained providers. On the other hand, mobile technologies can deliver care in a more consistent way, decreasing the dependence on the therapist/clinician, allowing a layer of anonymity, easiness of personalizing the messages, high intervention delivery efficiency as well as increased accessibility provided by lower cost, ignoring territorial distances, enhanced portability, and ease of use of mobile phones, resulting in increased patient adherence to treatment. The author mentions similar studies on student tobacco use, diabetes self-management, smoking cessation, and physical activity, which are positively impacted by using SMS to address the patient under treatment and deliver the intervention.

3.2.2 Social Networks

Social networks are being extensively used on the internet to connect every kind of public, for every kind of objective. Also, companies are using similar networks to enhance - and register - communication between its collaborators. Social networks for patients are important to improve patient engagement and support, enhance health behaviors and decision making, connect providers and patients, and improve health service delivery (CUNNINGHAM ET

AL, 2017). On social networks for healthcare application, Margolis et al (2013), provides the following point-of-view:

Network-based production is particularly suited to complex systems such as health care, precisely because the knowledge, skills, and tools necessary to develop and implement real change are often beyond the capacity of one place, person, or organization since the stakeholders in the process (in this case, patients, clinicians, and researchers) are motivated and have skills that can be devoted to the task, and finally because the scientific questions about how to accomplish improvements in health and health care require a multidisciplinary complex systems science perspective (MARGOLIS ET AL, 2013).

Several innovative products are based on connecting different healthcare stakeholders in web-based communities. Some examples found on literature are social networks for patients to exchange experiences - such as group prenatal care to improve perinatal outcomes (CUNNINGHAM ET AL, 2017), or foster contact between chronic disease patients (MARGOLIS ET AL, 2013) and a primary care innovation diffusion network for practitioners (MENDIZABAL ET AL, 2013).

The “Expect with me” social network for prenatal mother groups was created with the objective of increasing information flow and awareness on pregnancy. The US rates of preterm birth and low birth weight (9.6% and 8.1%, respectively) were considered one of the higher among developed countries, despite efforts from the government in the last three decades. These adverse birth outcomes accounted for 36% of all US infant deaths at the time (CUNNINGHAM ET AL, 2017).

It has been found that when grouped together, women on prenatal presented not only lower rates of preterm birth and higher birth weight preterm, but also decreased the number of sexually transmitted infections, better maternal weight control, and fewer cases of maternal depression, resulting in increased patient satisfaction. The “Expect with me” network was created to increase interaction between a group of expecting mothers. However, the solution was not solely based on the online community - first, the group met face-to-face and information on pregnancy, sexual health, nutrition, mental health, exercises were provided. The social network approached the group after the face-to-face sections, providing a channel

for the future mothers to discuss relevant topics, to raise questions, to track health metrics, being all of them monitored by health professionals (CUNNINGHAM ET AL, 2017).

The expectations are that the groups will present lower rates of birth complications, thus improving the quality of the mother and the baby health, directly impacting in the costs of primary and tertiary care.

The article from Margolis et al (2013) approaches the use of collaborative networks to chronic care on a platform called Collaborative Chronic Care Network (C3N). The platform has the intention to connect the several stakeholders and eHealth solutions, allowing the process and interventions to be designed, tested and implemented. Some of the conditions in which C3N is being applied are Crohn's disease and ulcerative colitis, through the tool ImproveCareNow Network, where pediatric gastroenterologists, patients, researchers and patient families work together to enhance care experience (MARGOLIS ET AL, 2013).

One of the mottos of using social networks is due to the passivity of the patients under the treatment, usually driven by the knowledge-based relationship between physicians and researchers. The patient is set aside, not receiving the optimal treatment, once they and their family are not participating in the decision-making about care (MARGOLIS ET AL, 2013). Once all the stakeholders are set together, each one can individually contribute to the development of the patient better service provisioning, in a co-participative, co-creative and patient-centered way.

In Spain, the social network called HOBE+ was created to support primary care through the fostering of innovative solutions by increasing communication among health professionals. Physicians, nurses and administrators could bring their individual day-by-day experience, share with peers and propose changes to the current solutions or even new ones. Some of the topics discussed were improvements to EHR, stock management, new centralized purchasing procedures for health centers, initiatives to promote training and information for adolescents and young people, among others. The professional access was voluntary, and after the inauguration of the service, only 3.6% of the users remained active. Still, more than 20 new ideas were put forward by the Basque Public Health Service (MENDIZABAL ET AL, 2013).

Traditional social networks are being commonly used by nearly everyone. People are already inputting personal information, engaging in discussions, sharing opinions, joining specific

groups, connecting to friends, families, colleges, and even companies. It would not be unreasonable to conclude that the users of regular social networks would know how to use specific social networks for healthcare. Having that said, the benefits of joining patients and providers, or peers practitioners, or peer patients, or large and small companies are evident in terms of stimulating the creation of patient-centered solutions, effective and based on evidence treatments, incentives to new products to prosper, and why not the creation of environments where disruptive innovations can come into existence and be tested, evaluated, developed and launched into the market.

3.2.3 E-Learning

A relevant aspect of the mobile-technology is the immediate anywhere portable access to information. The relationship between healthcare and knowledge is very close, thus, the cited characteristics of mobile devices greatly enhance health professionals availability to pertinent information on diseases, medicaments, treatments, processes, protocols, conditions, EHR, and communication with peers, clients and suppliers. Still, in some distant, rural and poor districts, organizations may not have medical databanks providers.

But even if providing services at metropolitan areas, health professionals may be in situations where information reference is scarce. For instance, professionals in need for a mobile health databank are nurses on homecare. In this situation - very common for this profession - they are unaccompanied, distant from other nurses and supervisors, therefore, out of reach for orientation. Thus, providing information at any time will lead to improved quality of care, improved quality of nurses work life, and improved patient outcomes. So, mobile devices allow health providers to access relevant information directly at the point of care (DORAN ET AL, 2010).

The article from Doran et al (2010) also describes nurses' perceptions on using different portable devices, such as PDAs or tablets. The research measured the satisfaction levels, ease of use, and device characteristics. It has been noted that a user-centric approach is very important; otherwise the device will not fulfil its purpose, since nurses will not adapt and switch to other sources of information. Since service provisioning like home care is both produced and consumed at the same time, it is important for nurses to have a simple and quick

tool that allows them to check medical reference and provide the best results for the patient (DORAN ET AL, 2010).

The Lymphedema Network on Whales, was aimed to unify a diffuse disease treatment system into a nationally organized one, through the settlement of a consistent and organized approach, supported by standardized, evidence-based protocols and procedures to be followed (THOMAS AND MORGAN, 2017).

Before the implementation, the Lymphedema care was dispersed, sometimes based in a single clinic in one region, and in hospitals at another, with roughly specialized staff. The whole development and implementation of the network were planned and orchestrated to ensure that stakeholders were aligned and creating value for the patient by increasing treatment control through performance indicators and reliable information on lymphedema. The performance indicators were used to take actions to improve one treatment area or another. A management hierarchy was set to manage the information flow at the network. Also, all available policies and documentation can be accessed by other lymphedema services across the UK. (THOMAS AND MORGAN, 2017).

Actions related to the professionals' education were educational websites for both pediatric and breast cancer Lymphedema, a mobile motorized unit for cancer treatment and awareness, and the establishment of telehealth fund to support treatment. The universities were involved to accelerate research through direct access to patients (THOMAS AND MORGAN, 2017). It is important to notice the importance of national policies and leadership supporting the project entirely and allowing other innovative solutions application. The Lymphedema treatment became a great deal more focused on the patient and on treatment results - information that was exchanged among stakeholders to continuously improve the outcomes.

Thus, e-learning tools are a very important mean for providing information and training to health professionals. Nonetheless, the routine of the health professionals must be understood to not compete with the time needed for training modules. A literature review on the efficiency of ICT education tools (CURRAN ET AL, 2015) showed that online education - like articles and videos, video conferences, web-references, among others, are comparable and sometimes with a better level of user-experience in comparison to the traditional face-to-face

format. The amount of information retained and the application of the knowledge was well attested (CURRAN ET AL, 2015).

3.2.4 Electronic Health Records

A relevant number (33%) of the selected articles are related to EHR applications. The solution has a large number of acronyms: EMR (Electronic Medical Records), EPR (Electronic Patient Records), PHI (Personal Health Information), PHR (Personal Health Records) and even "patient portals". Some may rank the different entries by defining the EHR as the parent system where the patient individual EPR are connected with. Also, "patient portals" are considered to be a form variation of the EHR (WELLS ET AL, 2015).

There are many different definitions of EHR. One of them is by the American Health Information Management Association (AHIMA), cited by Vezyridis et al (2015):

> The personal health record (PHR) is an electronic, universally available, lifelong resource of health information needed by individuals to make health decisions. Individuals own and manage the information in the PHR, which comes from healthcare providers and the individual. The PHR is maintained in a secure and private environment, with the individual determining rights of access. The PHR is separate from and does not replace the legal record of any provider (AHIMA 2005apudVEZYRIDIS ET AL, 2015).

The EHR systems can also be classified by the entity responsible for collecting patient information, hosting the database and managing the system. Some EHR are accessed and managed exclusively by the patient. They are developed by independent IT solution vendors for the market. Patients are responsible for adding information, which can be added to online applications and wearable devices. The patient chooses with whom he will share their information. Other EHR systems are managed by insurance companies or by an employer. Patient data can be obtained from the patient himself and also from other associated institutions (hospitals, clinics, laboratories, pharmacies). Individual healthcare organizations can also provide their own EHR, where patients can access appointment services, direct communication with doctors and other functionalities related to the health services provided by the organization. Finally, EHR can be provided by national health systems (federal governments) or by large healthcare institutions, where several other functionalities are added in a much broader scale (VEZYRIDIS ET AL, 2015).

As noted before, there are several functionalities added to the EHR. Health providers, especially large healthcare institutions, have a broad portfolio of service, being provided by diversified units, and the EHR is a channel to provide easy service access to the patients. Some of the functionalities are secure electronic messages with patient physicians; real-time access to EHR for visualization and data entry; access to exam results; record of medical history, such as physician visits, medications taken, allergies, vaccines; doctor prescription and medication database; medication refills; educational material, including the possibility to review disease and procedure specific information; participate virtual care sections; request for a referral authorization; connectivity across patient care settings and procedures, both inside and outside care facilities; and online schedule of physician visits and laboratory tests (CHEN ET AL, 2009; DIXON, 2010; RALSTON ET AL, 2010; WELLS ET AL, 2015; GRANT ET AL, 2016).

Despite being available for patients in any physical condition, it has been noticed that EHR is most used by chronic patients (RALSTON, 2010; WELLS ET AL, 2015), such as mental disorders (RALSTON, 2010; KAY-LAMBKIN ET AL, 2014; WOZNEY ET AL, 2017); HIV (RALSTON, 2010); obesity and diabetes (RALSTON, 2010; DIETZ ET AL, 2015; GRANT ET AL, 2016); alcohol and drug abuse (KAY-LAMBKIN ET AL, 2014); multiple sclerosis (HAASE ET AL, 2012). Yet another use for EHR was related to acute post-surgical and post-traumatic pain management (GOLDSTEIN ET AL, 2013) and to medication self-management for both young and older patients (ROSS, 2011).

Governments are incentivizing the adoption of EHR - in some cases, not only the implementation, but a meaningful use - health register by physicians and information access and interaction with patient and families (RALSTON ET AL, 2012). Some EHR implementations, when it is integrated with other systems, increased patient value and empowerment. On the other hand, some institutions have not provided proper system integration, what directly impacts on system adoption by physicians, nurses, and ultimately patients (DIXON, 2010; SZCZERBA AND HUESCH, 2012).

3.2.5 Other Health Service Innovations

The PCMH is a care delivery innovation that attempts to bring new payment formats to primary health care by emphasizing the patient-value over the fee-for-service model and on evidence-based processes (MCGYNN AND MCCLELLAN, 2017).

The PCMH is a solution based on providing personalized patient care, so the resources are all focused on fulfilling patient needs. This model encompasses seven main components. The first one is the (1) Personal physician, the practitioner responsible for first-contact and continuous care. The personal physician is also responsible for coordinating a group of health professionals that will provide treatment - the (2) Physician-directed medical care. The personal physician role as patient's health conditions manager is the third component, called (3) Whole-person orientation, and it makes the physician responsible for all stages of the patient treatment - preventive, acute, chronic and end-of-life care. The fourth component is the integration of care by all health care provider institutions around the patient, including the patient community. For this component, called (4) Coordinated/integrated care, a critical point is the integration between the health providers chain (such as clinics, hospitals, home health agencies, nursing, pharmacies) and patient community (such as family, friends, public and private community based services), only achievable through information register and exchange, and availability of communication channels. On (5) Quality and safety, the PCMH model is concern about using evidence-based information, patient feedback, performance indicators from providers, patient education, as entries to enhance patient well-being. Surrounding all the previous components is the (6) Improved access, as patients must have timely communication and improved communication channels to access providers when needed; and finally (7) Payment, where a mixed system would be based on patient-value, where additional payment would be given for achieving better treatment results and long-term well-being, and fee-for-service payments for punctual services, like the IT infrastructure structure and coordination of care (AAFP ET AL, 2007; RITTENHOUSE ET AL, 2008).

Several health innovations are related to the PCMH model. EHR allows register of patient data and availability of the information to the personal physician, to the health practitioner team, to providers and patient community. Quality indicators can also be measured from information contained in the EHR (RITTENHOUSE ET AL, 2008). For increased access to

physicians, telehealth can be used as a solution. For patient education, e-learning tools can be used.

