THE FUTURE OF THE HEALTHCARE INDUSTRY

How will digital transformation create better healthcare?

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Dissertation written under the supervision of André de Almeida Pinho

Dissertation submitted in partial fulfillment of the requirements for the degree of MSc in Business Administration at Católica-Lisbon School of Business & Economics

June 2019

Abstract

Title: The future of the healthcare industry: How will digital transformation improve care delivery?

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Keywords: Healthcare Industry, Stakeholders, Technology, Opportunities.

This dissertation focuses on the analysis of the opportunities raised by emerging tech dynamics to improve care delivery. Specifically, it focuses on assessing its impact in the main healthcare activities covered in the prevention and diagnosis stages through the lens of three main stakeholder groups - the patients, the health professionals and the health service's experts.

In order to reach these objectives, an exploratory and qualitative research was conducted through the analysis of primary and secondary data, collected from existing literature and semi-structured interviews with the considered stakeholder groups.

The conclusions suggest that tech dynamics can bring significant impact to the healthcare industry through three main key applications: (1) information generation, which have a major impact in the activities covered in the prevention stage; (2) information treatment, impacting both activities covered in prevention and diagnosis; and (3) experience improvement, mainly useful in activities that require in person interactions. By applying the tech dynamics into medical practice, the stakeholders may benefit from enhanced user experience, productivity and cost reductions which ultimately has a positive impact into the improvement of the quality of care delivered. Moreover, this impact is extended through other stakeholders in the life-science such as insurance companies and pharmaceuticals.

Sumário

Título: O futuro da indústria da saúde: De que forma é que a transformação digital pode melhorar os cuidados de saúde?

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Palavras-chave: Indústria da saúde, Partes interessadas, Tecnologia, Oportunidades.

Esta dissertação centra-se na análise das oportunidades que surgiram do desenvolvimento de novas dinâmicas tecnológicas no sentido de melhorar a prestação de cuidados de saúde. Em concreto, tem como foco a avaliação do impacto destas dinâmicas nas principais atividades médicas, desde a prevenção até ao diagnóstico e incluindo os três principais stakeholders - pacientes, médicos e administrativos. Neste sentido, foi realizada uma pesquisa exploratória e qualitativa com base na análise de dados primários e secundários, dados estes que foram recolhidos através de entrevistas semi-estruturadas com os stakeholders acima identificados e segundo a literatura já existente relativa ao tema. As conclusões sugerem que estas novas dinâmicas podem resultar num impacto significativo para a indústria da saúde através de três principais aplicações: (1) geração de informação, que tem um grande impacto nas atividades abrangidas pela fase de prevenção; (2) tratamento de informação, que impacta as atividades abrangidas pelas fases de prevenção e diagnóstico; e (3) melhoria da experiência do paciente, que é principalmente relevante nas atividades com maior interação pessoal. Com a aplicação destas dinâmicas tecnológicas na saúde, os diferentes stakeholders podem ser beneficiados através de: uma melhor experiência para o paciente, uma maior produtividade e reduções de custos que, em última análise, tem um impacto positivo na melhoria da qualidade dos cuidados prestados. Adicionalmente, estes impactos abrangem ainda outros agentes ligados à indústria da saúde, tais como companhias de seguros e farmacêuticas.

Acknowledgments

This dissertation was the culmination of 5 years of academic commitment that have mostly contributed to my personal development. Therefore, my sincere acknowledgments go to all the professors, staff and colleagues from Católica-Lisbon, which have crossed my path and shaped my personal and professional growth. My foremost gratitude goes to André Pinho, this dissertation supervisor who has always and patiently encouraged and challenged me to look at things from different perspectives, beyond what I thought to be a dead end.

Finally, my gratitude goes to my family and friends who have closely accompany, guided and supported me throughout this journey.

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Chapter 1: Introduction

1.1 Background

In the second half of the twentieth century, Joseph Schumpeter, the renowned Austrian economist, popularized the term "creative destruction" to designate the transformation that accompanies rapid innovation. In recent years, companies across all industries have been taking initiatives to explore the opportunities brought by new technologies. Such transformation encompasses key business operations, making it urgent to establish contextualized organizational and strategic management practices (Matt et al., 2015).

The cumulative effect of extraordinary innovation that exploits digital information has turned our world upside down (Topol, 2012), but the most unpriced part of our existence - our health - is still far from maximizing the benefits from the imminent transformation.

The healthcare industry is characterized as being a very conservative one; and its resistance to change comes from all stakeholders – from physicians, to drug and medical equipment producers, to regulatory government agencies and perhaps even ourselves, the consumers – all have contributed to undermine the life science industry from breaking into the vast possibilities offered by the digital revolution.

There is however, one trigger, which may prompt the start of such creative destruction - for the first time in history, we can now digitize humans (Topol, 2012). Digitization is the transformation of any form of analog information, such as text, images, sound or physical attributes to a digital format. That information can then be processed, stored, and shared easily through digital devices and networks (Ng and Wakenshaw, 2016). There is a widespread perception that all information today is easily digitized and widely transferable. But rarely do we pause to think what it would actually mean to digitize information provided by our own body? "Digitizing a human being is about determining all of the "life codes" of one's genome, is about being able to continuously monitor our heart beats, blood pressure, the rate and depth of breathing, body temperature…" (Topol, 2012) and the list goes on. All of this information is available thanks to the latest technology out there: wearables and wireless biosensors (incorporated with IoT technology), genome sequencing, smartphones etc., but more importantly it is also ready to be integrated with all the traditional medical data, which would allow it to be constantly updated and monitored. These are the tools which form the solid ground to enter the new era of medicine, an era in which we are close to be fully defined and identified at an individual level, resulting in a shift in the way

medicine is practiced at a macro level, eg. with mass screening policies for peculiar conditions or with consistent prescriptions of the same medication and dosage for a given illness, rather than needing an individual diagnosis. This may represent the next and most important frontier of the digital revolution - preserving our health.

1.2 Problem statement and research questions

The present dissertation intends to give an overview of the future of the healthcare industry.
In particular, it aims at accessing the emerging tech dynamics and its impact on the main healthcare activities (medical process steps) covered in the prevention and diagnosis stages; as well as to evaluate the opportunities of such impact, through the lens of three main stakeholder groups - the patients, the health professionals and the health service's experts. The following research questions were considered:

RQ 1: Which are the tech dynamics and what is their impact on the medical process steps covered in the prevention and diagnosis stages?

RQ 2: How can the identified tech dynamics be an opportunity to improve care delivery in the prevention and diagnosis stages, through the lens of three stakeholder groups: patients, health professionals and health service's experts?

1.3 Scope of analysis

The scope of this dissertation is mostly focused in healthcare services that are capable of providing care in the areas of study - prevention and diagnosis - such as hospitals, since they are the primary link between the users and the considered medical process steps. However, this work extends its conclusions regarding the tech impact, to other players in the life science industry, such as pharmaceuticals and government.
Accordingly, the insights drawn apply to any current or potential stakeholder operating in the prevention and diagnosis stage of the healthcare industry interested in accessing strategic insights (as opposed to technical), meaning that the research focuses on the business strategy side of this technology deployment.

1.4 Relevance

Regarding the relevance of the topic, despite being clear that technology and innovation has transformed many industries, healthcare, due to its human-sensitive nature remains slow in changing, casting aside several opportunities to improve patient care. This research is relevant, not only for its innovation in the academic background but also for the understanding of the technological opportunities through the lens of three different stakeholder groups. This research allowed to uncover the patient's opinion on the topic; the health professionals' concerns and ultimately give a glimpse into the landscape faced by the business executives operating in the health services, from their own perspective. Such consolidated overview will be able to grasp which tech dynamics may be most impactful for each stakeholder group given their specific context, challenge and objective. In fact, the pertinence of this topic extends to anyone interested in technology and the healthcare industry since it intends, besides analyzing the technology's potential for an overall better care delivery, to provide insights on the industry, predicting how it may evolve in the future.

Chapter 2: Literature review

2.1 The healthcare industry: its past, present and future

Brief overview

In the past decades, the healthcare industry has evolved significantly (Marjoua and Bozic, 2012). If we look back at disruptions from the past – namely the work of Ernest Codman, a surgeon who was a pioneer in the creation of hospital standards and in the implementation of strategies to evaluate healthcare service outcomes - they continue to contribute to the care delivery we have today. Currently, different drivers and needs in healthcare-related services call for change - the increase in competition, the empowerment of the patient and the need for an efficient and effective health delivery has led healthcare organizations to redesign their patient logistics and to vertical integrate their businesses (Aptel and Pourjalali, 2001). During the gradual evolution of care delivery, efforts have been undertaken to align stakeholder interests and even attempt to transition to data-driven models (Marjoua and Bozic, 2012). Indeed, some of those efforts have already produced positive outcomes for patients, including IT infrastructures that enable patients to send their wearable data directly to their doctors for real-time monitoring (Kunst et al., 2018).

Although the healthcare historical ladder has proven to give productive steps towards overall care improvement (Marjoua and Bozic, 2012), concerns regarding the quality and cost structure of healthcare is putting pressure on stakeholders to rapidly find innovative solutions (Putzer and Park, 2012). Such urge has mainly to do with the aging population and the fact that people will live longer, will soon result in the increasingly need for treating elderly-related diseases (associated with high costs) which the current health system cannot bear (Putzer and Park, 2012). One specific challenge regarding cost minimization, is related to problems of underuse, overuse and misuse of health resources. There are multiple underlying causes and they include for example, “the accountability of processes, structures, and outcomes that only diffusely inform objectives without necessarily improving care, or the existence of insufficient information on healthcare outcomes” (Marjoua and Bozic, 2012) therefore resulting in the lack of efficacy in the use of resources. Emerging technologies can play a major role in helping to address these and other problems by lowering healthcare costs, reducing medical error rates and by improving the overall quality of care delivery (Putzer and Park, 2012).