Other solutions found in literature that could be implemented along with PCHM and EHR is the Computerized Provider Order Entry (CPOE), a digital system to prescribe and order medications. The idea is to increase medical service quality by reducing medication errors during prescription. The system is composed of the list of medications available on national lists, with some brief information about the product, dosage, and recommendations. Also, the previous prescriptions are available for consultation. It could also be used by nurses to manage drug administration according to physician orders (RAHIMI ET AL, 2009).

An add-on functionality to EHR and patient portals is the Shared Decision Making (SDM) tool. The SDM is an approach where both patients and doctors can discuss the patient physical information, exam results, and medicament and procedures options so they can get to an optimal disease treatment together. With this tool, patients can get more transparent and complete information about benefits and harms, thus increasing confidence and adherence to treatment (GIGUERE ET AL, 2012). When sharing the responsibility for the process, patients get more involved, thus empowered and with increased receptivity to doctor's orientations.

Still, on the field of patient electronic management tools, an automated management system for diabetes-depression patients was engineered to help health care providers to monitor patients' conditions through evidence-based information. The system was able to analyze patient disease management history and, in the event of a possible depression crisis, an automatic telephonic assessment system was actioned. The automated calls have the advantage of proactively reaching the patient instead of waiting for him to schedule a visit to the doctor. Also, the same algorithms can scan patients' medical records and call history to assist health professionals to identify the ones in most need of care for a closer follow up. A suicidal alert mechanism was also implemented. Once the algorithm identified a set of symptoms, the automated call system can immediately communicate with emergency responder physicians (WU ET AL, 2015).

Another proposed innovation was a home-based music therapy. Patients that are discharged from the hospital still require continuity of therapy sections at home. It has been proved the efficiency of music therapy for several mental illnesses like traumatic brain injury,

schizophrenia and schizophrenia-like, psychosis, neurological diseases like multiple sclerosis, dementia, dyspnea and anxiety crisis, for chronic pain, tinnitus, cardiac rehabilitation, chronic obstructive pulmonary disease, autistic children and oncological patients. Technologies involved in providing music-therapy can be both simple as cassette players, headphones, as well as tapes and CDs, and music listening programs imbued with therapeutic techniques such as guided imagery, cognitive-behavioral techniques, such as slow repetitive music to enhance falling asleep, rhythmic music to enhance energy, and also music listening in conjunction with drawing or painting, among others (SCHMID AND OSTERMANN, 2010).

Wildervuur and van Dijk (2011) describe a device in the format of a doll called “Scottie” that is capable of nonverbal communication between hospitalized patient and his family. The patient receives a Scottie and the family another one to take home. The devices are connected to wireless networks and are equipped with sensors capable of perceiving the touch or the presence of a person. Instead of providing physical treatment, the solution socially connects people so they feel like being in the presence of their beloved ones. At first, the solution was designed for children, but it was perceived the device also benefited older people.

Another innovation was proposed for physical therapy. It is composed of a tracking device installed at mobility impaired patients that records the movements of the patients as they move around the room, such as to get up, to walk and to sit on a chair. The system helps nurses to measure patient movements, what has a direct impact on treatment management. Other innovations are related to the use of digital communication tools, such as online therapy and training program updates, Skype and regular phone calls to access the patients and follow their treatment, improving results (WOJCIECHOWSKI, 2012).

The use of RFID technology in hospitals is still another innovative solution to improve management of equipment, medication, medical supplies and even patients. Although the cost of an RFID tag can be expensive (from 0.50USD to 50USD), there are several benefits of using a system that can track the location of much more costly medical equipment preventing the loss, storage and material flow control by tracking exactly where each supply is and the identification and movement-control of each patient. The advantages are improved patient safety, improved medical services, cost reduction, improved patient satisfaction, improved process management and workflow, decreased equipment costs, improved inventory management, and improved overall efficiency (KUMAR ET AL, 2010).

A great concern related to health care innovations in on security of information. Su et al (2014) proposes a system based on a health card that stores personal health information obtained from sensor medical devices, smartphones, and other sources. With this card, the patient can reach an ATM machine with the same cryptography and other safeguards available to the banking system and have their personal medical information analyzed by health professionals, receiving a diagnosis without compromising their privacy (SUN ET AL, 2014).

3.3 IMPLEMENTATION AND ADOPTION OF TECHNOLOGICAL-DEPENDENT INNOVATIONS

Adoption is a relevant topic on technology. eHealth poses a challenge for acceptance not only because of the new systems and solutions, but also due to a new service provisioning system for a very traditional service industry, where the communication channels and service delivery locations and providers are well-known and remained unchanged since the first health care institutions were established.

There are several aspects to be understood when implementing and adopting new service offerings on health care. Price and Martin (2010) proposes the following steps: assess local needs and priorities - where the use of technologies must be related to the current difficulties of the healthcare service provisioning, like its performance, thus identifying investment needs and priorities of the current system; specification of the service required - local community (both providers and receivers of service) must be accessed to better identify their needs and the innovation must be implemented accordingly to its expected results and means to measure performance; securing services - the solution must be certified, along with the provider, to ensure quality and productivity levels; and monitoring performance and evaluating outcomes - use of key performance indicators and users and providers feedback to further adjusts and developments (PRICE AND MARTIN, 2010). The idea is to assure that innovation attends to clinical and government regulations at the same time that it provides value to healthcare. It is mentioned the necessity to address the necessity first and then decide about the technology that will help to deal with it.

Some studies show that patients are not used to resort to digital solutions when looking for health care. A study on an online appointment website in Australia showed only 6% adoption

to see the doctor - the other 94% preferred the old telephone way, even though it took more time from them and from the clinic. Not only have that, but 10% of the patients missed the appointment, leading to inefficiencies represented as longer waiting-lines for patients, decreasing satisfaction (ZHANG, 2015).

Taylor (2013) express that the sustainability of telehealth projects must pass through integration with other systems - interoperability and platform portability and performance indicators, to assure the solution is meeting measurable objectives, such as improved clinical outcomes and efficiency gains and other distinct value propositions, specific to each of the value-chain members - patients, physicians, administrators, and so on. The same points can be applied to other solutions: unless the value proposition is perceived by all players involved, barriers can affect up-scaling the product, leading it to failure.

On EHR adoption, there are several papers that discuss how it affects medical staff workflow (BANAS ET AL, 2011; GOLDSTEIN ET AL, 2013; PEARL, 2014; VEZYRIDIS ET AL, 2015; WELLS ET AL, 2015). Some barriers to EHR implementation are: financial, technical, time, psychological, social, legal, organizational, change management, lack of training, lack of computer skills, lack of technical support (internal or external), systems that are complex and difficult to use, breakdown of hardware/software, lack of wireless connectivity, system not be suitable for their needs or incompatible with other hospital systems, and lack of consistent standards. It has been noted that stakeholder participation is important in the development and implementation stages of EHRs in order to incorporate their feedback and to ensure the EHR system is embedded within their workflow. EHR adoption facilitates communication, patient management, research, and improved patient safety (GOLDSTEIN ET AL, 2013).

There are several available implementation strategies to assure health professionals adherence to EHR, such as to designate EHR champions - a member of the staff that would be responsible for supporting implementation and facilitate communication between staff and management. Support and coordination from high-level management are also important, especially by implementing specific internal policies, listening to staff for system improvements - such as to fit EHRs into a routine workflow. Training sessions are important to decrease the sense that the system is too difficult and complex to use. Also, IT team support is fundamental for adjusting minor features and their proximity diminish the impact of errors

and other problems on a daily routine. Finally, it is important to both monitor adoption and also to provide incentives (BARNETT ET AL, 2011; WELLS ET AL, 2015).

On social networks, users must pass through cultural shifts, where health care can be seen as a process with different players act together to achieve a result, and not a single service or good being commercialized. This shift encompasses all stakeholders - which one will provide specific expertise to add to the patient treatment. A difficulty for the adoption of such innovation is communicating the network proposes, in order to convince people to join it. The role of project champions and support from leadership are important to ensure engagement and connection between stakeholders. Finally, another option would be to use a peer-monitoring program, where more experienced-users are linked to less-experienced ones (MARGOLIS ET AL, 2013).

Other barriers to the adoption of online care systems are not related to the health professionals or the patients, but, looking from a broader perspective, the healthcare environment. A huge barrier is the payment system, based on fee-for-service and physician's office visits (especially at the USA, where reimbursement rules are very strict and does not comprise out-of-office communication), a reimbursement system that is blind to recognize new services provisioning through virtual tools (DIXON, 2010; RALSTON ET AL, 2010; PEARL, 2014).

The lack of basic infrastructure, like electricity, can be a strong barrier for underdeveloped countries. Even for basic, lower complexity communication networks like GSM, some countries are still unable to provide support to solutions built on cell phones and SMS. On the article from Noordam et al (2015), the RapidSMS platform, although providing several advantages for supporting the primary care in Africa, suffered from unreliable network coverage, limited access to electricity, lack of technical knowledge to implement privacy of data procedures and even general network maintenance. The local government is the major responsible for the lack of sustainability for the program since there was not a national policy nor government leadership for eHealth incentive and coordination with private and public sectors.

Still, another view over the adoption of innovative products on health care is given by Procurement of Innovation (PPI), a European network for procurement of health innovations. It was designed to act as a link between the public healthcare system and the medical

technology industry and the innovative small and medium enterprises (SME). Through collaborative procurement, large organizations are more eager to deal with the increased risks associated with innovations, sharing costs and gain by promoting partnerships (SANCHEZ, 2016). It is a European Commission program to stimulate the development and the adoption of healthcare innovations; small companies have access to sell their solutions to larger companies (both public and private), ensuring more capital to keep innovating, at the same time that European governments are concern about decreasing the costs of healthcare.

Finally, health care innovations are bringing new opportunities for service delivery in a much faster way than before. Therefore, the time for implementation of new Academia discoveries is becoming a critical point for implementation and adoption.

There is an increasing necessity of creating systematic-ways of implementing scientific findings into health care, a trend focusing on provisioning faster patient care-value innovations. It is inevitable the approach of academia and practice of medicine. Innovations will require rapid feedback and follow-up to ensure results; reimbursement models will have to be created; development of new purchasing models; and creation of new team-based coordinated care models. The Academia itself will have to change, by bringing down silos, building bridges, thus providing interdisciplinary collaboration. The creation an experimental atmosphere and the access to diverse patient populations are also important to foster testing, faster feedback, new developments. Thus, it is important that health organizations and other stakeholders participate in this process (BONHAM AND SOLOMON, 2010).

Important to mention that other disciplines are becoming critical for the development of new health innovations, such as engineering, data scientists, among others, due to the amount of telecommunication, electronics, sensors, and other technological subjects (WU ET AL, 2015).

3.4 PATIENT-VALUE, EXPERIENCE, AND EMPOWERMENT

There are several definitions of patient-value. According to Prof. Michael M. Porter in his article “What is value in health care?” from 2010, value can be defined as the result of the delivered health care service per service cost for the patient. The result of the service is based on the quality of the service provided, and can be measured by several means, such as timely access, effective use of interventions, avoidance of unexpected misfortune such as infections

and side effects (WYNN, 2016), among others, like lower incidence rates, overall well-being quality (physical, mental, social) after treatment, and fast recovery.

Another proposed definition summarizes patient-value into 5 concepts: the first one would be health, defined as experiencing and maintaining physical, mental and emotional well-being, the second one would be cure, as regaining functionality on one or more health aspects, the next would be healing, as the process of recovering health, then preconditions of health, such as availability of housing, food, income and other resources needed to support well-being in society, and experience of care - accessibility, relationship, and technical excellence (ROLLOW AND CUCCHIARA, 2016).

The definition can be very broad, but it is closely related to patient-experience before, during and after treatment, encompassing several different aspects. Innovations can tackle one or more of the described aspects that contribute to patient-experience, improving the quality of healthcare.

Solutions that are proved to be patient-centered are also ones that build up patient-value. Patient-centered care is a partnership between patient and healthcare provider, where improved communication, clinical outcomes, and patient satisfaction characterizes their relationship (CAPKO, 2014). The results from patient-centered solutions are linked to reduced healthcare costs, since the proximity to physicians improves adherence to treatment and disease management, decreasing dropout rates, leading to better results and to increased patient-satisfaction (CAPKO, 2014; FERWERDA ET AL, 2013).

When discussing new, innovative approaches to health care, it is noticeable the increasing concern on delivering value to the patients. One of the main reasons is that governments are linking reimbursements with patient’s perceptions of the service (CAPKO, 2014; WYNN, 2016).

There are government evaluation organizations (like the Vermont Blueprint for Health and the Comprehensive Primary Care Initiative), making available aspects like practice transformation, community program for healthcare management, self-management support and care coordination (ROLLOW AND CUCCHIARA, 2016).

US hospitals are being scored under the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS), part of the Value-Based Purchasing (VBS) program by Medicare, where the hospital's payment will be based on patient-experience performance. The HCAHPS is based on eight dimensions to evaluate patient experience: nurse communication; doctor communication; hospital staff responsiveness; pain management; medicine communication; hospital cleanliness and quietness; discharge information; and overall hospital rating (CAPKO, 2014). The result is a 5-star rating, where 22% of the rating is based on patient-experience. Still, another rank based on patient-experience is the MSSP - Medicare Shared Savings Program, for ambulatory physician practices, where patient-experience weighting is about 24% (WYNN, 2016).

For the population, it is important to have more patient-centered solutions, once the quality of service is perceived to be better, increasing adherence to treatment, low drop-off rates, decrease visits to emergency rooms and even to physician’s office. The government policies based on using patient-experience surveys to rank clinic and hospital services forces institutions to look with different eyes to innovations, speeding up the implementation and adoption to boost capitalization on reimbursements and attract more patients.

The main trends identified after careful analysis of the literature were: telemedicine, social networks, e-Learning, EHR, and patient-centrism. These are the topics that will guide the choice of the Startups. After that, it is important to take a look at the Brazilian healthcare landscape and understand how it is organized, the current status and how innovations can disrupt the Brazilian Health Care Ecosystem, since the theoretical framework is also related to the health care innovation system.

4 METHOD

The strategy to answer the research question “Does mobile technology have the potential to impact healthcare services by decreasing costs and improving availability, under a theoretical analysis of information acquired from startups’ entrepreneurs?” was to divide it in separate stages, each one gathering information and defining concept that would serve as a base for the next stage, until the discussion and conclusion of the research, where both strengths and improvement points to the method will be appointed.

First, a theoretical framework was developed in the Theoretical Review chapter. This specific objective was to create a common guideline for analyzing the disruptive potential of service innovation on health care information provided on innovation by the entrepreneurs. The theoretical review was based on well-known and proven theories from the most relevant articles in each area of business administration knowledge – service, service innovation, disruption innovation and healthcare innovation systems.

After that, another specific objective is to determine trends in health care innovation using mobile technology, applied to service provisioning. Startups that follow these technology trends are keener developments solutions that may impact the healthcare industry. A systematic literature review was applied to research for these trends on worldwide publications, then separated into common technology trends, which will be used as criteria to select startups – as it will be demonstrated on this chapter.

Once the research objectives are well defined, criteria for choosing companies to be interviewed will be present. Startup companies bring the last innovations into the market, and for being small, they must be creative to avoid direct incumbent competition. As a result, they are more apt to follow disruption path, according to the disruptive theory presented earlier.

A startup can be defined as a company founded on the objective of creating an enormous social or economic impact through an intense innovative process, no matter the company size of market performance (ABREU AND CAMPOS, 2016). The importance of startups does not stop at innovation. They are transforming the economy by creating new business, leading to economic growth and providing new sources of employment (MULAS, MINGUES,

APPLEBAUM, 2015). Under this view, it is natural to appeal to startups when studying innovations that have potential to disrupt a market.

In order to find startups that somehow present some kind of importance, the strategy was to find a well-renowned association, ONG, or institution that evaluate the companies using a structured rating methodology, as much impartial as possible.

The 100 Open Startups platform was chosen for using a well-structured ranking methodology and a board of representatives from more than 70 global organizations that support the initiative. Their objective is to engage communication and approximate corporations and startups. Every year, the Brazilian Division of the 100 Open Startups conduct a 5 step process, including a survey with more than 350 Brazilian and global companies, to select the 100 most attractive Brazilian startups, divided into 10 areas: agribusiness and food; business applications; cities, tourism and events; energy; future of education; people management; industry of the future; marketing and retail; small business; and health and well-being.

To be ranked, the startup will get a different amount of points according to the interest of the surveyed company into the startup, gained during the whole process. The first stage is a web-based evaluation. If a company shows interest in a startup at this stage, it will receive 1 point. As many companies get interested in the same startup, more points it will get. The second stage that a startup will receive points is in a personal, face-to-face speed-date between company executives and startup personnel. If selected, this encounter will provide another point. If both company and startup sign out contracts for service provisioning, for pilot runs and for equity, more points the startup receives.

Lastly, it is a metric based on the given importance of the big market players on the startups. From the 2017 ranking, the top health and well-being startups are list as follows:

Table 1 - Selected Healthcare Startups from 2017 100OpenStartup ranking.

Category Position	Startup	Description	City/State	Website
1	Cuco Health	Cuco Health is a digital nurse that uses artificial intelligence to foster patient adherence to treatment	Sao Paulo, SP	http://cucohealth.com/
2	Nuclearis	Nuclearis presents an integrated, flexible management solution for nuclear medicine for productivity gain with more quality and less resources.	Salvador, BA	http://www.nuclearis.com.br/
3	Guepardo Sistemas	Gueoparto offers an efficient and low cost system that allow customers to implement teleradiology.	Rio De Janeiro, RJ	http://www.guepardosistemas.com/
4	SmartCompras	SmartCompras is a purchasing platform that links health care institutions and suppliers from several segments.	Sao Joao Del Rei, MG	http://www.sistemasmartcompras.com.br/
5	HOOBOX Robotics	HOOBOX was founded to bring out robotic solutions to assist people on their activities of daily living.	Campinas, SP	http://www.hoo-box.com/

6	Oxiot	Oxiot monitors patient medicinal oxygen consumption through IoT to measure treatment adherence and cost reduction on Home Care and in hospitals.	Sao Paulo, SP	http://www.oxiot.com.br/
7	HelpBell	HelpBell empowers old people using transparent technology, providing safety and peace of mind regarding drugs, falls and emergencies.	Porto Alegre, RS	https://www.helpbell.com.br/
8	Pickcells	Pickcells prepare laboratorial diagnosis using computational vision.	Recife, PE	http://pickcells.com.br/
9	VivaBem	Vivabem is a gamified platform that promotes individual well-being through a personalized engagement.	Sao Paulo, SP	https://www.vivabem.com/#!/index
10	Vestal Oncogenomics	Vestal Oncogenomics is a diagnosis and oncology analysis system based on new generation DNA sequencing technology.	Florianopolis, SC	-
11	Sugarzyme	Sugarzyme is a biotech startup focused on cosmetic and pharmaceutical areas using	Sao Jose Dos Campos, SP	-

		agroindustrial waste (biomass)		
12	Piron Health	Piron Health is a global health integration platform for patient data for analysis.	Uberlandia, MG	https://piron.co/
13	Arkmeds	Arkmeds automatizes management and maintenance of hospitalar assets.	Belo Horizonte, MG	http://arkmeds.com/
14	Lab. Alquimista	Lab. Alquimista recovers gelatinous capsules from drugs, transforming them into raw material.	Anapolis, GO	http://www.laboratorioalquimista.com.br/
15	Ambra Saúde	Ambra Saúde stores images and medical certificates into the Cloud, with online visualization and sharing possibilities.	Sao Paulo, SP	http://ambrasaude.com.br/
16	PluriCell Biotech	PluriCell uses pluripowered stem cells technology on medicament research without animal testing.	Sao Paulo, SP	http://www.pluricellbiotech.com.br/

From the list, another selection was made, based on the four appointed mobile technology trends from systematic literature review chapter – telemedicine, EHR, e-learning and social networks.

The first, Guepardo Sistemas, was chosen due to its possibility to enhance telehealth capabilities for physicians and patients. They developed a software and hardware solution for compressing and transmitting radiology images using low speed internet. Radiologists can access a digital platform to analyze exams and give reports. The reports are sent to the senders using the same technology. Locations with medical image equipment but without enough technicians can send images to other institutions, receiving faster exam results.

Oxiot was also chosen for delivering a telehealth solution for oxygen cylinder measurement from distance. It is a startup in its maturation stage. The founders have developed a software plus hardware solution able to convert oxygen cylinder analogical gauges to digital signals for wireless measurement and control of volume and flow. Their main markets are patients and patient's family and home care companies for remote monitoring of oxygen cylinders. Their main advantage is the solution costs, much lower than incumbent solutions.

HelpBell developed an electronic drug box, wirelessly connected to the internet. The patient is alerted about which medication to take and in which period. If he fails to take the drugs, previously registered contacts are informed. The box also contains an emergency device that alerts up contacts without the need for a telephone call. A supporting service is based on a monthly fee. The solutions were classified within the telehealth trends since the devices made possible for the family of the health team to supervise treatment adherence, drug administration, and emergency situations.

The last company is VivaBem. They developed a one-stop shop platform for healthcare, where the patient can add personal health information, analyses physical data and provide tips for better results, schedule appointments, engage health challenges with other users, and share information with family and physicians. The platform allows company ambulatory and human resource departments to monitor specific cases, such as chronic patients, or even create challenges and health promotion campaigns. VivaBem one-stop shop presents an EHR solution and a social network for health care.

Another startup that was chosen was CucoHealth, but, unfortunately, it was not possible to schedule an interview conversation. CucoHealth has a very interesting telehealth solution, where the first contact with the patient is through a highly advanced artificial intelligence algorithm that simulates a nurse. It is capable of fluid communication, where the artificial

nurse makes questions about the well-being of the patient, her treatment, if she is taking the medication correctly, asks the patient to enter physical data and even answer basic questions about treatments, diseases, and drugs. The CEO of the company was contacted several times, answered some emails, but it was not possible to schedule a phone call. Other partners were also reached, but they declined to talk about the company, indicating the CEO as the sole responsible for giving an interview. It was disclosed in one of the communications that CucoHealth was passing through a major restructuration and it could be difficult to have some time for the interview.

The other startups were discarded by not being related to the trending topics, not presenting patient-centrism, by focusing on health institutions management tools or being concerned about technically supporting laboratory research on medicine.

For this essay, it was chosen to follow the explanatory case study strategy, based on interviews with representatives from startup companies.

In general terms, a research can be classified as exploratory (where the following methods apply - experiment, surveys, archival analysis, history, case study), descriptive (survey of archival analysis) or explanatory (case study, experiment or history) (YIN, 2014). The history method is based on past information, so primary and secondary documents, cultural and physical artifacts would be the main sources of evidence. Experiments are useful when the researcher has control over the behavior under study, being capable of directly, precisely and systematically manipulate it (YIN, 2014). Startups have none of the above. These companies are very young; there is almost no secondary data file available for research. The complexity of the startup environment is a great disadvantage for proposing an experiment. The process makes it impossible to restrain and control all the internal and market elements that may influence the outcomes.

Case studies are similar to history methods, with the inclusion of two additional sources of evidence, the direct observation of the event and interviews with participants involved in the event. For the event to be directly observed, it would have been necessary to participate in the startup routine to collect evidence, what cannot be done due to the already said complexity of the process dynamics, leading to difficulties as the unpredictable amount of time a company can take to launch an innovation, confidentiality of information, availability of company

employees to share information, among others. On the other hand, interviews can be conducted with prominent participants, such as founders and CEOs. It is a primary source of information. Special caution must be taken because there will be difficulties to triangulate and confirm the information with secondary sources.

Therefore, after choosing startups, another specific objective is to address entrepreneur from selected, relevant startups to analyze the potential of their solutions to disrupt the healthcare industry under the information provided, according to the framework developed from relevant theory on disruptive service innovation.

The entrepreneurs are a valuable primary source of information, and when researching startups, they can be the only source. Startups are new, small companies, without secondary documents that could provide data on past operations. They are lean structured, with few employees, which could also be interviewed. Their clients are patients – thus their treatment information is private and confidential. Also, they are not always open to discuss how the solution improved their health while they are still under treatment. Partnerships are still under development, suppliers do not have a wide understanding of the solution or they are under a confidentiality agreement.

On the other hand, entrepreneurs are dynamic, forward-thinking persons, willing to show their advances and to discuss their difficulties. They are the ones who came up with the idea for the innovation, who studied the market and nourishing partnerships. Entrepreneurs are in contact with government agencies, investors, suppliers, potential clients, and participating in innovation encounters and Congress. They are constantly dealing with the dynamic market forces. In this sense, entrepreneurs sufficiently cover all the information one can obtain from a startup and its innovation.

Regarding the entrepreneurs, the information to be obtained was who the founders were, what they studied and where they worked before, how the process that leaded to the idea was, where the inspiration came from, what was the solution, what values they were trying to propose, what was the main target public, who are the partners, the competitors, how did they got investment, what was their opinion on the healthcare innovation system in Brazil, and so on. So, it is under the perspective of these founders that the information was collected and the theoretical framework was applied.

A single founder per startup was chosen for the interview. It was expected that different entrepreneurs from the same company would present different points-of-view, but, due to time constraints, it was given a higher priority to interview as many diverse companies as possible as a matter of comparison between district products, strategies, business models, and so on.

The interview was semi-structured. An interview script (Appendix 1) was prepared to guide the conversation. Topics related to the theoretical framework were added, such as description and final customer cost of the innovation as it was launched and nowadays (to attest for differentiation from other competitors (GALLOUJ; SAVONA, 2008), simplicity and low costs, against incumbent product complexity and higher prices (CHRISTENSEN; RAYNOR; MCDONALD, 2015)), information on scalability (as one of the indicators for disruptiveness (CHRISTENSEN; RAYNOR; MCDONALD, 2015)), relationship and partnership with other institutions (to check for positioning inside innovation ecosystem (CONSOLI; MINA, 2009)), among others. The entrepreneurs were also incentivized to speak as freely as possible about their ideas and impressions on their business, the healthcare industry and the startup ecosystem in Brazil.

The interviews were based on phone calls that lasted from 45 to 95 minutes. It was not able to perform face-to-face interviews due to the location of each of the entrepreneurs (each one lived in a different Brazilian State). The calls were recorded for later transcription. The transcript interviews were sent to the interviewed for a final approval. Some parts of the interview were suppressed as requested by the interviewed to preserve sensible aspects of the company operations, strategy or even personal opinions on market, competition, and partners.

The difficulty to find information about the companies led to the interviewer to ask the entrepreneurs about some contact that could provide information about the solution. Unfortunately, most of the contacts were not found or were not comfortable to disclose information about the product or the company for many reasons, such as the experimental aspect of the pilot products, unwillingness to share personal health information, or even very superficial information about the experience of using the service.