2.1.1 Information-intensive healthcare nature

When information is being shared on an interaction between a health provider and a patient, the primary objective is to accurately understand the patient's problem. The main task of a patient is that of information giving - that is, to share all relevant information about the problem with the health provider (Serrano and Karahanna, 2016). In contrast, health professionals take the role of information-seekers. Their ability to elicit and gather all the important information is considered one of the key elements of clinical competence (Epstein and Hundert, 2002). In this process of exchange of information, technology can play a major role in collecting larger and more reliable sets of patient data which will improve medical evaluations (Serrano and Karahanna, 2016).

From a business-process point of view, healthcare is an information-intensive activity. Indeed, there are only two types of actions in this industry: "medical procedures to support diagnosis, therapy, or disease prevention; and, the acquisition, use, communication, and storage of information" (Masys, 2002). Therefore, it is fair to infer that variations in the quantity and availability of information would have tremendous impacts on healthcare operations.

In healthcare, data consists of primary facts and observations that are acquired while providing care services, such as the numerical value of cholesterol in an individual or the family history regarding a specific disease. Data is then transformed into information, which can be systematically organized and analysed in order to produce knowledge, which is the understanding of real-world situations (Masys, 2002). This process (data-information-knowledge) sets the framework upon which "healthcare professionals base their decisions about individuals, comparing the person-specific data and information with the science base of what is believed to be generally true about human health and disease" (Masys, 2002).

Information technologies

E-health is the application of information and communication technologies to health care. Information technologies are meant to help in communication, sharing and tracking of patients' care and health information systems (HIS) to facilitate the internal and external coordination of medical care (Jawhari et al., 2016). "A HIS is defined as a system that captures, analyzes, processes and uses health information to inform decisions and improve quality of care" (Jawhari et al., 2016).

Despite the potential of technological help in improving care delivery, physicians, other healthcare professionals and industry experts have showed resistance and slowness to accept and use such technologies in their medical practice (Khalifa, 2013). Possible barriers that may have contributed

to the delay in the adoption are human barriers, including negative beliefs, behaviors and attitudes of healthcare professionals towards such systems (Khalifa, 2013).

In fact, criticism has been made to healthcare professionals regarding the lower degree of usage of information technologies when compared to other professions. Existing studies suggest that less than 10% of physicians are using such digital tools in their medical practice (Putzer and Park, 2012).

2.1.2 The patient is changing

In the first decade of twenty-first century, while scientists were focused in discovering the genomes' zip codes, engineers were constructing the wireless phone platform to add on features like camera, email, and access to the internet. At the same time, the bandwidth of the internet was rapidly expanding, enabling the ability to rapidly search for anything we want, anywhere (Topol, 2012).

According to a survey of internet users done in 1997 (Masys, 2002), 65% of the respondents had sought out health information at least once in a year, and more than a third used the Internet to find health information regularly (Masys, 2002). With successful health-informative websites emerging, such as PatientsLikeMe, and ZocDoc, this trend should only continue to increase (McKinsey & Company, 2017).

As the knowledge and health awareness about oneself increases, the patient is progressively moving from a stage of being an informed activist to become the decision maker in its own medical diagnosis and treatment alternatives, whereas healthcare professionals are instead assuming the role of ´tech support´ to explain medical terms and complex concepts to internet-savvy patient-consumers (Masys, 2002).

The shift from the traditional "doctor knows best" model is emerging. However, it is yet far from complete. Despite of the rising number of empowered consumers, there is still a fraction of the population who do not want to bear the responsibility of understanding the complexity of their health problems and just want the doctors to "take care of me" (Masys, 2002). The difference in the pace of adopting such technological mindset by the different users has been called a "digital divide," and it is far more a matter of literacy, motivation, and educational level than of access to information (Masys, 2002). Due to the sensitive nature of medical care, many industry experts believe that patients don't want to engage in digital services. But in fact, the slowness in patients' digital adoption in healthcare has to do with the fact that existing services don't meet their needs or because they are of poor quality rather than the patient's own unwillingness to adapt (McKinsey & Company, 2017).

2.1.3 The shift in the healthcare focus

Healthcare is evolving to a new world of patient choice and focus on outcomes and value. In fact, healthcare services that have traditionally focused on medical interventions with the patient, is now shifting to a model of fully acknowledgement of exogenous factors - genomics, behavior social and new data sources - valuable to consumers and to deliver continual and better care (Cavlan et al., 2018). While the life science industry stakeholders - providers, governments, payers, consumers and others - are struggling to manage clinical, operational and financial challenges, technology is swiftly enabling new business models oriented to the capture and analysis of such real-world data to succeed (Deloitte, 2019). This vision can be enhanced by the participation from all stakeholders in shift of focus away from a system of treating the sick to one which supports wellbeing, prevention, and early intervention (Deloitte, 2019).

2.2 Tech dynamics impacting the healthcare industry

The following sub-chapter aims at identifying and assessing the emerging tech dynamics that are causing harm among healthcare best practices.

2.2.1 Patient generated health data

The traditional way of collecting medical data through in-person historical questionnaires and typical clinical trials does not quite fit an era in which relevant medical data is ubiquitous - available to be collected continuously, anywhere, at any time - by multiple sources, resulting thus, in a constant patient monitoring (Da Xu, He and Li, 2014). These emerging patient points of contact - sophisticated medical instruments, web or mobile based health communities, wearables - among others, have produced a vast database of healthcare related content (Chen, Chiang and Storey, 2012).

Patient generated health data (PGHD) is data created, recorded or gathered by patients, from a wide variety of available sources, that is valuable to help addressing a health concern (Advisory board, 2018) and has proven to be able to effectively complement the knowledge gained from traditional sources (Cavlan et al., 2018).

A breakdown and an in-depth explanation of the different PGHD sources is undertaken below:

Sensors and wearables

The internet of things (IoT) “is a network of physical devices and other items, embedded with electronics, software, sensors and network connectivity, which enables objects to collect and exchange data” (Dimitrov, 2016). Generally, IoT refers to the notion that many different ‘things’ are connected to the internet and thus can be connected to each other (O’leary, 2013). The high velocity at which IoT devices and objects are able to capture data continuously made it possible to generate huge amounts of data, that today we recognize as ´big data´ - which is characterized by its complexity, diversity and unstructured nature of generation - this type of data demands cost-effective and innovative forms of information processing in order to enhance insights and improve decision making (O’leary, 2013).

Intelligent sensors can provide accurate and on-demand information about the involved device or object and integrate it with wireless connectivity to better track ‘things’ [MM1] in real time (Da Xu, He and Li, 2014). In a more detailed explanation: “each physical object has a rich set of data on current and historical information about that object's physical properties like, its origin, ownership, and sensory context” (Ng and Wakenshaw, 2016).
“The tendency of connecting not only people, but also objects to the internet will soon result in an unimaginable repository of data” (Henry and Venkatraman, 2015). However, its capacity of providing insights into business problems, help on decision-making and even make suggestions as to when and where future problems will occur (predictive analytics), depends on its further in-depth analysis and on its ability to process outputs (Henry and Venkatraman, 2015).
A possible healthcare application coming from a non-healthcare player could be for instance a toilet paper manufacturer that, by integrating a sensor in its offerings, gives the user the ability to extract information about the state of the urine, which can then be used as a data-resource on the person's wellbeing to be analyzed, stored, or shared (Ng and Wakenshaw, 2016). Another example is Apple’s ResearchKit, in which users may allow the app on the connected device to access and then monitor, store and analyze oneself’s biometric data. The collected data can then be shared with healthcare professionals for multiple use cases: to test hypotheses on nutrition, fitness, disease progression or treatment success.

Mobile health applications

Related to the above mentioned transformation in customer behavior and enabled by high-speed internet and smartphones is the growing self-care trend - a lot of people have started to monitor and manage their many health needs and preventive efforts - eating habits, exercise, water consumption - among others, through smart watches and mobile apps (Dimitrov, 2016).

In fact, the smartphone - “a mobile telecommunication device with advanced features such as medical applications, word processing, internet access, and other computing capabilities” (Putzer and Park, 2012) has had huge developments in the last decade - voice, video, touch-screens, web 2.0 capabilities, multiple sensors integration and wearable devices - all of these have turned mobile devices into a possible channel for the delivery of healthcare services (Riccardi, 2016).
This channel has been growing and it’s not expected to stop any time soon, having already a vast number of health apps in a variety of languages and domains (mental problems, self-diagnosis, heart-monitoring, etc.). Such health applications are able to track user activity (eg. exercise and fitness apps) sleeping and eating habits (eg. calorie-counting apps) and provide all kinds of information on blood pressure, heart rate, skin temperature, speech, location, movement, etc., while being constantly connected and communicating with its users through multimodal interfaces (Riccardi, 2016).
All of this new information fed by each interaction (or by constant connection) is relevant to enrich the user healthcare background.

2.2.2 Genomics

An important source of health-related data is genomics-driven (Mehta and Pandit, 2018). Genomic medicine is defined as the use of an individual’s genotypic information in his clinical care (Manolio et al., 2013). Genome sequencing enables physicians to detect whether there are functional variants in genes that may contribute to the development of diseases (Sander, 2000). Assessing disease susceptibility enables predicting responses to known drug types and, throughout a person’s life, risk identification diagnosis may be refined with more information through screening processes, leading to new and more accurate recommendations about the individual’s life-style, nutrition, and preventive initiatives overall (Sander, 2000).