The information obtained from the interviews is organized in chapter 5, where a summary of each company is presented. Every topic is about a company, and the information was divided

into three sub-topics. The first sub-topic will be about the origin of the company, the founders, the area of operation, and competences. The second sub-topic will be about innovation itself, its target-audience and its characteristics of the service. The third sub-topic will describe the business model and the relationship with the healthcare ecosystem.

Once the information is organized, the proposed Disruptiveness Potential on Service Innovation framework will be applied step by step, in order to ensure that every requisite was being fulfilled. Even if some step was not fulfilled, the analysis would continue until the last step.

The framework is composed of business administration theories on service, service innovation, disruptive innovation and innovation ecosystems. The combination of different, initially unrelated theories, allows different solutions and startups' value propositions to be analyzed. The redefinition of products into sets of characteristics and competences makes it possible to compare solutions based on both devices and services with competitors. By analyzing disruptiveness, the solution can be tested on the potential impact on the market by checking for business model and strategy. Finally, by checking the positioning of the companies inside the innovation ecosystem, it is possible to comment on the level of alignment of the company with partners, clients, suppliers, regulators for information generation and information flow – such as feedback channels, which provide relevant insights for improvements and new products.

The three step framework addresses diverse aspects related to how innovative a product really is; how the company tackles market strategy, competition and growth; and how it relates to other players inside the market. A company that presents favorable indicators for every step will potentially have more chance to impact the health care industry, since the innovation and the company were submitted to broadly studied and proved business administration theories.

In another view, a validation of innovativeness provided by the first step, of disruptiveness by the second step and relevant information flow by the third step all together allows a product and a startup to be checked for strengths and weakness, opportunities and threats and redesign the strategic plan to remain competitive.

The first step is based on comparing innovation and the main competitor competencies and characteristics, in order to assure the innovativeness of the solution vis-a-vis the current

incumbent offering. The information on competencies and characteristics was based on the interview, the company website, and recorded video presentations on the innovation.

The second step is on attending four disruptive innovation indicators: innovation must be simpler and cheaper than the competitor, it must address an unattended market segment, the business model must be innovative, and the product must be scalable.

Finally, the third step is the relationship and the position of the company on the healthcare ecosystem, how it interacts with customers, government agencies, incumbent companies, investors, suppliers, health institutions, physicians, and so on to collect information about improvements and foster relevant partnerships for future developments.

At the end of this process, it is expected to understand, over the perceptions of startup entrepreneurs, if mobile technologies have the potential to disrupt healthcare industry through service innovations by increasing patients access to low cost, high quality, healthcare services, thus challenging the paradox of medical new solutions providing enhanced patient treatment value, but being expensive and with low availability, what comprises the main objective of this essay.

5 STARTUP COMPANIES' PRESENTATION

Before applying the theoretical framework, a description of each startup company is presented, based on the company's website and retrieved information from the interview with the founder. Each topic comprehends a company, which was divided into three sub-topics: the first one describing the company – how the company started, the founders' background, the target market, and the competitors; the second sub-topic describes the innovation – it's main features and advantages over competition; and the third sub-topic describes the business model – pricing concept, current and potential clients, marketing, funding sources, ecosystem positioning, and relationship with other players.

The last chapter detailed the specificities of the Brazilian healthcare landscape. In this chapter and in the next ones, the startups will be contextualized inside this environment, how it is positioned and how it interacts with it.

After the presentation of the case studies, a chapter on the application of the proposed Disruptiveness Potential on Service Innovation Framework on each company will follow. The information to be used through the analysis process guided by the framework will be provided by the topics below.

5.1 GUEPARDO SISTEMAS

5.1.1 About the company

The group of founders started the business in the beginning of 2015 but only at the end of that year, they have formalized the company. It began with a project to transmit medical images using low-speed internet networks. The project was submitted to SEBRAE Innovation Reward (SEBRAE is one of the main Brazilian institutions to foster entrepreneurship initiatives in Brazil) and won the first prize. They also won an investment of R$1,2 million from Innovation Public Notice from FAPERJ that is yet to be received .

The idea to open the company started with a glimpse of the opportunities on the new teleradiology services in Brazil. The founders figured out that most of the incumbent companies were big multinationals from abroad that presented costly solutions, aimed at high-

level clients that required high-speed internet links. Local health institutions, usually from remote regions, could neither afford the solution prices nor they had available a high-speed internet infrastructure. The incumbents had no interest in developing solution for this market.

Other competitors had already established image diagnosis centers, where the image and the diagnosis report were provided by the same institution. But the capacity limitation of these diagnosis centers and the increasing demand led to high costs and longer waiting time, what could impact patient's treatment.

Guepardo Sistemas solution aimed at this unattended market. According to one of the founders, in Brazil, 94 million image exams are performed annually and there are few than 10 thousand radiologists to analyses and report this exams, where 70% of them are located at the metropolitan areas. Usually, a countryside patient has to wait up to 15 days to receive the exam results, negatively impacting treatment.

5.1.2 About the Entrepreneurs

The three founders have an undergraduate degree in Computer Science, but followed different paths – two of them pursued specialization in Business and Administration, as one did an MBA course and the other a Ph.D.; and the last has a post-Ph.D. in Computer Science. Because of that, the post-Ph.D. founder became the main responsible for the development of the technical solutions and the other two are the responsible for managing the company. The company has a lean structure, as besides the founders, they are only employing two internship students for product development.

The entrepreneur that was interviewed was the one who graduated in Computer Science but followed the business administration path by completing the MBA course. He lives in Riode Janeiro and started his career on radiology on a Brazilian medical images company, where he later became the CEO. Eventually, he decided to leave the company and to join the other two former-graduation colleges to open their own startup company on teleradiology. He declared to have seen the opportunity to provide a service that incumbent companies were unaware or did not considered being a potential market.

5.1.3 Describing the innovation

The innovation is composed of an image compressing software, a very low internet link speed module, called G-Proxy, and a web-based platform for radiologists.

The image compressing software was developed to shrink the size of the files for transmission without compromising the analysis by the radiologist. An important concern was image resolution loss. According to the company, the compressed images (10 times smaller than the originals) were tested against common images and the technicians could not differentiate one from the other.

The incumbent transmission devices are composed of servers that have final customer costs of about 200 thousand reais, 20 times higher than the G-Proxy. As it was said before, the incumbent servers required high-speed internet connections, imported from abroad, and not available in remote sites. On the other hand, the G-Proxy was designed and built completely in Brazil. It is smaller, cheaper and can support transmission using very low internet speed, such as mobile phone networks. The size and the availability of the network allow the G-Proxy to be portable to other locations, and it can be even used in mobile laboratory vehicles (such as for female health campaigns, like mammography exams during Rose October).

Regular image diagnosis centers sometimes have the capacity to take medical images but lack enough radiologists for analysis and report. The images can be sent to other diagnosis centers, located in other cities. The images can be transmitted using incumbent servers (described above) or printed and sent by private transportation, increasing, even more, the patient's waiting time.

The Guepardo's online platform was designed for image analysis and report emission. The medical image results are made available to the specialist or the team of specialists to be analyzed and to be issued a report with the results. This report is then sent back to the client using the same module. The platform is also able to store individual patient medical history. There are several EHR patterns embedded in the platform to allow it to connect to both Brazilian and international EHR systems standards. The information is encrypted using cryptographic protocols.

5.1.4 Business model

Instead of selling the hardware and the license for the software, the company decided to offer a monthly fee for the whole package. There is not limit for the number of exams transmitted. Specifically for the exam analysis platform, there is still to be decided if technicians will be charged a monthly fee for access or a percentage of the technician report. The company is not focused in performing the exam analysis and results - they are concerned with providing the transmission solution to radiologists directly instead of relying on diagnosis centers.

The product is already being used by some clients, but it isn't being commercialized freely yet (they expect to launch the product officially in 2018). Their main market is based on B2B. Physicians from small clinics are the main target - with a much smaller structure, the system allows them to compete with bigger competitors. Not only small companies, but also big institutions, such as SESI-RJ, are already clients and are using the technology on the day-by-day basis.

Government is also a potential market. The key point is to use the technology to decrease primary care costs, increase the quality of care - by providing exam results faster. The innovation can also support health promotion campaigns, where health services are provided in loco for remote populations, like the previously commented mammography.

The company is studying to scale up the service not only in Brazil but also in other countries. Their platform already meets international protocols for secure medical information transmission, thus being able to be used abroad. For example, the French and the Portuguese consulates showed a desire to take the solution to Europe.

5.2 OXIOT

5.2.1 About the company

Oxiot was created in September 2015, during the GE Health Hackathon. The idea came from one of the founders, who had a personal problem with an elderly relative that had problems controlling the oxygen levels of the cylinder installed at home. Some research showed that this specific market - oxygen cylinder monitoring - had some interesting particularities: low entry barriers, flexibility, fewer regulations, and a small number of competitors.

From 2015, they have built seven prototypes and were able to execute two try-out tests. The first prototype was 100% Brazilian made. The next generations were build using both own and third-party hardware.

Their first client is a patient who started using the solution in October 2017. They classify their current status as pre-operational phase, with still no earnings from the commercialization of the solution.

Along with the GE Health support, the company has won a Public Notice from SENAI and a Brazil-Germany Innovation Tender, resulting in monitoring support from Bayer AG Company.

5.2.2 About the Entrepreneurs

The three founders have diverse backgrounds. The one that was chosen to be interviewed has an undergraduate degree in International Relationship and a Masters in Entrepreneurship; other, an industrial designer, specialized in service design and internet of things (IoT); and the last is a mechatronic engineer, responsible for the technical development of the solution. Their company is also composed of one volunteer for software development, seven technicians, along with additional four co-inventors from GE Health. The founders and the company are based on the city of São Paulo.

5.2.3 Describing the innovation

The solution is based on oxygen cylinder data monitoring using a data acquisition device that converts the analog signal provided by the cylinder meter to a digital one, allowing the transmission of the information using both wireless and 3G technologies, along with a platform for monitoring. Thus, the innovation can be classified into the field of telemetry, where the service to be provided is remote monitoring of oxygen consumption.

With the online register of oxygen consumption, the patient and the medical staff are able to better monitor the patient conditions, since the digital information can be stored with greater efficiency and reliability. Treatment is improved with better data, and physician can respond faster to changes in physical conditions, minimizing risks and improving safety. The information can also be used by research (academia, medical schools, and research centers)

for development of new techniques and better understanding of chronic respiratory diseases, and also feedback on current treatments.

5.2.4 Business model

The company is struggling to develop a sustainable business model. There are some potential markets that are being focused, such as selling directly to the patient or their family. Remote monitoring of oxygen cylinder levels allows security and control of patient conditions from far, as long as faster response to adverse conditions (such as low oxygen levels or lack of gas flow, what could indicate problems with the cylinder or even the patient). Patients could also permit their personal physicians to access cylinder data to check for abnormalities concerning oxygen consumption, oxygen flow, and other respiratory parameters.

Another market is home care companies. They can receive the cylinder information, and provide professional care support for the patient and the family for longer periods (a 24-hour duty). The home care companies are the main focus of Oxiot today.

Hospitals are also intensive users of cylinders and other gas systems. These institutions provide backup cylinders, cylinder transportation and allocation outside the hospital facilities for patients. Oxiot is developing with SENAC (*Serviço Nacional de Aprendizagem Comercial*) special devices for hospitals to be used with oxygen and other gases fixed lines.

The company has the expectation to work with other gases in other markets, for example, chemical and manufacturing industry, where remote control of process has a fundamental impact on product quality. Thus, the company is not concerned about providing health services or even to keep focusing on health care.

As a startup company, there are several concerns to keep growing. A first concern is profitability, so developing additional sources of funding. On government initiatives, there is difficulty to understand the innovation - innovation support funds are deeply focused on cutting-edge technology. It is hard to explain that the innovation is not necessarily on the hardware or the software itself, but on providing reliable, real-time, anywhere information about the patient respiratory conditions that will allow a better medical response and treatment adjustments. There are also several control points, reports, collections, on using the provided investments. For example, it is asked from the company a spending planning, but innovative

projects are adaptive, and not planned, and the resources are redirected according to a dynamic environment, making it impossible to forecast expenditure in an annual base plan. Finally, it can take years for the funds to be available for the startups - what can completely impair the business proposition.

Other funding sources, and also managerial and technical support, are incubators - both private and public. Oxiot argues that the contract with them can be very aggressive for small companies. In exchange for support, startups must abdicate from a share of the company and even after that the incubators do not always provide expected resources. For example, technical support for supply chain development is lacking, and a company that depends on hardware can be deeply affected.

On the other hand, medium companies are more interested in partnerships than big companies. They are more open to lend resources - like tools, systems, working locations, experts - than bigger companies. Exceptions are big companies that promote hackathons and other innovation events - they are more open to this kind of collaborative culture and tend to provide support and resources to chosen startups.

On scalability, Oxiot is seeking for partners - especially for manufacturing of the digital devices, and on intellectual protection (such as patents) to keep growing. The technology is ready to be used both in Brazil and abroad.

Finally, on the topic resistance to the use of technology, their clients and partners are aware of the benefits of the technology and are eager to start using their solution. Their concerns are related to easiness to clean the device, data reliability, hardware robustness, and absence of redundancy. Health care policies and regulations are very strict, thus asking for robust products. Redundancy is a major concern, so Oxiot developed remote testing and calibration features that are able to test the device and calibrate it automatically. So, there is no resistance to adopt the system, but there is difficulty to pre-establish the minimal requirements for the product.

5.3 HELPBELL

5.3.1 About the company

HelpBell was founded in 2013. The starting focus was on elderly necessities, as it was found out this market suffers from several biases. It was difficult to find attractive products for old people, even though it is a growing market, with a higher income than other market segments, and in great willingness to spend on smart and specific solutions. The current products developed for elder people are not sophisticated, aesthetically obsolete. But trends show that people are getting older and remaining active and lucid, eager to keep a routine and enjoying new experiences, and therefore they are demanding products with better quality, functionalities, and aesthetically beautiful.

The founder studied many solutions abroad, but the Brazilian reality was found to be very specific. According to him, Latin America culture tends to keep families closer and more dependable than in other countries. This results in an expectation from parents that their children will look after them when they get older. But this is changing. Sons are leaving their parents' home earlier and not to come back, even moving to another region with better job conditions, not to come back.

This reality is already happening in developed regions like the USA and Europe. In these places, the parents start to prepare for their elderly much earlier with improved saving plans, improved health insurance plans, vitamin prescriptions, home adaptations, health devices and other healthcare services.

In Brazil, as in other underdeveloped countries, most of the population doesn't have access to basic care, and cannot afford health insurance for elder - since they are much expensive - or even a daily caretaker. Thus, solutions that help elder and their family to monitor their health from distance will fit an unattended market.

After launching three products (described below), HelpBell also started to address other companies to propose internet of things (IoT) innovations, like to monitor drug temperature

and devices for monitoring patients' physical indicators. The revenue projection for 2018 is about 8 million reais.

5.3.2 About the Entrepreneur

The interviewed was the sole founder of the company. He has a mechanical engineering degree and has extensive experience on the automotive industry. He lives in Porto Alegre city, in the south of Brazil.

After a sabbatical year, he decided to search for other professional opportunities and started an entrepreneur path on health innovation. His first focus was on finding information on devices designed for elderly. He pursued several opportunities to meet both Brazilian and foreign entrepreneurs (from Germany and Finland, for example) and incubators to learn more about the health care market. He designed and launched three products for this market (more details will be presented below), all based on IoT and remote monitoring. After some months, he decided to venture into B2B market by designing specific solutions for bigger companies, based on the knowledge gained on B2C.

5.3.3 Describing the innovation

The company has several solutions for both B2C and B2B markets. On B2C, they are mainly focusing on elderly patients. On B2B, the company develops customized solutions based on sensors and IoT for several monitoring and control applications.

On B2C, elderly solutions, the company has developed three different products, the Box, the Fix and the Locker. They are devices with wireless connection capabilities, each one with different features, but all able to send information about the user health status online.

The Box was designed to be as similar to a conventional drug box as possible, thus making it easier the identification and acceptance of the client. The HelpBell version alerts which medication must be taken at a given time and if the user fails to take the medicine up to one hour, it can alert pre indicated contacts. It also has emergency call functionality without using telephone or cell phone.

The Fix is an emergency button. It is also connected wirelessly to the internet and can warn up to 10 contacts. It can resist water and can even be installed inside the shower.

The Locker has a direct connection to the emergency feature: if the emergency button on the Box or the Fix is pressed, the contacts receive the location of a safe and the code to open it. Inside, the door keys can be found to access the patient house.

A first impression of simplicity from the presented innovations may hide a deeper evaluation of the elderly pitfalls and the Brazilian particularities. HelpBell invested on user experience to understand the needs of the Brazilian elderly needs and lifestyle.

For example, the Locker was developed to allow easier access to the patient home. In other countries, it is much simpler to get inside someone's house, once there are no additional door padlocks, locked windows, gates and so one. Because of all violence, Brazilian residences are much more protected, and to help a patient in need, the firefighters must be called - instead of ambulances - to break through all the safety devices. So, to allow contacts to have access to a door key can be the fastest way to attend to an emergency call.

Other products, developed to B2B market, are based on temperature controlled coolers for drug preservation, personal step, and heartbeat counters, among others. One example is a mattress with embedded sensors for the heart at frequency monitoring, without the need for attaching a device to the patient body that could be applied to hospitals or by homecare institutions. Another innovation is a cooler vent with electronic modules capable of registering temperature variation inside the box and transmission of the temperature registry through the internet for remote monitoring. The coolers can be used to preserve oncology medication, vaccines, and other situations were temperature control is critical to assure treatment quality.

5.3.4 Business model

As explained before, HelpBell is targeting both B2C and B2B markets. On B2C, the main focused is on elder people. The company is guided by the increasing prospects of population aging both in Brazil and abroad. More people are getting older and living more, thus consuming more dedicated products. They saw an opportunity to develop a market that is neglected by the medical equipment incumbents, by proposing solutions that innovate in functionalities, design and payment system.

Their products - the Box, the Fix and the Locker - are all given for free when the client buys a monthly plan, which features: up to 10 emergency contacts, emergency notification, drug administration time monitoring, wrong drug administration alert, low battery alert, and e-mail and SMS alert. More than just an IoT gadget, the Box has the same function as a caretaker or a nurse attending the elder patient 24 hours, 7 days a week. Thus, a family without the possibility of hiring a caretaker would spend between R$29,90 (basic plan) and R$39,90 (premium plan) to monitor drug taking. This is a major value proposition for HelpBell, to give elderly conditions to be maintained on their own.

On B2B, the company is developing special projects based on IoT depending on the client needs. Pharmaceutical companies are interested in solutions to monitor temperature, hospitals and home care companies are interested in IoT integration on daily routine products.

5.4 VIVABEM

5.4.1 About the company

The company was created at the first semester of 2015, and the main product, the VivaBem platform, was launched 1 year ago. The company was founded after the founders decided to apply years of experience in health care management acquired from positions occupied at consulting firms. There were two main drives behind the company foundation: the ever increasing costs of companies with health care and the development of portable devices that could acquire and transfer physical information about the user, what could be used to inform the user and the company about his health conditions

The main product is the health platform ViBe, a one-stop-shop for several functionalities. They are focused on B2B - provide the platform for companies to better manage their employees' well-being. Nevertheless, the platform with basic features is available as a free mobile application, and additional features require payment. The current revenue is about R$ 1.2 million per year.

5.4.2 About the Entrepreneurs

The founding partners are an industrial engineer with international MBA course, and a bachelor of science, marketing, and philosophy degrees. Both partners have worked for

consulting companies, where they first got in touch with healthcare industry, such as market players (health care plans providers), possible problems (companies' increasing costs with health care plans for employees), and health care innovations (IoT for healthcare, wearable devices, smart watches, physical metrics measurement - step and calorie counters). The first one – the industrial engineer - was the one available to be interviewed.

Besides the founders, the company has a team of five full-time professionals to assist with product development and other back office activities. They are looking for new partnerships to foster company growth potential.

5.4.3 Describing the innovation

The ViBe is a one-stop-shop platform for healthcare services. The user is encouraged to input personal information, like physical and medical metrics, results from last exams, events that influence well-being (like a bad night sleep or bad habits like smoking), among other related data. Using algorithms, artificial intelligence and human-based coaching, the platform - both mobile application or website - delivers personalized advice on activities (like to sleep earlier if you have had a bad sleep night at the previous day), health tips (like presenting quit smoking assistance programs), challenges (like step counter contests between friends, according to the current physical status), among other features to engage into better health habits.

Other functionalities of the platform are the possibility to register family member medical information, a search engine for physicians specialties and visit scheduling, online purchase of medicine, online hiring of additional health services like e-coaches for training exercises and treatment follow-up by SMS, discussion forums for patients with the same condition and supported by physician moderators, and even a medical databank powered by artificial intelligence to help users to find information about diseases, treatments, and other relevant information according to their personal information. The main objective of the VivaBem is to have as many health care offerings in a single platform as possible.

Every user will have a health score - based on habits, physical metrics and other information. As he engages in health activities and presents better health indicators, his score will improve accordingly, following the gamification trend solutions to promote user engagement.

The platform is made available for employees by the company that hires the service from VivaBem. The value-proposition is that engaging employees on healthier habits, they will become more productive, less absent, use less frequently corporate health care plan (decreasing overall costs), and retaining employees by presenting additional benefits. On monitoring workforce well-being, the VivaBem platform provides a BI (business intelligence, a control and monitoring screen) for overall health conditions and the possibility to focus on pre chronic, already chronic, stressed employees, among other conditions that require fast and directed actions, thus improving health risks management. There are also tools to analyze the misuse of corporate health care plans. It can be established and proposed personalized health promotion programs for collaborators who really needs it, according to their personal necessities. Health promotion challenges - for example, to fight sedentarism - can be implemented, such as competitions between individuals, groups of individuals, different company departments and even between different companies.

The confidentiality of the medical information is preserved since the user can only access their information. Other professionals that have access are the company's responsible physicians and personnel appointed used health professionals. In the case of employee dismissal, he will be able to keep accessing the application and his personal data.

Future developments are based on the integration of the ViBe with commercially available EHR and privately-owned ones - such as from hospitals, clinics, diagnostic labs - and other healthcare institution systems to automatize the data input with exam data, medical appointments, surgeries, procedures, treatments, drug prescriptions, and so on. The objective is to avoid information loss by direct linking information databanks from different providers. Thus, the platform would be able to present a complete medical history for patients and doctors.

5.4.4 Business model

VivaBem is mostly concerned with B2B, where private companies can use their platform to engage, promote and maintain a healthy culture among their employees, thus increasing satisfaction, preventing absenteeism – employee absence from work - and presenteeism – employee lower efficiency due to a physical indisposition. Their pricing model is based on monthly-fee.

The B2C is a good way to engage common users. The application is available at mobile app stores with no initial costs, but following the freemium model.

Other markets to be developed are health plan operators that could use a white label version for their clients. The same value-propositions are also applicable in this case - health promotion that would result in improved well-being, improved preventive actions and less emergency room and other punctual hospital services, decreasing overall health plan operator expenditures.

The company has also sounded out contracts with the government, such as municipalities that could use the platform in benefit of the population. Features would be related to scheduling SUS appointments at UBS, AMEs and other primary care institutions. But in their experience, they faced several bureaucracy barriers, lack of support, long approval times, what made them give up the initiative.

Since the platform is completely Cloud-based, it can scalable to any state in Brazil and even abroad. A difficulty would be to find local coaching services since it depends on local health professionals.

The next chapter is the application of the proposed theoretical framework, based on the information given by the founders and startup websites and disclaimed on this chapter. The startups will be submitted to the 3-steps and an assessment of the framework will be provided. The conclusions on the potentiality of disruption by the innovation will be given in the Conclusion chapter.

6 THEORETICAL FRAMEWORK APPLICATION

Once the information on the startups has been organized, the previously Disruptiveness Potential on Service Innovation Framework will be applied. Each topic corresponds to a company, and the sub-topics are the steps to be followed.

The first step is based on SDL (VARGO; LUSCH, 2004) and characteristic-representation of the product (GALLOUJ; SAVONA, 2008), where the innovation and the competitor will be redefined in terms of competences and characteristics and compared. By translating the innovation – that can be a good and a service or a mixture of both (GALLOUJ; SAVONA, 2008) – into service terms, a common base for comparison is created. The separation into user and provider competences, and technical and service characteristics helps to organize the elements and to discriminate where the innovation has advantage over the incumbent offering.

The second step is based on the disruptive theory. Four aspects are being questioned: if the innovation is simpler and cheaper; if the target market in unattended by incumbent company; if the business model is innovative and if the innovation is scalable (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

The third and last step is about innovation systems (CONSOLI; MINA, 2009). The positioning of the company inside the ecosystem and the relationships it develops with suppliers, partners, competitors, government, investors and clients will facilitate of difficult access to information flows, essential for feedback on products, improvements and new developments.

On the last topic of this chapter, the steps will be reassessed one by one. The proposed framework will be further analyzed under the results from the application of the framework on the companies and the theories from theoretical review chapter.

6.1 GUEPARDO SISTEMAS

6.1.1 Step 1 – Distinct Competences and Characteristics

On characteristics-based representation of the product (GALLOUJ; SAVONA, 2008), the Guepardo Sistemas solution will be compared with the regular diagnosis centers from small and remote cities, where most of the image diagnosis are taken and either analyzed locally or send it using high speed internet to another diagnosis center.

Once the patient has taken the images on a radiography center, the user competences are basically the same: the technician must use software to send the image to the radiologist for analysis. Both innovation and current solution will use software that requires basically the same competences.

The provider competences (GALLOUJ; SAVONA, 2008) are very different: Guepardo Sistemas have programing and hardware skills that allow them to send the image information using low internet connection to any diagnosis center that has the same system. They also have the knowledge on assembling the components for the module, giving them great control over the solution. The regular diagnosis center does not have comparable competences.

On technical characteristics (GALLOUJ; SAVONA, 2008), the Guepardo solution allows the user to send the image using cheaper low speed network to any diagnosis center; their competitors does not have much option besides analyzing the image locally, or use a high speed connection – not always available and more expensive – or physically deliver it to another diagnosis center for analysis, taking much time and increasing costs.

This will all reflect on the service characteristics (GALLOUJ; SAVONA, 2008), which the Guepardo Sistemas allows the image to be diagnosed in another location with lower waiting lines; low transmission costs, using an integrated low speed connection – like 3G network – from a G-Proxy module that is portable. The incumbent solution has none of these possibilities, presenting much higher costs and waiting time.

The Guepardo innovation has been described and the novelty characteristics have been highlighted, but what about disruptiveness?