Despite encouraging and intuitively positive, there are many concerns regarding the processual complexity of genomics. In practice, for this to happen it is implied that a generation, processing, and analysis of large data sets must be undertaken (Sander, 2000). The problem is that, currently, the ability to sequence is higher than that of interpreting the data extracted, which is characterized by the ability to distinguish the noise (irrelevant information) from the signal (functional variants that matter) remaining thus, a big challenge to overcome (Topol, 2012).
However, physicians believe that once genome sequencing is practical and affordable it will be increasingly difficult for diseases to be left undetected (Topol, 2012). The result will be a quantitative and predictive understanding of life processes, from molecular detail to macroscopic

phenotype, that is a new predictive biology. Therapy would therefore be personalized, taking into account the patient's history and details of his molecular health profile. This predictive behaviour will potentially result in much smaller need of performing routine examinations at healthcare delivery centers (Sander, 2000).

Real-life examples of relevance and practicality

In 2000, the first draft of human genome sequence was achieved by scientists and, on a ceremony held in the white house, Bill Clinton said: "Today we are learning the language in which god created life...It will revolutionize the diagnosis, prevention and treatment of most, if not all, human diseases. It is the most important, most wondrous map ever produced by humankind" (Topol, 2012). How will then, the knowledge about one's genome prevent diseases and help to keep one healthy?

The topic of personal genomics earned wide attention when, in 2007, companies like Navigenics commercialized genome-wide scans for the public. The final results report shows all the disease susceptibility a user may incur in (Topol, 2012).

A case study of genome sequencing promising success, describes the story of a patient whose risk of having prostate cancer was double the average value; and even in a situation which at the time would not justify the prescription of the exams needed to screen such disease (according to the standards medical procedures), thanks to a DNA test he had the screening done that confirmed he had prostate cancer, which we would not have known otherwise (Topol, 2012).

Improvements in the quality of life are promising, as soon as prognostic genotyping and diagnostic molecular profiling are used in routine medical practice (Sander, 2000).

With regards to the importance of such findings for other stakeholders from the life-science industry, it is major also for pharmaceutical professionals, for instance; Each individual's DNA has its particular components and susceptibilities, therefore each patients' response to drug administration is remarkably variable (Beijer and de Blaey, 2002). "An adverse drug reaction (ADR) is defined as a harmful, unintended injury which emerge from drug related causes." Such injuries often result in longer hospital stays and additional drug therapies, hence, resulting in more costs incurred (Pirmohamed et al., 2004). ADRs account for 5–10% of all hospital admissions and most of them could have been avoided (Beijer and de Blaey, 2002).

An example of the infectivity of mass drug development is the standard treatment for Hepatitis C, one of the most significant health problems globally, affecting 3% of the planet's population,

which only works in approximately 50% of the people who takes the drug (Topol, 2012). Genomics-driven medicine have helped in detecting (and preventing) risk factors that influence a patient response to a medication (Topol, 2012), therefore contributing to improvements in overall care delivery.

2.2.3 AI, as medical assistant

AI as it is commonly referred, arises as a possible answer to the processing demand of analysing the data captured. There is no single definition of AI, if we break the term in two words, everyone understands the "artificial" part of it, but what about "intelligence"? And one could even consider an intelligence that is artificial? (Legg and Hutter, 2007). Is AI mathematics? Linguistics? Software engineering? Psychology? AI can be all this, it all depends on the objective with which it is being used (Wang, 2008). In a broader perspective, Schank (1987) defined AI as "the science of endowing programs with the ability to change themselves for the better as a result of their own experiences" whose primary goal is to "build an intelligent machine" and secondly it is to "find about the nature of intelligence".

As healthcare data grows bigger along with the development of big data analytic methods, successful Artificial Intelligence (AI) applications in this business have been recently emerging (Jiang et al., 2017). AI uses sophisticated algorithms to 'learn' features from a wide volume of data, and then apply the extracted insights to assist clinically. More specifically, AI systems can help on diagnosis by analyzing data from imaging, genetic testing and electrodiagnosis (Jiang et. al., 2017), among others. Additionally, AI techniques can be programmed with learning and self-correcting skills based on feedback, which helps improving accuracy and reducing diagnostic and therapeutic errors that are inevitable in the human clinical practice (Lipitakis, 2017). Algorithmic methodologies are given "data teaching sets" and then use this data to answer specific questions. These "teaching sets" can add to one another, thus developing each time a stronger programming tool that can aid different tasks over time (Lipitakis, 2017). What does this mean in practice? If a patient allows access to his data, the experience is as follows: demographic and clinical data are collected (images, electrophysiology test results, genetic results, blood pressure, medical notes and so on) into the AI system, which later makes clinical suggestions that are sent to healthcare professionals to assist them in their decision making. The system will learn with feedback and improve results for the next evaluation (Jiang et al., 2017).

While the optimists say AI programmed "doctors" might eventually replace human physicians in the future, some believe that this won't happen in a foreseeable future. However, AI can definitely

assist healthcare professionals to make better clinical decisions or even replace human judgement in certain functional areas of healthcare, as radiology (Jiang et al., 2017).

2.2.4 Virtual assistants

New medical services such as health advisers have been rising from all the mentioned opportunities. Such a middleman doesn´t have necessarily to be a healthcare service provider but would help others to better acknowledge their own medical conditions, as well as give guidance to which medical counseling is most appropriate (Masys, 2002).

The emergence of Virtual Assistants (VA) is just other example of how AI systems can assist in medical activity, thus transforming the interaction between patients and medical services. Based on Artificial intelligence programming, "VAs have the ability to interpret natural language via spoken interaction and providing responses either in the form of a software program execution (e.g. opening the contacts folder) or a spoken response (question answering)" (Riccardi, 2016). In regards to how far artificial intelligence goes, the span of supported questioning is quite large and varies from factual questions such as "what should I take for headaches?" to more situational questions like "where is the nearest hospital?", where such circumstancial questions are enabled by the VA access to phone sensors (GPS, user agenda, etc.) while factual questions are assisted by third party services like Google search (or similar) (Riccardi, 2016).

These VA have many possible use cases, such as keeping track of the patients' medical activity by ensuring he/she is taking his/her medicine on time. Typically, they don't produce biometric data, instead VA give back information (informative or evaluative) regarding patients' inputs. However, the storage of the patients' history has relevant content that contributes for improved medical evaluations (Riccardi, 2016).

New paths are yet to be explored, nevertheless it is clear that such dynamics have a direct impact on the quality of life and health of people by disrupting the current models of delivering healthcare services (Riccardi, 2016).

2.2.5 Telemedicine

With remote sensing capabilities available and the ready video chat accessibility, remote visits could soon replace the routine physical ones (Berwick et al., 2008). Telemedicine enables the delivery of medical services by being able to evaluate the clinical condition of a patient remotely

(Berwick et al., 2008). In order to successfully deliver medical services remotely, conditions must be set to (1) enable clear communication to leverage effective information sharing and (2) have the sensory information needed to perform relevant physical evaluations (Serrano and Karahanna, 2016).

There is already a record of initiatives regarding telemedicine implementation across healthcare institutions in developed countries. Indeed, the Norwegian Ministry of Health has recognized telemedicine legitimacy to effectively deliver care, and hence have had a leading role in supporting politically and financially its further development and application (Hartvigsen et al., 2007).

By 2006, experiences in vast telemedicine activities have been applied in Norwegian health systems in order to study its applicability and success - teleradiology, teledermatology, tele-otorhinolaryngology (remote endoscopy), telepsychiatry - among others. Results have shown improvements in economic metrics - less travel costs by both physicians and patients, less hospital admissions and time spent by health practitioner - and qualitative metrics - more time for other tasks, patients' comfortability and empowerment, competence in medical activities, professional confidence and efficient use of resources (Hartvigsen et al., 2007).

These experiences, however, are today considered traditional telemedicine applications, whereas more recent efforts have focused on how to explore telemedicine to support patients with tools that will enable them to take care of their own health, ultimately in the hope of promoting the shift to disease prevention (Hartvigsen et al., 2007).

2.2.6 Tech enablers

Because of the variety of emerging health data sources, each one with different software and interfaces, an urgent call for an effective interoperability (the operational ability to exchange and use information) is necessary to maximize the use of the available information into medical practices (Tyndall, 2018).

Application programing interface (API) appears as a solution to this problem. An API - "increases usability by specifying shared application program interfaces to enable structured queries regardless of the participating systems" (Tyndall, 2018). To simplify, APIs enable the data generated by the different sources (with different software from origin) to be used and integrated with one another. It works like a piece that must be in the center so all of health data sources can be integrated to into medical practice. A visual representation of how an API works across a connected world is below.

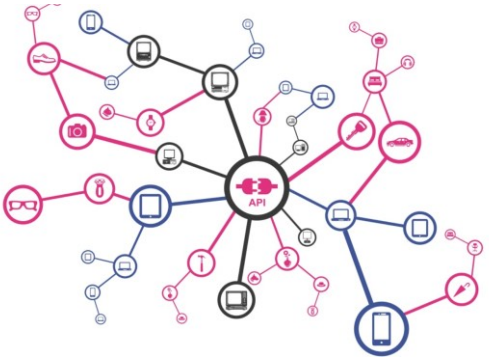

Figure 1 - API network
Source: Fabernovel 2014

Once data is integrated, cloud computing (CC) plays a major role in its process and storage. In simple, CC, is a digital infrastructure that allows for data storage and data processing to happen outside its origin device (eg. medical equipment, mobile phone...). Such capability has enabled all the data coming from the emerging sources (sensors, mobile health applications…) to be easily accessed (Dinh et al., 2011) and possibly used in medical practice.

In healthcare, an example of CC application is the Electronic Medical Records (EMR) which are patient data centers in the cloud that have been recently magnified for their ability to store, transport and exchange of all patient medical data in comparison to paper records (Jawhari et al., 2016). These tech enablers are crucial to implement all the above technologies into medical practice.