6.1.2 Step 2 – Disruptiveness Indicators

The first indicators are related to the innovation being simpler and cheaper than the incumbent product (CHRISTENSEN; RAYNOR; MCDONALD, 2015). The G-Proxy module is assembled in Brazil, using both national and imported components. One of the founders informed this module would cost 10 thousand reais for the client, but instead it would be provided for free in the monthly-fee plan. A high speed server for medical images would have to be imported and would cost around 2020 thousand reais for the client. Thus, it is clear that the solution is much cheaper than the incumbent company. The system is also simpler, requiring only the installation of the G-Proxy module in a desktop computer and software for compression and submission. Instead of a high speed internet connection, a 3G chipset from any mobile phone operator can be used for the transmission.

The target market is composed of remote health institutions – such as small clinics, hospitals, laboratories, over capacity diagnosis centers and even mobile health ambulances - that lack a high speed internet link and proper hardware for sending the medical images to be diagnosed elsewhere. Far from metropolitan areas, access to high speed internet services is much difficult. Also, smaller institutions lack resources for the expensive servers for image transmission. Incumbent companies prefer to focus on mainstream markets, normally on larger cities, where there is a better telecommunication infrastructure and health institutions with more resources for investing on their solution.

Another requisite for disruptiveness is the divergence between the incumbent business model and the company's (CHRISTENSEN; RAYNOR; MCDONALD, 2015). The incumbent companies charge for the equipment and for the license to use their native software. Also, the user needs a high speed internet access. The Guepardo Sistemas business model is based on charging a fixed monthly-fee from users to send as many images and requests for diagnosis as necessary. The hardware and software are included with no additional costs. Only the 3G chipset is not included and must be provided by the user. Another source of income is a fixed percentage from radiologist's service that uses the cloud-based platform to perform image diagnosis. This allows a greater competition between diagnosis providers and lower costs for patients and lower waiting time for the results.

The last requisite is on scalability of the innovation (CHRISTENSEN; RAYNOR; MCDONALD, 2015). The Guepardo System is composed of software and hardware. The software will require minimal parametrization if requested by the client, but normally the shelf version can be used. As described earlier, the hardware is build using components from international and national suppliers and assembled in Brazil. Once they have the know-how over all the technology and well developed relationship with suppliers, they would be able to increase production.

6.1.3 Step 3 – Innovation Ecosystem

On the healthcare innovation system, they are building partnerships with relevant clients to foster feedback and increase the installation of modules. Guepardo Sistemas has a partnership with SESI, a large Brazilian institution, which provides a source of income and an open feedback channel. SESI cardiology center is composed of seven cardiologists, all of them using the system and providing comments about it. Another relevant fact is that one of the founders is a professor at Federal University of Bahia, and two internship students are employed for the development of the system. The direct contact with academia assures access for yet-to-be published technologies that are incorporated to the innovation before coming to public, granting competitive advantage over competitors. Both SESI and the Federal University of Bahia are gateways, and the relationship between them and Guepardo Sistemas are the pathways (CONSOLI; MINA, 2009).

The startup has been in touch with Portugal and France consulates to study the possibility of taking their technology abroad. Guepardo Sistemas has also been fostering a good relationship with radiologists, since the company is developing an online platform for image diagnosis reports that will allow the radiologist to perform the image analysis and submit the report by charging a service fee.

6.2 OXIOT

6.2.1 Step 1 – Distinct Competences and Characteristics

For the compared with Oxiot innovation, it will be chosen the care taker. Since oxygen cylinders are located at patient’s home, a care taker such as a hired nurse would be responsible for checking the cylinder displays for oxygen flow and pressure. Other caretakers

could be family members, friends and the patient himself are other individuals that could check for the displays and take the decision to replace the cylinder.

The user is the patient, who hired the caretaker or the Oxit solution, and rented the oxygen cylinder. The user competences (GALLOUJ; SAVONA, 2008) in this case are only related to hiring the service, and make regular cylinder display readings for replacement, according to oxygen volume monitoring.

The provider's competences (GALLOUJ; SAVONA, 2008), under the view of the care taker, are linked to the ability to correctly and periodically read the display, interpret the measurement value, and take the correct course of action, such as to replace the cylinder or to call the physician in case of uncommon respiratory behavior. On the Oxiot competences, there are hardware and software development and maintenance skills, analog to digital signal conversion, internet network configuration, remote sensor monitoring, data pattern analysis, and communication link to patient, family member and physicians. The provider's competences will have direct impact on the technical characteristics.

The technical characteristics (GALLOUJ; SAVONA, 2008) of the care taker are based on the discipline to read the display periodically, on having knowledge of experience on how to interpret the measurement, and on initiative to take a course of action. The Oxiot solution technical characteristics are linked with the connectivity of the display with the internet, converting the analogic signal to a digital pulse and sending the information more frequently than a human being would be able to do to be analyzed by software. Software parameters can check for flow pattern anomalies and alert a technician for support, in real time.

Finally, some of service characteristics (GALLOUJ; SAVONA, 2008) are basically the same for both products, the monitoring of the oxygen cylinder and an alert when outside the regular pattern. The greatest advantage of the Oxiot system is the frequency of the digital signal reading, that is much higher than a care taker would be able to do, allowing with a higher predictability when the cylinder will have to be replaced; a more immediate course of action in case of misbehavior; and also a deeper analysis on the respiratory condition of the patient over time.

6.2.2 Step 2 – Disruptiveness Indicators

The Oxiot solution is much simpler, since the device must only be attached to the cylinder and connected to the internet so the digital signals can be sent to Oxiot to be analyzed in real time. The measurement of the oxygen level and flow would be done software, and at any misbehavior or eminent oxygen deplete, the patient or other provided contact would be warned. The monitoring and control are automatized, without the need for a care taker to check it regularly. A single technician could monitor several oxygen cylinders, what would decrease the cost of the service by optimizing the process. The company was unable to provide an estimative of cost for the patient to have the Oxiot system at home. It is expected, though, that it would cost less than a full time care taker. This fact compromises a complete analysis at this disruptiveness indicator (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

Oxiot target markets are mainly patients with oxygen cylinders at home. Target institutions are homecare services and hospitals. Homecare companies could provide the system as an additional feature to their services. Hospitals use oxygen cylinders on ambulances, mostly. Oxiot is also developing a specific system for fixed oxygen lines inside hospitals.

The main weakness of Oxiot is the absence of a business model. It was explained that the founders were still defining the best pricing strategy for the system. Even the decision to change to another industry was up to discussion. There was only one patient using a prototype version, and no further information could be given. Another problem was with supply chain development – mainly for the hardware. This difficulty compromised the analysis of disruptiveness, since it could only be based on current situation assumptions.

Finally, scalability is also affected by the lack of a developed supply chain. The hardware was developed locally, but the components are imported. The solution is highly dependable on hardware, since it is responsible for converting the analog signal to digital, what allows the data to be sent though an online link and monitored at distance.

6.2.3 Step 3 – Innovation Ecosystem

On partnerships, Oxiot is being mentored by a large multinational that could provide important feedback and put the startup in contact with other companies, what would foster the development of new partnerships. The company has obtained a contract with SENAI, who is

supporting the development of the system and can provide technical insights for improvements or new products. On clients, Oxiot first prototype is already in use by a patient. The company is taking a close supervision on this experimental client for feedback. The startup is looking for medical research institutions that would use the acquired data on oxygen consumption for respiratory disease researches. On the other hand, it was made clear that the company is struggling to find investors. There is also a difficulty on developing a reliable supply chain.

Oxiot have some relevant gateways of information (CONSOLI; MINA, 2009) – the mentor company, SENAI, the experimental user, and is trying to develop new contacts. The pathways that seemed to be more responsive are from SENAI technicians and from client's feedback.

6.3 HELPBELL

6.3.1 Step 1 – Distinct Competences and Characteristics

The application of the theoretical framework will be based on the Box (B2C) solution, since the B2B business model is closer to a consulting office. As in the previous case (Oxiot), the competitor to the Box is the caretaker, which can be a hired nurse, a family member, a friend or even the patient herself.

The user (patient) competences (GALLOUJ; SAVONA, 2008) on hiring the caretaker are based on the awareness of the treatment – which drugs, in with dosage and when to take them. Since the Box has all this information into its software, the user competences are more related to knowing how to program it or even asking HelpBell for support.

The provider competences (GALLOUJ; SAVONA, 2008) are very distinct – the caretaker must know about the physician prescription and report if the patient is having any problem with the medications. HelpBell competences are related to programming and software skills, remote monitoring and support to patient in real time.

The technical characteristics (GALLOUJ; SAVONA, 2008) from the caretaker are based on the knowledge on following physician prescriptions and having the ability and initiative to take a course of action (calling a family member or asking for an ambulance) once the patient fails to take a medicine or present an emergency. HelpBell competence are based on internet

of things – and their system replaces the human skills for an automatized monitoring system that provides more reliability on controlling drug administration and a real time emergency call service.

The service characteristics (GALLOUJ; SAVONA, 2008) are basically the same, to monitor treatment by granting correct drug administration and providing support in case of an emergency.

6.3.2 Step 2 – Disruptiveness Indicators

The Box solution is cheaper than a caretaker – a visit to their website provides monthly fees for the service – much less than a full-time caretaker, and the device is given to the patient without charge. On simplicity, the acquiring model is more direct – there is no need of interviews or request for references. Programming the Box could be hard, but HelpBell provides support, minimizing the problem.

The target market is elderly people and their families that do not have enough resources to afford a caretaker. Sometimes, a family member will be responsible for the elderly, and the Box can be used as a safeguard. The elderly market is increasing both in Brazil and abroad, and it is being especially set aside by incumbent companies for some time.

On business model, HelpBell focused only on their website. The CEO said that it didn't bring results, and they moved to focus on B2B solutions, so providing the Box to other service companies, acting as a consulting firm instead of a product provider. The Box uses Brazilian and imported components, and it is assembled in Brazil. The supply chain is developed and attends the current company needs. There is some concern with imported components due to the long delivery time, but this problem is already known and does not affect scalability – according to the HelpBell CEO. A point to be clarified concerning the business model is that the startup appears to be leaving the B2C model, where the present results were very modest, and reading to a B2B, where there is not enough information yet. Also, the marketing channels for the Box were not developed, but stagnated on a single point-of-sale. It is difficult to be sure about the disruptiveness as the business model is not clear structured (CHRISTENSEN; RAYNOR; MCDONALD, 2015).

6.3.3 Step 3 – Innovation Ecosystem

HelpBell development of relationships with larger companies was an important driver to allow it to switch from B2C to B2B. Contact with pharmaceutical and medical equipment provided opportunities for HelpBell to employ its competences on building solutions according to joint projects. The information exchange obtained from these contracts is highly relevant for new developments. Other relationships were not disclosed by the interview.

6.4 VIVABEM

6.4.1 Step 1 – Distinct Competences and Characteristics

Most companies uses a ERP - Enterprise Resource Planning software, a full management system for companies, composed of several modules, such as finance, accounting, fiscal, purchasing, billing, stock, and human resources. They are usually very expensive and complex to use, since it requires several parametrizations to adequate to the organization routines. Human resource, ambulatory and benefits departments have management software for registering employee health information. These systems are used for monitoring periodic exams, physical data, surgery, occupation medicine reports and other information, normally requested by government labor regulation agencies. Most of the health insurance companies request this information when negotiating corporate health plans with employers, what impact costs (from subsides) for the firm and health plans prices for employees. This human resources management software will be chosen as the main competitor from ViBe platform.

The main users of the corporate system are administrative personnel. They request a deep understand of the system, such as how to locate employee information, how to enter data, how to print reports and so on. Normally, the employee is summoned to give the information directly to the departments, since they are forbidden to access the system. The user competences are directly linked to this particular system.

It is not different from ViBe. The user competences are linked with knowing how to use this system. The advantage is that some of the fields to will be filled and later updated by the employees using a mobile application – what was not available at the incumbent solution.

The provider competences (GALLOUJ; SAVONA, 2008) have similarities. The incumbent company and VivaBem have software skills and personnel management knowledge, but the incumbent company will have deeper knowledge on every organization structure, since it must program management software for every department of the company. On the other hand, VivaBem specializes at health promotion, physical information, mobile interaction, and healthcare services provisioning.

The technical characteristics (GALLOUJ; SAVONA, 2008) are also basically the same. The incumbent and the innovation with both have employee data base, access levels, healthcare data fields, among other registering capabilities. The differences in favor of the ViBe will be on employee access to their information using the mobile app; cloud-based software; and additional features linked to health care promotion.

The service characteristics (GALLOUJ; SAVONA, 2008) are a result of the previous vectors, resulting in an interactive platform for healthcare promotion, what does not exist on incumbent human resources management software. Using ViBe, human resources department can monitor chronically ill employees, create health campaigns, allow employees to update physical health indicators, and provide additional healthcare services, such as physician specialization scheduling, drug purchase, and so on.

6.4.2 Step 2 – Disruptiveness Indicators

ViBe system is a white label platform that can be parametrized for the company. It is a one-size-fit-all solution. ViBe is also cloud-based, and the mobile app allows employees to enter their own information. Because of the given reasons, the innovation is much cheaper than a more complex ERP. When the ViBe was launched, it was simpler than an ERP module, since it had fewer features, and as the users get used to it, more features were being enabled.

The target market is companies that are looking for more accessible management software for managing personnel health or companies looking for a solution to promote health for internal collaborators. The ViBe platform is cloud-based, so no software installation is required, and the system can be access from any computer. The mobile application is very intuitive, and it can even be found on app stores for free, fostering employee adoption. These two characteristics allow the company to implement the ViBe solution without impacting the

current software structure. Also, the solution is much less costly since no installation is required.