2.3 Conclusions - Humans and Machines

With the continuous production of data by both, humans and machines, the amount of data available is much more massive than at anytime in the past (Hardgrave, 2013). Because of this, the need to avail technology as a full-time assistant to human actions and decision making is crucial. In fact, this urge had been noticed quite a long time ago. For instance, the term Internet of things (IoT) was initially developed in 1999 to hypothesise the following situation: "Today computers – and, therefore, the Internet – are almost wholly dependent on human beings for information. The problem is, people have limited time, attention and accuracy – all of which means they are not very good at capturing data about things in the real world. We need to empower computers with their own means of gathering information, so they can see, hear and smell the world for themselves" (Ashton, 2009).

As already concluded above, the adoption of innovative healthcare delivery methods has been unjustifiable slow. Resistance to change has result in an inefficient use of available resources to provide better healthcare. Part of this inefficiency is due to the lack of accessibility in available

knowledge. In other words: “in healthcare, as much as, or more than, in other human endeavors, knowledge is power and the redistribution of access to knowledge will mean an inevitable redistribution of power over the decisions that affect the delivery of healthcare services” (Masys, 2002).

Chapter 3: Methodology

3.1 Research methods

With the aim of answering the research questions mentioned in the introductory section, this research engaged in an exploratory approach, using both primary and secondary data.

An exploratory research is generally conducted in order to gain in-depth knowledge on a specific problem with the aim to then extract insights to identify relevant courses of action.

A qualitative approach to the research was also used due to its ability to fundamentally comprehend and extract meaningful insights on the stakeholders' drivers, concerns and behaviors towards the topic of digital practices in the healthcare experience that could not be measured in a quantifiable manner.

The research is based on two methods – the collection and analysis of (1) secondary data and (2) primary data. Secondary data is mostly presented in chapter 2, the Literature review, although additional secondary data is also used throughout chapter 4, hence contributing to sustain a core part of the findings. This data is mainly composed of published materials (existing literature) and research from well-known entities. Primary data is gathered through the development of semi-structured, individual in-depth interviews to the industry's considered stakeholders: patients, health professionals and health service's experts.

3.2 Data collection

Secondary data

The secondary data was collected to obtain the theoretical backdrop that sustains a core part of the answers to research questions. The literature review started off by giving an overview of the healthcare industry - its past, present and future. The discussion continues by assessing the potential impact of current and future tech dynamics on the healthcare industry and ends with a conclusion regarding the merge of the two. Additional secondary data is further used in the results' analysis.

Primary data

After establishing a solid ground to answer the research questions, the research extends its thoroughness by gathering primary data. A total of 20 semi-structured in-depth interviews with patients, 4 with health professionals and 2 with health service's experts were conducted in the main areas of Lisboa and Porto in Portugal. These interviews were mostly held on the streets and in hospitals. This step aimed at gathering real and concrete insights regarding needs, concerns and

beliefs from the lens of the three stakeholder groups: patients, health professionals and health services experts, in order to complete the foundation to the answers to the research questions.

3.2.1 Interviews

The interviews were conducted based on an interview guideline – detailed on, Appendix 1 – however, due to the fact that they were mostly held in a free setting in public places with unknown users, the conversation flow often encouraged the interviewee to talk freely within the proposed topics, which is more to result in sincere insights. The guideline is embodied with four main topics: (1) Stakeholder context questions - consists of 4 general questions, aiming to screen the interviewee in terms of digital profile in a healthcare context; (2) The patient and its health concerns questions - consists of 12 questions with regard to their overall thoughts on healthcare, digital tools, societal behavioral shifts and other relevant topics. These questions are meant to represent the user's own experience as well as, to perceive its overall opinion on the topic.
(3) The stakeholder and its relation with health services questions, applicable to all stakeholder groups - consisting in 3 questions aimed to grasp the stakeholder's opinion of the healthcare industry and in specific the services he resorts to, as well as to uncover what he values / what could be improved in said services. (4) The health professional/ industry expert and the healthcare transformation questions - consisting in 8 questions aiming at uncovering their daily struggles, concerns and thoughts on where the future of healthcare is headed.
The interview main insights summary can be found in Annex W. In Appendix M, Annex J, the full main insights on each interview are detailed.

3.2.2 Participants

The interviews were conducted with patients, health professionals (such as doctors) and industry experts. The patients and health professionals enquired had between 20 and 75 years old, all of which had a smartphone in their possession and were, at least, engaged with basic social network mobile applications. As far as the health professionals are concerned, interviews were conducted with doctors, nurses' psychologists and pharmaceutical experts. Finally, as for the industry experts, whose individual details are summarized in the table below, the main findings from each interview can be consulted in, appendix 2.

Participant #	Name	Company	Country	Activity	Position
Participant 1	Marisa Morais	Hospital da Luz	Portugal	Healthcare	Marketing Director
Participant 2	Miguel Martins	José de Mello Saúde	Portugal	Healthcare	Healthcare Manager - CUF Cascais
Participant 3	PNS*	Pfizer	Portugal	Pharmaceutical	Quality Controller

Table 1: Participants' description.

*PNS - prefers not to say

Chapter 4: Analysis and findings

Aim of the analysis

The analysis aims at assessing the impact of the tech dynamics (first-identified in chapter 2) in the different medical process steps through the lens of the stakeholder groups considered. The following sub-chapters present the opportunities and challenges to which each tech dynamics can provide significant change or improvement.

4.1 Introduction to the tech dynamics

In order to provide the answer to the first part of research question 1, the following subchapters aim at analyzing the potential impact from each tech dynamic into the healthcare industry. The different techs are clustered within three main key applications - information generation, information treatment and experience improvement - Accordingly, throughout the analysis these clusters are considered.

4.1.1 Cluster 1 - Information generation

The cluster information generation includes all tech dynamics whose impact affects directly the quantity and availability of health-related information that is relevant to patients' evaluation. There are two tech dynamics considered in this cluster - patient generated health data and genomics. An in-depth understanding of each is done below.

PGHD

The importance of PGHD lies primarily in the fact that it enables continuous patient monitoring. By constantly providing health professionals with patients' information, they will have a more comprehensive view of the user and therefore will be able to deliver a better and more personalized response. Secondly, it represents the democratization of data capturing and control: while health providers used to be almost the only ones producing and storing medical data and using it for care delivering, PGHD has empowered consumers and other stakeholders with the same capability, turning the traditional health services data model less powerful and valuable alone (Ng and Wakenshaw, 2016). So, who has the power to produce and control health-related data after all? The fact is that any object embedded with IoT sensors or any other source of content creation available to consumers which can provide information on the user current state in the medical landscape is relevant - this can be smart watches, toilet papers or the clothes we wear every day; It can be the mobile apps we use for exercising or calories counting. Such multiple data sourcing

will perhaps be able to tell how the patient is feeling and why (Chen, Chiang and Storey, 2012). This means that those potentially non-health-related players have now power over information that is highly valued to healthcare providers and other stakeholders. Insurance companies, for example, can highly benefit from having access to a patient's biometric data to more precisely determine risks and adjust premiums, hence reducing costs. Users on the other hand, get tailored insurance products based on their routines and wellbeing.

PGHD Example

A practical example of this democratization is Dip UTI, which offer users a kit to test their urine at the comfort of their homes. When all the indicated procedures are done, the user scan the dipstick with his smartphone camera. The sample is sent to clinical specialists which will assess the results. Finally, users can get medication prescription if necessary. This is an example of how an emerging service can go over health providers and offer users with a better experience.

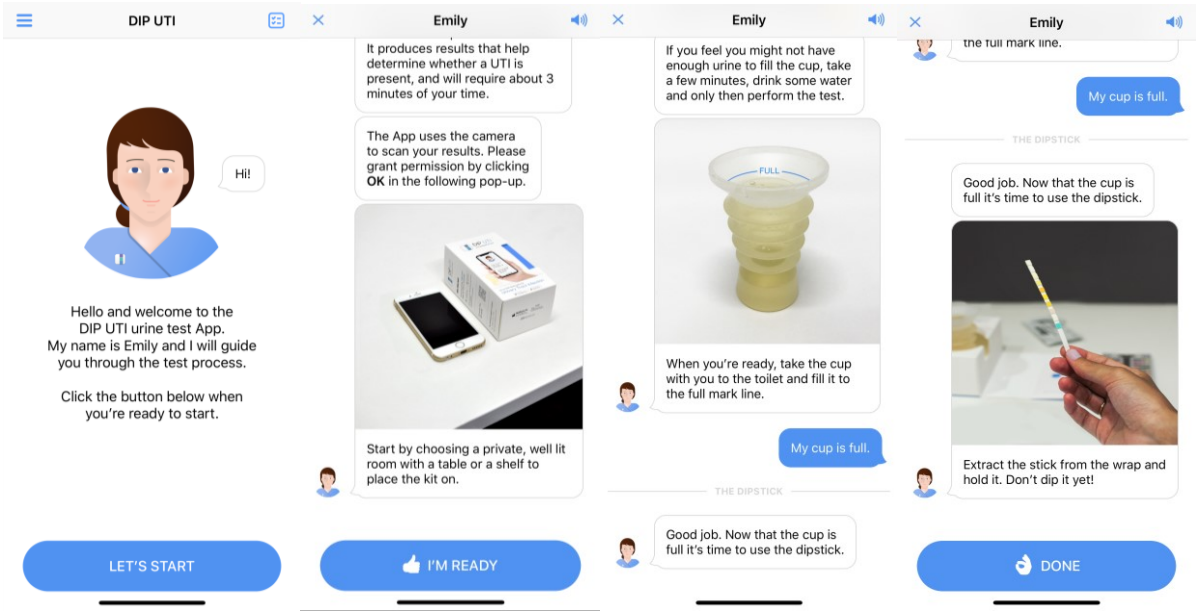

Figure 2 – Dip UTI interaction
Source: Dip UTI mobile app

Genomics

Acknowledging something early in life that someone might be substantially predisposed to, and having the chance to adjust one's life to reduce the odds, perform and support research into such diseases long before they come into effect brings to the world a completely disruptive view of how healthcare should be delivered. Naturally, the access to a patient's DNA will bring highly

relevant information to all medical activity, and other stakeholders from the life science industry. For instance, genomics driven medicine has helped in detecting and preventing risk factors that influence the response to a medication hence providing significant impact to pharmaceuticals. It may result in a shift from developing drugs to the masses, towards a personalized and effective drug creation, contributing to an overall care delivery improvement.

4.1.2 Cluster 2 - Information treatment

The second cluster considered regards the tech dynamics impacting directly the treatment of health-related information. Such data treatment generally refers to the automation of processes which currently, mostly depend on human expertise. That is possible because of different Artificial Intelligence applications. In the analysis from cluster 2, two tech dynamics are considered - AI, as medical assistant and Virtual assistants.

AI, as a medical assistant

In contrast to human capabilities for decision making, AI systems can provide advantages in speed, capacity, quality, and consistency. Through its ability to manage vast data sets, AI systems can add to human expertise and support medical teams on interpreting the emerging ubiquitous data. Moreover, they are able to learn with experience resulting in a growing evaluation function. A possible application to AI is in radiology practices in which typically, physicians visually assess medical images for the detection, characterization and monitoring of diseases. AI methods can automatically recognize complex patterns in imaging data and provide assessments of radiographic characteristics, hence mostly substituting the role of the human performance in the task - interpreting - towards that of explaining the outcome. Such automation will ultimately result in cost advantages.

Virtual assistants

AI is an essential element of chatbots (automated online chat helpful in customer support) and virtual assistants, it can help with screening patient conditions on mobile applications and provide the kind of support customers look for. With this ability VAs are transforming the way patients interact with medical services. An example of a VA is Ada - a personal health guide founded by doctors, scientists and engineers - it aims at helping users to understand their health and assess their symptoms. By its AI incorporated technology, it also supports clinical decision making, contributing therefore to the deliver of higher quality and more effective care (Ada health, 2019). A visual representation of an interaction with a Ada is below in figure 3

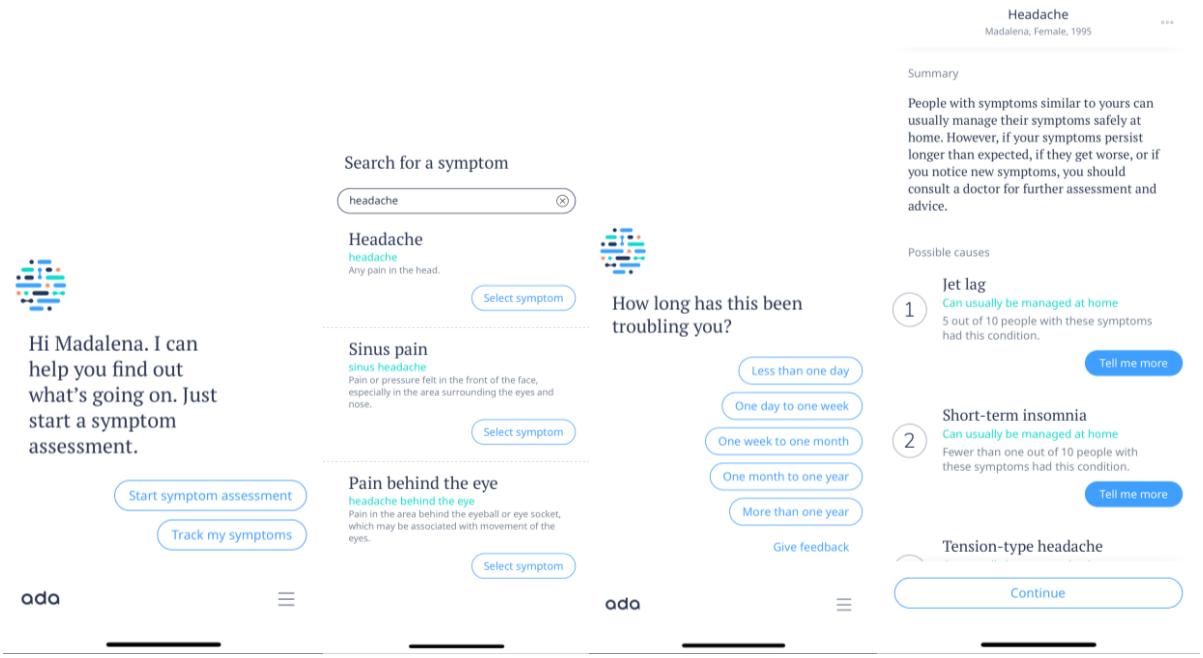

Figure 3 - Ada interaction
Source: Ada mobile app

4.1.3 Cluster 3 - Experience improvement

The final cluster considered has to do with the overall experience improvement to all the stakeholders involved.

Telemedicine

With the increasing ability to remotely assess a patients' diagnosis in a variety of domains, telemedicine provides solutions that are cost saving, more effective and convenient to all stakeholders. Telemedicine is also perceived as a kick start to provide and instruct patients with tools for preventive and wellbeing habits.

Example

An example of a telemedicine application is in dermatology. Goderma is a German platform (web and mobile) in which patients can pay to have a dermatology consultation remotely. The only thing they need to do is to upload the picture and so that the consultation with an expert and diagnosis may be held within 24 hours.

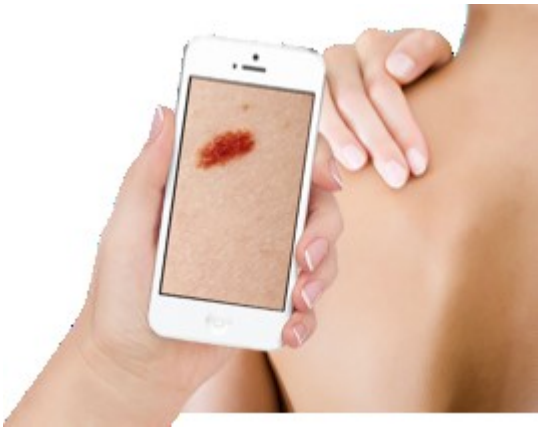

Figure 4 - Goderma example
Source: Fabernovel

4.2 Tech dynamics value capture in Stakeholders

As the interviews suggest, each stakeholder group has different problems, needs, concerns and beliefs regarding healthcare and its future orientation. In order to assess the opportunities and challenges tech dynamics bring and to provide the first line of conclusions for answering RQ2, an in-depth analysis across each different stakeholder was undertaken. Each stakeholder's analysis contains the impact level brought by each tech. Such was measured by the extent to which the tech covers the need. Accordingly, Impactful - provides change to some of the need extent; Quite impactful - provide change to significant part of the need extent; Very impactful - the impact fully covers the need extent (explained in each stakeholder group analysis).

4.2.1 User's perspective

Human-centered strategies have been used for decades by organizations to create new business solutions. With the arrival of the digital era, companies have been paying more attention to such approaches in the seek of rapid innovation (Brown, 2008). The reason why it is called Human-centered is because it starts by examining the problems, needs, and behaviors of the people affected by the solution.

Main findings from the interviews

The patient and their health concerns

Most of the interviewed admitted that their concerns about health issues have been increasing recently, mainly because of the intense information flow leveraged by digital technologies (eg. internet access). With regard to that concern, on a regular basis, 80% of the respondents mentioned they try to have healthy eating habits and practice sports. Those above 40 years old (60%),

mentioned they do exams on a regular basis to make sure their biometric data is within the desirable value range.

According to the results, 90% of the interviewee searches for health-related content on the internet in order to gather more information on their symptoms and possible diagnosis.

Out of those 90% of people looking out for explanations on the internet, 30% is conscious about the fact that the information found may not be reliable or applicable to their specific condition, hence resulting in unnecessary worries. Because of this, it is expected that the growing informed population will increasingly demand in-depth explanations from the health professionals rather than treating and medicating only. The higher expectation on physicians coupled with the patient increased knowledge, may result in diagnosis questioning and in challenging the doctor's opinion. However, there are naturally many people trusting the doctor and believing that this status quo will not ever change.

The patient's experiences with medical services

With regard to the current medical experience, the questions made aimed at uncovering the problems users face on their interactions with medical services. Results show that 70% of the respondents spontaneously mentioned that there is a dehumanized health service in the sense that there is a lack of worry with the patients, stating an interviewee, "people are numbers, the faster they move, the better"; 50% of the respondents said they feel abandoned after interacting with healthcare services and that the patient-service relationship should be permanent, suggesting a continuous track on the patient, from both the doctors and the administrative of the services in order to enhance customer relationships. Related with this feeling of unconcern is the lack of personalization, also spontaneously mentioned by the same users. They argued that it takes too long before any stakeholder on the health service side acknowledges who the patient is (if they do, at all). The disintegrated information about a person is a huge pain point on the user perspective resulting in unnecessary processes that are time and cost consuming.

Because of the limited resources (eg. medical equipment), the prescription of certain exams is restricted to a preset of medical standards. This means that, when a patient does not fit the criteria (apparently) the exam is not done. This situation is worrying 40% of the respondents which don't want to take the risk of missing an opportunity to diagnose a disease. Users understand that medical expenses are high and therefore resources should be thoughtful allocated, however there will always remain doubts on whether it was the doctor's misinterpretation of the initial screening. Because of these incidents they don't trust the doctor and medical services completely and call upon their own sources for double checking.