VivaBem business strategy was to start with a smaller and simpler solution and increase the number of functions according to the need of the clients – it allowed the solution to address specific jobs that the regular systems are unable to provide. So, even if the target market was the same as the incumbent, their product aimed to bring innovative features that complemented the current solution and can eventually replace it – as already happened with some VivaBem clients. They are now adding more functions to increase the portfolio of options available, aiming to create the one-stop-shop described earlier.

On scalability, the product is cloud-based, requiring only additional VivaBem computational infrastructure to provide more user accesses. For other countries, it would only be necessary to translate the fields to the native language. The additional functionalities – drug purchasing, physician scheduling, e-coach hiring – would also require a local assessment.

6.4.3 Step 3 – Innovation Ecosystem

VivaBem is fostering several connections inside the healthcare industry. They are in touch with clients – large companies – for new functionalities. Insurance companies are requesting information from them on the employees to better calculate health insurance plan costs for employees, according to their health condition.

ViBe platform is being turned into a one-stop-shop, what means that it will be adding new functionalities, such as online medical scheduling, exams scheduling, drugstore location and e-coach hiring. So, partnerships must be developed with clinics and physicians, laboratories, drugstores and coaches.

There is also an important pathway (CONSOLI; MINA, 2009) from mobile app users. Their feedback allows VivaBem to improve the application and attract more users to it. They are very attentive with their clients, keeping a close relationship that has being used to implement new features that best approach their needs.

6.5 THEORETICAL FRAMEWORK ASSESSMENT

After the application of the theoretical framework, a closer look on this process is presented. On the previous topics, the Disruptiveness Potential on Service Innovation Framework was employed step by step, following the guidelines established at the Theoretical Review chapter. Each startup presented specificities that required a cautious evaluation on how to use the framework, according to the step.

The first step, namely Step 1 – Distinct Competences and Characteristics, is concerned about redefining the innovation, according to what makes it innovative face to an incumbent offering. Thus, it is important to define both innovation and competitor.

In the case of Guepardo Sistemas, it was first appointed by one of the founders that the main competitor was the high resolution medical image solutions that required high speed servers. Later, diagnosis centers were appointed as another competitor. Different competitors will lead to different analysis. Thus, a unique main competitor must be chosen for the application of the framework.

Sometimes, it is hard to separate a client and a competition. Oxiot's oxygen cylinder sensor could either be supplied to patients directly and compete with homecare services, or be offered to homecare companies, who would later install the devices on patient's homes. The same case happened for HelpBell and the Box – a drug box that could warn the patient and the family about medication administration could be sold to patients directly or to homecare service providers. VivaBem competitor was clearer: the company's employee health management software.

Returning to the framework, for two products to be compared, a common ground is required. And that's where the theory of SDL (VARGO; LUSCH, 2004) comes in. When the product is defined as a service, the value attributes that are disclosed behind the physical attributes are brought forward (VARGO; LUSCH, 2004). The characteristic-based representation of a product theory helps us to organize the value attributes into sets of competences and characteristics from the users – whom the product was destined to be addressed – and from the provider – the startup; and the technical characteristics of the innovation and the service characteristics – the ones that define which values are being proposed (GALLOUJ; SAVONA, 2008).

This redefinition can be very complicated if user, provider, technique and services are not well defined. The patient was chosen as user for Oxiot and HelpBell solutions. The administrative employee from human resources department or benefits department was chosen as user for VivaBem platform. But on Gueopardo Sistemas, it was not made clear who would be the user. It was informed during the interview that the company was focusing on small clinics; it could be a local technician, a secretary or even the physician. Since the solution required knowing how to use their proprietary platform, the user could be any of them – but for illustrative proposes, the technician was chosen. In any case, it is important to have a clear definition of who is the user so her competences can be defined accordingly.

The provider was always the startup. In the cases presented, the startup competences are completely different from the incumbent company – except in the case of the VivaBem, where both companies were software developers and they had some competences in common. In view of the academic formation and past experiences of the founders, it was expected.

The technical characteristics (GALLOUJ; SAVONA, 2008) were impacted by the mobile technologies. All the startups presented internet connectivity, real time communication, remote monitoring and control, portability and anytime, anywhere information. None of the incumbent companies had these attributes, giving a great advantage for the startup innovations. This fact corroborates with the strategy adopted on the literature review on choosing mobile technology to define relevant trends of technology that could impact health care industry.

Finally, service characteristics vectors (GALLOUJ; SAVONA, 2008) were added elements of performance improvement, lower costs, high availability, due to the improved technical characteristics. Most of the startups presented a completely new service offering, meaning that the user's jobs were still being fulfilled the same way incumbents solutions were, but with improved attributes. VivaBem platform added new functionalities to the service as it added new modules to their platform, such as the health promotion campaigns and the online medical services scheduling and hiring.

Once it was verified that the innovation had advantages over the competitor by comparing competences and characteristics vectors (GALLOUJ; SAVONA, 2008), it could be attested that the solution proposed is adding more value to the user than the competitor. If, otherwise,

it could not be proved, the solution would not be competitive and no potential to be disruptive.

The next step was the Step 2 – Disruptiveness Indicators. The main requisites imposed by the Disruptive Innovation theory (CHRISTENSEN; RAYNOR; MCDONALD, 2015) for an innovation to be truly disruptive were tested. The first two requisites questioned if the innovation was simpler and cheaper than the competitor. All the innovations started as a simple and cheaper product and later added new functionalities. Guepardo Sistemas developed locally software and hardware for compacting and transmitting images and receiving diagnosis reports using 3G networks. Their system was much simpler and cheaper for small clinics to use than regular high speed connections that required imported servers. Their clients will not pay for the system; it will only be charged a montly-fee. Oxiot and HelpBell solutions were also cheaper than a full-time caretaker and installing and operating the solution was part of their service provisioning, so for the patient it was not necessary a deeper interaction with technical aspects of using the solution. VivaBem case was the most expressive: it was launched as a simple, interactive platform for health care promotion and later on they started to add new functionalities. Their free mobile app allowed patients to enter personal health data and join health competitions and campaigns. After that, the app was updated with other features gave the users access to additional health care services. The platform also received improvements, allowing administrators to monitor employees that presented riskier health conditions, configuration of health promotion campaigns, additional health care management tools that allowed them to negotiate with health insurance companies to decrease employee's health plan costs. But all started with a lean solution.

The target market was the next requisite to be tested. According to the disruptive innovation theory, the solution should be attending a market that was ignored by the incumbent companies' products. Not only the innovation is avoiding direct competition, but it is supplying customers that otherwise wouldn't be capable of fulfilling their need (CHRISTENSEN; RAYNOR; MCDONALD, 2015). Most startup companies were investing on unattended markets. The founder of HelpBell was very straightforward on this topic. Research was made both inside and outside Brazil and it was concluded that the current products for elderly belonged to a "second category". Thus, they proposed a premium design, high technological and with improved functionalities drug box and emergency button.

Guepardo Sistemas was also very clear about their target market – small countryside clinics. On the other hand, Oxiot was not; during the interview, one of the founders explained about patients, physician, homecare institutions, hospitals, and even clients outside the health industry, but no market in special. Another exception to this topic was the VivaBem ViBe platform. The market was already being supplied with several incumbent human resources management platforms, and ViBe was presented as an alternative with a different value proposition – to promote healthier habits. None of the competitors presented something similar, so it can be said that the target market had a need that was not being attended, what fits into the theory requisite.

The evaluation of the business model was the point where some companies were finding trouble. Unless the company is internally structured, with a clear objective, defined market and market channels, developing a supply chain, fostering investors, and engaging with the ecosystem, it won't be sustainable. More than that, the disruptive theory states the business model must not follow the incumbent's, since an innovative product would propose different offerings and values, and its price would be much lower. So, there would be a need to do things differently – a lean structure, an alternative pricing system, partnership with other companies, and so on. Guepardo Sistemas, HelpBell and VivaBem all showed an organized and assertive business plan. They were all betting on a monthly-fee for user, and the platform was provided for free as long as the contract was in effect. Guepardo Sistemas and VivaBem already have clients and were prospecting for more. Their supply chain was developed, they were fostering investors (Guepardo Sistemas was even in contact with investors from Portugal and France), and they were concerned about positioning their business (VivaBem was in touch with other healthcare institutions to develop an EHR that could be accepted anywhere and that could carry relevant information about patient health).

HelpBell founder stated that their B2C business plan was not as profitable as expected, and they were investing on B2B as a consulting firm for internet of things applied to health care. The B2C plan was where the innovation – the Box - was offered to the market, but the only market channel was the company website (the founder said they didn't invest on any form of advertisement), and after 2 months the company decided this business model would not be successful on its own. That's when they moved to B2B, partnering with large companies – as

pharmaceutical – to develop specific products for their needs. This swift on business model affected the analysis and compromised appraising the business model requisite.

Oxiot was very clear on stating that they did not have a defined business plan. Despite having an advanced prototype installed at a patient's home and a formal product development plan, they were struggling to decide which path to follow - to keep investing on healthcare or move to another industry. Patients with a home located oxygen cylinder and family members could be a market to be developed, but also homecare institutions. From the information collected at the interview, it was not made clear which market they would pursue and how they would do it. Pricing was under internal discussion. Investment was also a concern, but again, no information was given on how they would approach the problem. Therefore, it was difficult to evaluate if the business plan were innovative or not, and it was decided that the company didn't complied with the theoretical requisite.

Scalability was the last disruptive innovation theory requisite and has direct relation to some of the technical characteristics and the startup's business model. When the solution is software-based only, it was easier to be provided for more users. That was the case for VivaBem platform: it was developed from the beginning as a cloud-based platform – scalability inside Brazil was not a concern, and abroad only depended on translating the program to the user's proficiency language. Guepardo Sistemas solution was composed of hardware and software. The hardware had imported and national components and the module were assembled in Brazil. They stated to have control over the production, and the component supply chain was structured. So up-scaling was not an issue for them. HelpBell followed basically the same points as Guepardo Sistemas on supply chain. Oxiot did not have a developed supply chain. They complained about lack of support from mentors and incubators about hardware development. Due to the stated difficulties, it was settled that Oxiot could not scale their innovation within the current company situation.

From the second step, only two companies were completing every condition: Guepardo Sistemas and VivaBem. Oxiot presented problems on defining business model and scalability, and HelpBell was moving from one business model to another, negatively impacting the fulfillment of the requisite.

The last analysis stage, Step 3 – Innovation Ecosystem, is about determining how the company interacts with relevant information flow inside the healthcare industry (CONSOLI; MINA, 2009). The theory explains the concepts of gateways – through whom the information flows and pathways – the channels which the information flows (CONSOLI; MINA, 2009). This network allows the improvement of launched innovations and the development of new ones. The lack of proper positioning and involved with this such dynamic environment will result in loss of competitive advantage.

Gueopardo Sistemas, HelpBell and VivaBem are well positioned. Guepardo Sistemas was the one that showed more clearly them positioning and relationships inside the ecosystem. They have developed partnerships with clients – such as SESI, where the board of resident cardiologists uses the system and provides feedback. The company also enjoys the proximity between one of the founders with the Federal University of Bahia, where he occupies a professor position. This pathway (CONSOLI; MINA, 2009) grants faster access to academic research and new developments, providing technical competitive advantages for the company. As already mentioned, the startup has also been in touch with Portugal and France consulates to study the possibility of taking their technology abroad. The startup is also concerned about approaching radiologists – they intent to launch an online image diagnosis platform for autonomous radiologists and other specialties to provide diagnosis services by their own. Guepardo Sistemas has effectively positioned them in the innovation system, aiming for relevant information sources (clients and academia) and fostering new contacts (international institutions and future clients).

VivaBem is employing new functionalities that are highly dependable on the relationship between them and the market. So, it is imperative for them to foster relationship and keep an open communication channel. Besides the contact with clients that are already using health management platform and the mobile application users, VivaBem is planning an EHR functionality that would be compatible with major hospitals and laboratories, a white-label version for insurance companies, a direct purchasing channel with drug stores, an online doctor visit scheduling, and an e-coach hiring. Unless developing a good relationship and communication channels, the company would be unable to settle with so diverse institutions. Therefore, their ecosystem positioning and communication channels are ones of the most important competences to be fostered.

A B2B business strategy implies a good relationship network. HelpBell has developed partnerships with big companies, as pharmaceutical and medical equipment, were they can build up new solutions according to the client's demand. The project requires great interaction between HelpBell and the client, allowing a direct exchange of information. On B2C market, the company did not presented any information regarding a feedback channel that could provide information on the innovations usage. Since the solutions were created for a specific public – elderly – it would have been interesting to approximate the users for unique needs, what could lead to new products.

Oxiot presented some relationship with the ecosystem, mainly with their mentor company GE Health, who also participated as co-inventors to the innovation; and SENAI, as investor and development of the technology. They are fostering a partnership with medical research institutions that could analyze respiratory patterns based on the digital data from the oxygen cylinder sensors. Oxiot has only one user, what compromises the feedback flow. As it was explained before, the lack of a robust business plan clearly impacts how they position themselves in the ecosystem – for example, they lack a structured supply chain, impacting scalability. The development of a relationship with hardware providers could mitigate this problem.

The proposed theoretical framework allows different side views over the startup and the innovation. The theories that supports the process, which at first look appeared to differ in propose, were linked together in a single tool for analyzing the potential for innovations to disrupt the health care industry. The conclusion to the application of the framework will be given in the next chapter, Conclusion. Also, other approaches to the proposed framework, its restrictions and possible improvements are discussed.