The patient and its digital habits

When asked about their digital involvement such as the use of wearables like smartwatches, health applications, or the overall acceptance of digital means to help on the prevention and diagnosis phase, there is a division among respondents: 50% showed great openness to whatever might come to improve the overall healthcare experience, while the second half showed some resistance in the adoption of such digital tools, simply because they seem too complicated. Although we find different digital profiles and adoption paces in disruptive health-related services (eg. Goderma, DIP UTI or ADA), there is common lack of trust in such services alone, making it crucial to have them integrated and recognized by medical services. The need and utility for a primary screening before deciding to go to the hospital was highly valued for time saving and convenience matters. Users showed curiosity on applications which are able to recognize eye or skin problems through their own smartphones, revealing they would use if they had the doctor confirmation of the quality and trustworthiness of such services. Suggestions on automated processes for scheduling necessary routine appointments, check ins and payments were made by some interviewed users. Moreover, due to the lack of time, some users mentioned that such autonomous service would leave them rested since the worry for appointment reminders or other health management issues would be now on the health services side and that would be enough to subscribe (and pay) such service.

Although few people mentioned they used mobile health applications, the ones who did, revealed they do so to help them manage their eating habits, steps traveled or sleeping levels. To those who use connected devices such as smartwatches, they also control other biometric data such as heart beats, calories, productivity levels, among others. All of these measures are preventive related and show that people are paying more attention to their health and trying to engage in healthier habits. One digital disadvantage pointed out by some users is the fact that they appreciate personal interactions in order to better communicate their problem and receive accurate and clear feedback.

In summary, when interacting with medical services or when facing a healthcare concern, users value/need:

Continuous tracking - User have mentioned they feel abandoned after interacting with medical services, urgently calling for a continuous track and attention by both, health professionals and services' administrative.

Personalization - Regardless of their digital profile and the data they are able to generate, users want their information integrated in the health service they attend so they can get personalized counseling.

Reliable/clear information - When searching for health-related information, users find it hard to filter all the information available to their specific condition. Content clarification is valuable to them since they want to become more active in their healthcare concerns.

Time saving - Users are discontents by time they waste between check ins, waiting times and payments. They urge for autonomous services in which such logistics are simplified and less time consuming.

Price - Many consumers have mentioned the expensive healthcare system as a huge pain point, resulting in limited service options for those who cannot afford private services.

Table 2 is a visual representation of tech's value capture from the users' perspective.

	CLUSTER 1		CLUSTER 2		CLUSTER 3
TECH / USER'S VALUE	GENOMICS	PGHD	VIRTUAL ASSISTANTS	AI AS MEDICAL ASSISTANT	TELEMEDICINE
CONTINOUS TRACKNING	X	XXX	XXX		
RELIABLE/CLEAR INFORMATION			XXX		XX
PERSONALIZATION	XXX	XXX	XX		
TIME SAVING			XX	X	XX
PRICE		X	XX	X	X

Table 2 - Tech value capture in users

Reading: X Impactful; XX Quite impactful; XXX Very impactful

Main findings from table 1

Patients' continuous tracking coupled with personalization are the user needs that can be most affected by techs in Cluster 1 and Cluster 2. More specifically, PGHD provide users with constant data measurements while VA may act as moderator to inform the user in case of alarming situations. This enables a personalized service for the user. It is expected that the price may be shortly reduced by each tech involved, since they contribute to leverage preventive healthcare and process automation hence resulting in cheaper care delivery.

Looking vertically from the tech side, VA play the major role in providing improvement to all the user's needs. Besides the above-mentioned impact, they provide information that is reliable and personalized to the patient specific condition, hence resulting in time and money saved in unnecessary medical appointments. When it comes to the experience improvement, telemedicine contributes for time saving and to get clear and reliable feedback. As expected, AI as medical assistant does not affect much the user, except for possible benefits regarding time and money savings.

4.2.2 Health professional's perspective

Once we have identified what are the patient's needs (value) it is crucial to look at the tech impact through the lens of health professionals. By evaluating relevant problems raised by physicians when performing their jobs, the analysis is being enriched and sharpened to its ultimately goal - access tech dynamic's impact to deliver better healthcare.

Main findings from the interviews

The health professional and their daily struggles

With regard to the problem's health professionals face in their daily basis when delivering care to a patient, the respondents mentioned the patient's empowerment as being a double edge sword Because of the access to information, some discomfort within the medical community has risen. On the one hand, health professionals recognize and value the fact that people are more aware of their medical condition since it leads to preventive course of actions and typically improves problem communication. However, on the other hand, the fact that most users take all of the information found on the internet as being generally true and applicable to all, physicians find their job of explaining a diagnosis or a treatment choice harder; now they have to extend their justification to subjects and beliefs that typically would not be necessary because it wouldn't apply to patient's specific condition. This "who knows more" 'battle', results sometimes in less humanized doctor-patient relationships and in breaches of trust, as confirmed by physicians. Participants suggest there should be some tool or someone to help filter irrelevant information so that all stakeholders could only benefit from information access.

The health professional and their technological adoption

The participants refer to health-related technologies as enablers to easily access any relevant information when delivering care (either about the patient or to support decisions). In order to support decisions (i.e which drugs and dosages to prescribe), physicians recall often to medical mobile applications, medical communities or the internet. The fact that it is increasingly required from physicians to know a lot about many health-related things, they highly value access to such information, as a backup in case of doubts. As stated by a participant - "we are nothing without our smartphone and wifi". When accessing patient information, physicians spontaneously mentioned they recognize the efforts done in this regard - recalling the times in which patient information was registered on paper, accessing medical history was not effective at all compared to today - However, there are still many information lost in medical notes, paper records... The more they know about the person that is going to receive care, the better the service is delivered. As an obvious consequence, they highly value any tech that may
allow having all available information about their patients integrated and ready to be use in their medical practice.

According to the physicians, users should only come to the hospital when it's strictly necessary, which is something it does not happen currently. Patients go to the hospital often when in fact they don't need, ending up spending the doctor's limited time. Any digital tool that is helpful in mitigating such problems is very well welcomed by the respondents.

In summary, the above listed challenges were raised by health professionals:

Healthy doctor-patient relationship - The fact that patients know more about health-related content, have empowered them to challenge the doctor's opinion, resulting sometimes in unhealthy doctor-patient relationships, which follows poorer care delivery.

Access to patient information - In order to provide better care delivery physicians value easy storage, access and exchange of all possible patient information available.

Access to information to support decisions - In order to support decision making and avoid medical errors, health professionals' value being able to access information on medical communities, drugs catalogs and other sources of relevant content.

Time saving - Due to hospitals overflows and little resources available to all, physicians perform their jobs as effectively and efficiently as possible so that everyone can receive quality care.

Table 3 is a visual representation of tech's value capture from the health professional's perspective. The impact level was done under the same criteria used in table 1.

	CLUSTER 1		CLUSTER 2		CLUSTER 3
TECH / HP'S VALUE	GENOMICS	PGHD	VIRTUAL ASSISTANTS	AI AS MEDICAL ASSISTANT	TELEMEDICINE
HEALTHY DOCTOR-PATIEN RELATION			XX	X	
ACCESS TO PATIENT INFORMATION	XXX	XXX	XX	X	
ACCESS TO INFORMATION TO SUPPORT DECISIONS			XX	XX	
TIME SAVING			XX	XXX	XX

Table 3 - Tech value captured in HP's

Reading: X Impactful; XX Quite impactful; XXX Very impactful

Main findings from table 2

It is natural to conclude that the techs embodied in cluster 2 are highly impactful for health professionals. VAs can provide improvements in all physician's needs, they can assist on basically anything, within AI boundaries. VA is an enabler in the doctor-patient relationship by returning access to the user history in the VA mobile app, prior to a consultation with an expert, which in turn facilitates communication. Additionally, it can provide doctors with assistance in decision making, thus saving time. AI, as medical assistant, has similar impacts. Looking to the HP's value perspective, having access to patient information is the need being mostly impacted by all tech dynamics in cluster 1 and 2. This means there are more available sources of health-related content integrated into medical practice, which improves care delivery.

4.2.3 Health services expert's perspective

Finally, the industry experts have shared their raw perspective regarding organizational feasibility and viability of the tech dynamics in a business and strategic context.

Main findings from the interviews

Healthcare service's experts and its innovation initiatives / challenges

Regarding the initiatives health services are undertaking to join the digital revolution, according to the industry experts, the focus for the upcoming years is to improve the user experience. Everything should be more automatic, from check-ins to payments. The objective is to reduce waiting times and provide a fluid experience in which a patient arrives to a hospital, check in on his hospital mobile app so that the hospital itself is aware and is able to communicate internally all the relevant information for that interaction to happen successfully. At the end, the patient should be invited to pay and book immediately the necessary following steps. Managing such logistics - consultations, exams scheduling - and others alike should be done in the service mobile app, as agreed by the industry experts.

As concluded before, patients are more interactive and participative in their medical choices, however, industry experts have doubts regarding the good of such user autonomy and empowerment, since some are searching for health solutions and acting by themselves without professional counseling. Industry experts also recognize technological opportunities to improve diagnosis efficacy, physicians can be provided with AI tools capable of detecting and reading what human eye sometimes misses. For that purpose, startups working on the field are under traditional health service's sight for eventual partnerships. Such technological adoption by medical services has to be thought in economic terms and to be considered by all stakeholders involved. With regard to data monitoring through wearables and similar, industry experts recognize the adjacent value in having such information - improve diagnosis and better patient monitoring are an obvious outcome - however, the implementation of an information system capable of receiving and treating such data has not been an easy task. There is in fact digital clinic centers within hospitals but in some cases the data is introduced manually, which is unsustainable considering the amount of data being generated. As a solution for this, third party services can be hired to this processing demand.

When considering the implementation of digital strategies, data protection is perceived as being a 'pulling back' factor. Despite the incentives brought by technologies to share more and more, regulation have come to difficult innovative implementations in the eyes of the industry experts. Other relevant factors pointed out were the bureaucracy and old-fashioned laws that are not contextualized with the current treatment and alternatives tools.

Healthcare service's experts' vision on the future of the healthcare industry

When asked about their thoughts on the industry future orientation, respondents believe we will have trustworthy diagnosis with much less need for medical intervention; the idea is that the user arrives to the hospital with a pre-screening and a diagnosis done so that the he can go straight

forward to do the already prescribed exam and receive the most suitable care. Jumping such steps is naturally good for the patient which saves time and money, and the health professional, besides also saving time it helps him getting a more comprehensive view of the patients. However, for health services, there is a conflict of interests. On the one hand, overall care delivery is improved, and customers should be more satisfied resulting in probable referral outcomes; on the other, health services loose revenue streams that coming from all these (unnecessary) steps. When a user goes to a care provider, even if he has an idea on what is the origin of his problem there are several exams prescribed on a first interaction to screen and confirm the suspicions. Such process leads to time and money investments by the user that could be avoided if they had had previous counseling (with VA for example). When it comes to telemedicine, the major concern pointed by experts has to do with the negative reputation. In case something goes wrong, everyone will blame the fact that the consultation was held remotely. While on services such as VA, the impact coming from this possibility is not as negative since they do not exist physically.

Due to the high costs associated with the industry, the healthcare of the future must act in the prevention rather than the treatment. Firstly, it is much cheaper and secondly because there won't be enough resources (hospitals, doctors, nurses and so on) to treat everyone. In order to avoid bankruptcy and maintain care quality, health services must invest on prevention efforts and even the treatment has to be as effective and rationalized as ever (restricted exams prescription, for example).

In summary, industry experts' value:

Efficacy - In order to reduce costs and improve care quality, industry experts call for effective internal and external practices. Efforts to automatize internal processes and patient logistics have been taken by healthcare organizations.

Reputation - Related to fact that healthcare organizations exist physically, there are strong reputation concerns when considering engaging and partner with digital solutions.

User experience - With the aim of providing a free of frictions service to its users, healthcare organizations have been working on improving the user experience.

Invest on prevention - Due to high costs associated with healthcare and the growing population living longer, healthcare experts say there will be lacking resources to deliver quality treatment care. Hence, urgent investment on prevention initiatives is required.

Table 4 is a visual representation of tech's value capture from the health services' perspective. The impact level was done under the same criteria used in table 1 and 2.

	CLUSTER 1		CLUSTER 2		CLUSTER 3
TECH / HSE'S VALUE	GENOMICS	PGHD	VIRTUAL ASSISTANTS	AI AS MEDICAL ASSISTANT	TELEMEDICINE
EFFICACY	X	X	X	XXX	XX
REPUTATION	X				
USER EXPERIENCE	X	X	XXX	X	XX
INVEST ON PREVENTION	XXX	XXX	XX		

Table 4 - Tech value captured in HSE's

Reading: X Impactful; XX Quite impactful; XXX Very impactful

Main findings from table 3

It is possible to conclude that the tech dynamics in cluster 1 (Genomics and PGHD) have their main contribution to prevention investments since they enable constant patient monitoring, resulting in early interventions. Looking from the HSE's value perspective, efficacy and user experience are partially improved by every tech, being VA the most impactful for user experience and AI as medical assistant have its main impact in efficacy matters which is partially impacted by all other techs involved since they all contribute to improve prevention, management practices and process automation.

4.3 Tech dynamics value capture in medical process steps

In order to answer the second and final part of RQ1 it is provided a structured representation of the clustered tech dynamics impact across medical process steps. Its impact level was measured by the extent to which the tech covers the medical process step. Accordingly, Impactful - provides change to some of the task extent; quite impactful - provide change to significant part of the task extent; Very impactful - the impact fully covers the task extent (explained in each cluster analysis)

4.3.1 Medical process steps

Medical process steps are the main activities or tasks which constitutes the medical experience in the prevention and diagnosis stage, they are the result of the research done in chapter 2 coupled with industry experts' insights. Accordingly, they are meant to provide a general overview which represent the main contact points from the different stakeholders in the medical experience, hence not considering other eventual tasks required for care delivering in these stages.

In the prevention stage, it is considered medical history, screening and identifying risk factors as the main tasks, whereas specifying exams, interpreting data and consultations embodies the diagnosis. Such process steps require the intervention of all stakeholder groups and the more knowledge we can extract from each process step, the better care is delivered. Hence, the following analysis aims at assessing how the different techs can provide improvements from each stakeholder group perspective. The medical process steps are explained below.

Medical History - Relative to the information available about users for any interested stakeholder to access when necessary. Variations in the quantity of medical history available will naturally influence all following process steps.

Screening - The process step that aims to identify the possible presence of a 'to be diagnosed' disease in patients, thus, enabling earlier medical intervention in the hope of reducing suffering and associated risks.

Identifying risk factors - risk factors are characteristics or exposures of an individual that increases the likelihood of developing a disease or injury. Such task is performed by physicians relying on the information gathered so far paired with their expertise.

Specifying, organizing tests - After all relevant information have been exchanged and analyzed, exams are thoughtfully prescribed to support and finalize the diagnosis.

Interpreting data - The task of interpreting health-related data coming from any source that is relevant for diagnosis evaluation.

Consultation with experts - The process step in which physicians have the job to clarify the patient's condition if a diagnosis have been undertaken before, to clarify any doubt the patient may bring and to forward to the right counseling.

4.3.2 Cluster 1 - Information generation

Tech dynamics considered: Genomics; PGHD

Enablers: Open API, Cloud computing

Table 5 is a visual representation of cluster 1 impact in medical process steps.

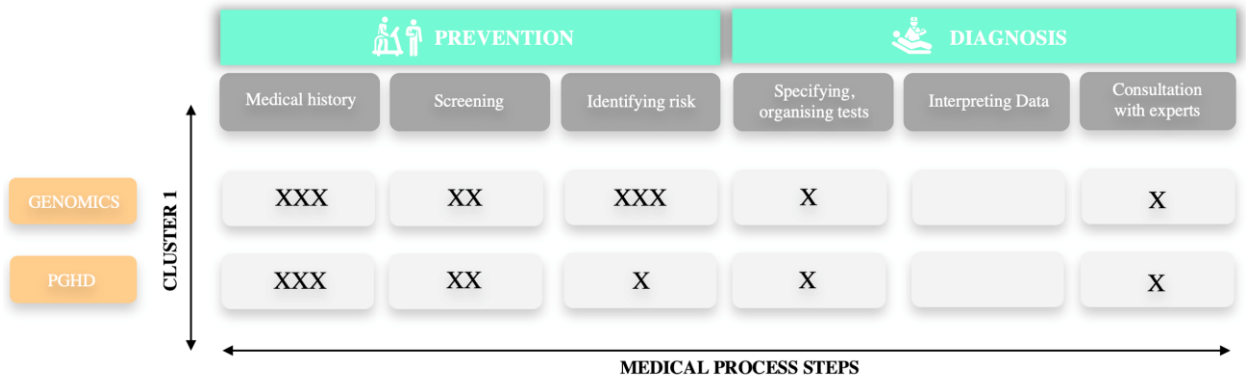

Table 5 - Cluster 1 value captured

Reading: X Impactful; XX Quite impactful; XXX Very impactful

Analysis

Conclusions suggest that the tech dynamics from cluster 1, which mostly enable continuous patient monitoring, have significant impact across all the tasks considered in prevention stage. The fact that they bring more information into patients' evaluations results in a deeper impact on medical history and screening activities. However, due to the importance of precedents in certain tasks (i.e. exam specification gets clearer as the previous tasks get improved), their impact is extended, being the only exception the task of data interpretation, which does not suffer any change from cluster 1. The fact that genomics can provide physicians with accurate feedback on a patients' propensity to develop a disease makes its impact much more important in risk identification.

4.3.3 Cluster 2 - Information treatment

Tech dynamics considered: Virtual assistants (mobile health applications); AI, medical assistant

Enablers: APIs, cloud computing

Table 6 is a visual representation of Cluster 2 impact level across medical process steps.

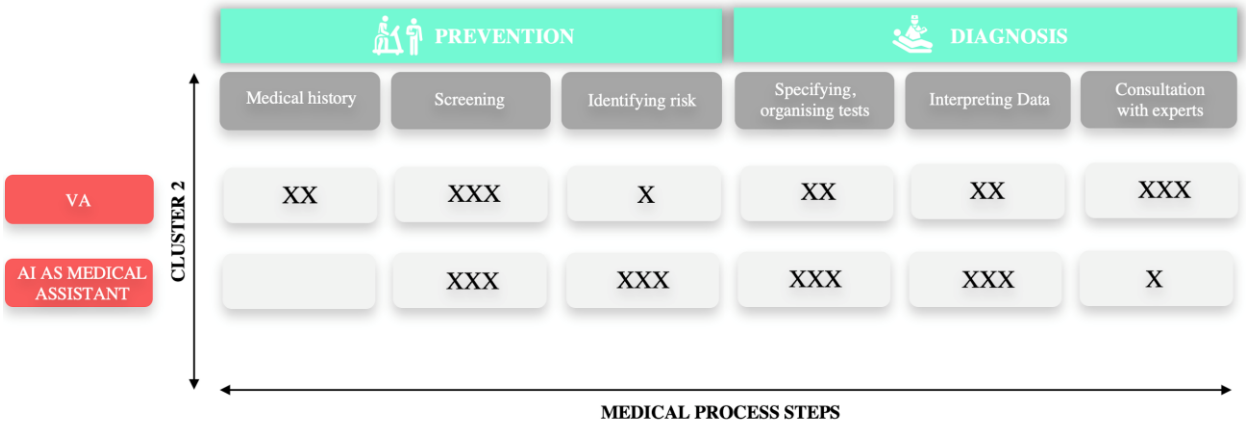

Table 6 - Cluster 2 value captured

Reading: X Impactful; XX Quite impactful; XXX Very impactful

Analysis

Conclusions suggest that VA can provide significant impact across both prevention and diagnosis stage. VA provide users with hypothesis regarding symptoms assessing hence improving screening activities. Because they are embedded with AI algorithms, they may also assist physicians in data interpretation and consequently exams specification. Moreover, it enriches patient's' medical history by saving all the information gathered from each interaction. Since it empowers patients with knowledge regarding their condition it improves the problem communication while on a consultation. Regarding the impact from AI, as medical assistant, from screening to data interpretation, these tasks are substantially improved since there is almost a task autonomation or at least with much lower medical intervention.