7 CONCLUSION

Historically, innovations on healthcare are synonyms of increased lifespan and life quality, but at the same time, new treatments, drugs, and equipment become less accessible for most patients, due high costs and low availability. In many other industries, innovations bring efficiency and accessibility, decreasing costs for both providers and users.

Mobile technology is one of these impacting innovations. Enhanced connectivity made available by internet networks and portable devices packed with all types of sensors allows information to be created, transmitted and accessed anywhere and at any time. The technology is already mainstreamed – costs are constantly decreasing, software and hardware are being improved every year

Patients can be cared for faster, cheaper, using their own personal devices (smartphone, tablet, computer, among others) and an internet connection (3G, Wi-Fi, and internet). Medical facilities, like offices, laboratories, emergency rooms, are much more expensive since several costs are embedded on such places, like displacement from home to the health institution location, maintenance, building facilities, administrative personnel.

Most of the latest disruptive mobile technologies are coming from startup companies. Most of the solutions are technology-based but focused on providing a service that was somehow inaccessible to users. Compared to incumbents, their proposals are less sophisticated, simpler, thus cheaper and more accessible.

Thus, the main objective was to understand if mobile technologies have the potential to be disruptive over the perceptions of startup entrepreneurs, impacting healthcare industry through service innovations by increasing patients access to low cost, high quality, healthcare services, thus challenging the paradox of medical new solutions providing enhanced patient treatment value, but being expensive and with low availability.

In order to fulfill this objective, it was decided to study the startups' perspectives under the view of the entrepreneurs or the founders themselves. Their views on mobile technology solutions, healthcare ecosystem, patient needs and innovation values are unique. So, analyzing this phenomenon, the question to be answered was:

“Does mobile technology have the potential to impact healthcare services by decreasing costs and improving availability, under a theoretical analysis of information acquired from startups’ entrepreneurs?”

To fulfill the objective, three specific objectives were determined: the development of a theoretical framework that could allow the analysis of disruptive potential of service innovation on health care; the determination of trends on mobile technology and health care service innovation, and later use this information to select startups; and the analysis of startup innovation potential to disrupt the health care industry according to the developed theoretical framework.

For the first specific objective, it was proposed a theoretical framework for structured analysis on the entrepreneur information. The framework combines distinct theories in service, service innovation, disruptive innovation and innovation systems. It allowed a broader view on innovations, making it possible to analyze the disruptive potential of service innovation on health care through the lens of well-known and proven service and innovation strategy theories.

For the second specific objective, to determine which trends in health care service innovation using mobile devices and platforms were the most preeminent, a systematic literature review on mobile healthcare innovations was conducted. The startups were primarily selected from a startup ranking platform. Four were chosen to be interviewed - Guepardo Sistemas, Oxiot, HealpBell and VivaBem, according to the resulting trends from systematic literature.

The last specific objective was related to the application of the theoretical framework. The information about the companies was organized into three topics: about the company, describing the innovation and business model. Next, the framework was applied to the information, step by step.

The results of the framework application on the information provided by the startups, the following conclusions could be made:

From Guepardo Sistemas, the G-Proxy solution attended all the framework steps. It is innovative, differing from the competitor by presenting distinct competencies and characteristics, such as low internet image transmission capability. It is cheaper and simpler

than the incumbent solution, attending small clinics and other health care institutions from remote regions; and it has a robust business model based on monthly-fee with two different income sources – the small clinic and the radiologist. Finally, they are putting effort to better position themselves on the innovation ecosystem, by building partnerships with clients, keeping a close connection to the academia, opening dialogues with foreign governments, and connecting to radiologists. Guepardo Sistemas has the potential to disrupt the teleradiology, according to the framework.

From Oxiot, the solution presents some innovative elements, as the remote automated monitoring of the oxygen cylinder allows the acquisition of oxygen flow information more reliable and frequent in comparison to a human caretaker. But the absence of a defined business plan compromises the potential disruptiveness analysis. It was not defined how the company would charge for the system, or even if they would continue to act on health care business. There was also a problem concerning scalability since the solution is dependable on the supply chain for hardware. According to the given information, the framework cannot indicate that Oxiot has potential to impact the healthcare industry.

From HelpBell, the B2C solution, the Box, has several competitive advantages over caretakers, once the monitoring of the patient adherence to treatment can be done remotely. The solution is cheaper than a caretaker service, and the system is given for free. The company is also well positioned in the healthcare innovation system, fostering relationships with larger pharmaceutical and medical equipment companies. But some critical aspects of the business model are not defined – is the Box going to be discontinued? Will HelpBell stop focusing on B2C and converge to B2B only? On B2B, the startup will be acting as a consulting firm for special projects, according to the necessities of the hiring company. Without a clear definition if the innovation will be discontinued or not, it is not possible to reach a conclusion on potentiality to disrupt the healthcare industry.

Eventually, from VivaBem, all the framework steps have been attended: the ViBe platform provides features that are not existent on incumbent products. It has a much lower cost since there is no need for installation – cloud-based software - and the mobile application for employees is available for free. On business model, VivaBem is diversifying their income sources: the platform can be used by companies concerned about promoting employees health; the one-stop-shop joins several health care service providers under one solution, and

ViBe can be provided as the white label for health insurance companies. The platform is scalable since it is cloud-based software that would only require additional server capacity to allow more accesses. VivaBem is positioned between client-companies, healthcare service providers, and health insurance companies – partnerships can foster feedback on the product, new development for specific needs and information on new necessities in other areas. All information can be used for further developments. According to the theoretical framework, it can be said that the ViBe platform has the potential to be disruptive.

Despite the extensive selection process to choose the most relevant startups following international trends on mobile technology for healthcare, the framework showed that only two of four companies – Guepardo Sistemas and VivaBem – had potential to impact the healthcare industry.

Oxiot and HelpBell failed to meet the proposed requisites. It means that the framework was able to distinguish companies with and without the potential to be disruptive, even when they were chosen following the same structured process. The analysis was not biased by the fact that they are all startup companies with cutting-edge technology and relevant competitive advantages over competitors. Other requisites were equally important on evaluating the disruptiveness of the proposed solution, providing a complete understanding on the innovation process by analyzing additional side views – such as the interface with the innovation ecosystem, the importance of the business model and the scalability of the product.

The theoretical framework was able to meet the main objective. Each startup and the correspondent innovation were analyzed under the scope of well-known, baseline theories on business administration. The startup selection criteria proved to select relevant startups – they all passed the step 1, which evaluated the innovation elements against the competitor, showing they were in fact solutions that were bringing novelty to the healthcare industry. Also, as expected from mobile technologies, they all presented simpler and cheaper solutions than the incumbent. But the framework also proved that these attributes were not enough for an innovation to be disruptive. Some startups had problems concerning business model, scalability, and access to the innovation ecosystem, what could jeopardize the sustainability and the disruptiveness of the solution. It has been shown that a thorough analysis of innovation is necessary to attest for the potential of innovations to impact healthcare industry.

This is the main point of the theoretical framework analysis. The theories gathered and organized into steps allowed four companies with very distinct products to be compared on a common basis and to be classified into potentiality to impact and succeed in healthcare industry. After the analysis, the startup companies showed several attributes that indicate they are presenting disruptive solutions that are not based on traditional medical advances, such as the cited new drugs, equipment and treatments, but solely on escalating access to health services.

It can be seen that health care industry is going thought a pivotal change, as huge investments on research and development are no longer the only indication of a future improved patient well-being. New technologies and business models are allowing new entrants to propose distinct offerings and affect more patients, delivering value through inclusion into healthcare provisioning. Governments and incumbent companies must be aware of the changes – rigid structures, regulations, outdated business models, distance from patients are disadvantages that goes on the opposite tendency brought by startup companies. Their flexibility, lean staff, alternative business strategies, and the focus on patients and on feedback, along with new, mainstream, low cost technology, allow them to provide a compelling alternative to traditional institutions.

Nevertheless, the theoretical framework has some limitations. First, the study strategy was structured as a cross-section, as only the current information about the solution and the companies were used – if, in a near future, one presents a different value proposition, strategies or innovations, the potential to be disruptive can be reviewed, for either confirming or denying it. Secondly, the framework is dependable on interpretative assumptions about abstract aspects of the innovations. A solution would be to let a group of evaluators analyze the information on the innovation individually and share the comments to check for common observations. Third, the framework can only be truly confirmed if selected startups impact the healthcare industry, proving that the potential to disrupt actually evolved into a disruption and company's success. That would require a longitudinal study strategy, with numerical evidence from indicators such as increased revenue, increased market share, increased earning, and so on. This strategy was unfeasible under this essay proposes. Another limitation was on the number of cases for testing the framework. Unfortunately, the difficulty of establishing

contact with startup founders and time limitations did not enable further startups to be selected.

Other uses for the theoretical framework can be on a managerial aspect. Companies interested in verifying the disruptive potential of their products can submit it to the framework for analysis. If the current company strategy has the potential to lead their innovation to disrupt an industry, what could result in relevant earnings and long-term success. The opposite is also true; a product with no potential to be impacting could be reassessed for improvements. For example, Oxiot would realize the harmful effect on disruptiveness for not developing a robust business model and underdevelopment of supply chain would compromise the scalability of their solution. HelpBell could realize that the Box was a possible candidate for disruptiveness, but the duality of the business plan – B2C and B2B – was affecting the potentiality of the product. The framework has the advantage to points out what are the problematic points, what could lead to a strategy to improve it and regain disruptiveness.

A great caution must be taken on relying solely on the entrepreneur interview. The information must be carefully interpreted, with the necessity to filter expected biases on appraising the innovation and the company. Unfortunately, startup environments are very dynamic to be followed by distance. Since startups are very new to the market and their account books are not made public, there are no other available sources or information as complete as the interview. Still, the entrepreneurs are a valid source of information. They are aware of the difficulties of the market, on finding investors, on dealing with government agencies, on developing the supply chain, on creating innovative products and launching them into an incumbent dominated market, where newcomers are treated with indifference by large companies and suspicion from customers. Entrepreneurs are avid to share their experiences, mainly their challenges and are very talkative and proud when discussing their products.

Suggestion for future researches would be to find companies that were founded as startups but already reached a more mature stage and already have enough secondary data for confrontation. The application of the theoretical framework for other technologies besides mobile and industries besides health care would be another suggestion. Finally, from the interview with the entrepreneurs, the startup ecosystem in Brazil is still very small when compared to other countries. There are no incentives such as tax reduction for these companies. Government regulations also make it difficult to approve a product for the market

– some interviewed startups even chose a different area of actuation due to excessive regulations. A study on startup ecosystem in Brazil, under many regulated sectors such as health care, would be another topic for future researches.

8
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APPENDIX

A. INTERVIEW SCRIPT

The questionnaire below was used to guide the interview with the startup entrepreneurs. It was not a rigid question and answer format, but a conversation where the interviewed was encouraged to speak freely about his company, the startup environment, and his personal opinions. Only when a particular topic was not discussed, the interviewer asked the question to guarantee that all topics were covered. The questionnaire is presented in Portuguese, the main-language of both the interviewer and interviewed, and in English for reference.

A.1. Script in Portuguese.

1) Sobre a empresa:
    a. Quando a empresa foi criada?
    b. Quem são os fundadores?
    c. Em torno de qual ideia de valor ela foi criada?
    d. Qual é o seu principal produto/serviço?
    e. Há quanto tempo a empresa atua no mercado?
    f. Qual o tamanho da empresa? Faturamento? Número de clientes atendidos? Equipe?
2) Área de Atuação:
    a. Quais são as áreas de atuação da empresa?
    b. Qual a abrangência do mercado? Público-alvo?
    c. Tem parcerias?

   d. Prevê envolvimento com o setor público? O procedimento está listado para receber reembolso?

3) Modelo de negócio:
   a. Qual o modelo de negócio?
   b. Serviço? Produto? Ambos?
      c. Como a empresa gera valor para: Pacientes; Médicos; Outras instituições de saúde.
   d. Buscou-se incentivo? Alguma esfera do governo ajudou? Recorreu a aceleradoras? Tem relação com investidores?
4) Sobre inovação:
   a. Como ela se deu?
   b. Quem envolveu?
   c. Quais competências foram necessárias?
   d. Quais tecnologias ela utiliza?
   e. Como lida com a segurança das informações?
5) Futuro:
   a. Quais resultados foram obtidos?
   b. É prevista a expansão do negócio? Dentro do Brasil? Exterior?
   c. Houve resistência durante a implantação da tecnologia?
   d. Quais as futuras tendências?

A.2. Script in English.

1) About the company:
   a. When the company was founded?
   b. Who are the founders?
   c. How did you come up with the product idea?
   d. What are the main products being offered?
   e. How much time is the company commercially operating?
   f. What is the company size, by: Income? Number of clients? Team size?
2) Field of Business:
   a. What are the company's fields of business?
   b. What are the market niches? Target-audience?

c. What about partnerships?
d. What about serving governmental services? Are the products listed for reimbursement?

3) Business model:
   a. Can you describe the business model?
   b. Is it based on a good? On a service? Or both?
   c. How does the company generate value for: Patients; Physicians; Other healthcare institutions?
   d. What about incentives? Has the government helped through special programs? What about accelerators and incubators? And the relationship with potential investors?
4) About the innovation:
   a. How did you come to it?
   b. Who was involved?
   c. Which competences were needed?
   d. What technologies does it use?
   e. How do you deal with information security, safety and privacy?
5) Future:
   a. What are the present results?
   b. What about expanding both inside Brazil and abroad?
   c. Was there resistance on implementing the technology?
   d. What are the future tendencies?