Not surprisingly, medical history tasks do not suffer any alteration because of clinical decision-making assistance. Consultation activities are not provided with direct AI assistant impact, however, all the previous work being impacted has certainly improved the outcome brought to the consultation.

4.3.4 Cluster 3 - Experience improvement

Tech dynamics considered: Telemedicine, Tech enablers

Table 7 is a visual representation of telemedicine impact level in medical process steps.

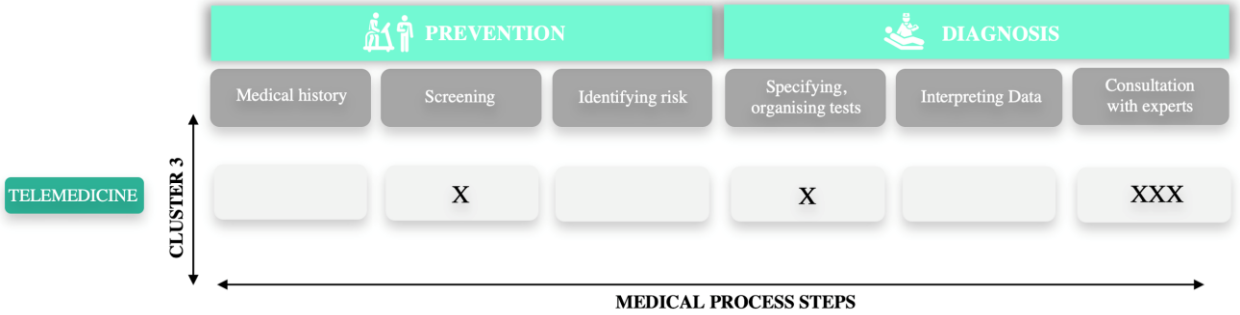

Table 7 - Cluster 3 value captured

Reading: X Impactful; XX Quite impactful; XXX Very impactful

Telemedicine's impact is clear - it enables all medical tasks that require in-person medical appointments. Medical history, identifying risk factor or interpreting data are areas in which telemedicine does not bring any substantial change or improvement. Whereas, for screening and exams specification purposes, telemedicine provides change for some extent of these tasks by clearly improving the experience. Finally, consultation with experts is provided with its most impact since it can substitute in person task completion from a remote one.

4.4 Tech dynamics value capture across stakeholder groups and medical process steps

After initially analyzing the tech impact across stakeholder groups and medical process steps, a consolidated tech impact was undertaken. The following analysis aims at presenting the final conclusions regarding the opportunities and challenges tech dynamics may bring. By doing so, the answer to RQ2 is completed.

Table 8 is a visual representation of the consolidated tech impact across stakeholder groups and medical process steps.

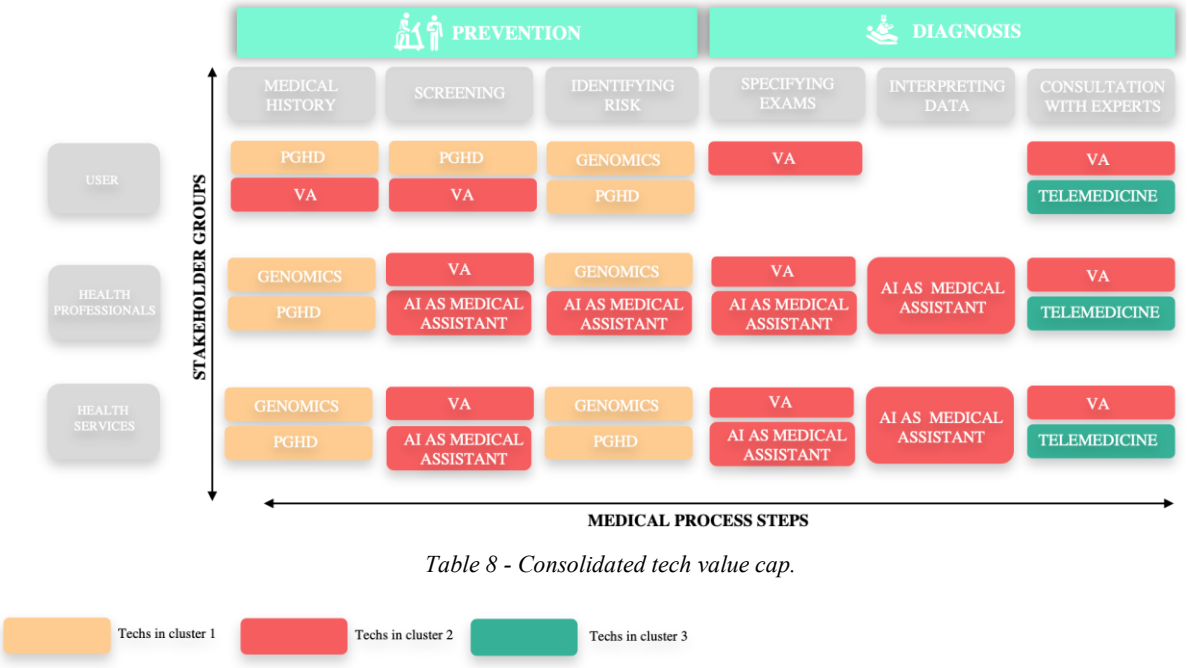

Table 8 - Consolidated tech value cap.

From this table it is possible to conclude that techs in cluster 1, only provide changes in medical process steps from the prevention stage. These process steps are ultimately, means to get inputs to later produce an output (in the diagnosis stage). Therefore, any tech that may provide change in the availability of information to deliver an output is relevant for the process steps in the prevention stage. Through the lens of the users, such changes are linked with the possibility for a personalized continuous tracking. Whereas for health professionals they enable the access to more patient data which will affect patients' evaluation. Finally, to health services' experts, techs in cluster 1 are contributing to mitigate the pressure they have while also contributing to a rapid rethinking of the whole cost/efficient structure of priorities – focusing efforts in prevention and wellbeing.

With regard to techs from cluster 2, they provide change in both prevention and diagnosis stages. These techs' nature is in its capacity a treatment of information in order to deliver an output and hence impacting any medical process step that requires such analysis.

In the user perspective, VA is the only tech from the cluster 2 that brings any change and may play a huge role for patients in the future. This change is related to their need of getting clear and reliable feedback on their specific condition at a given moment in time. By recalling to Virtual Assistants for such help, users get their screening done and receive recommendations to further steps preventing them from going often to the hospital for unnecessary reasons.

On the health professionals' side, techs in cluster 2 are tools to better perform their jobs and to more accurately assess patients' diagnosis. Hence all the tasks that require physicians' analysis and conclusions can be substantially improved by techs in cluster 2.

Finally, through the lens of the experts, the impact is relevant since it translates into efficacy improvements contributing to cost reduction. Moreover, they contribute to provide a better user experience which is a core part of health services' strategic efforts.

Lastly, Telemedicine, included in cluster 3 can only provide significant change in consultations with experts. Across all stakeholder groups, telemedicine brings improvements in the experience since it is more convenient, time and cost saving. However, health services' experts fear the risk of data misinterpretation leading to possible mistakes in diagnosis which ultimately impacts the service reputation.

Chapter 5 - Conclusions and limitations

The aim of this dissertation is to identify the emerging tech dynamics and assess their impact on the main healthcare activities - medical process steps - involved in the prevention and diagnosis stages; as well as to evaluate the opportunities of such an impact, through the lens of the different stakeholder groups.

The results show that the tech dynamics can significantly influence the healthcare industry through three key applications: (1) information generation, which has a major impact in the activities covered in the prevention stage; (2) information treatment, impacting activities both in the prevention and diagnosis stages; and (3) experience improvement, mainly useful in activities that require in person interaction.

(1) Regarding information generation techs, they are valuable for patients since they allow a continuous tracking from reliable sources, while to health professionals they provide more information on the patients' medical history resulting in more accurate diagnosis. This ultimately contributes to the user's empowerment, since he will be able to inform the physician about his condition in much more accurate fashion.

Because of the continued increase in life expectancy and the associated costs with the elderly population, health services stakeholders are in constant pressure by governmental agencies to reduce overall treatment costs. As they prevention oriented, stakeholders stand to benefit from this continuous patient monitoring. For instance, such monitoring processes enable health services to predict a gripper overtone in advance, which allows them to effectively manage all resources involved - medical teams, drugs stock, among others. This is materially impactful not only for hospitals but also for other stakeholders in the life science industry – which can furthermore adjust their stock management. Moreover, for pharmaceutical company the tech impact may be extended in depth to other areas of the value chain – namely, the production of drugs. With the access to one's genotype information, they can produce drugs that are more effective (both in cost and success rate) which results in drug developments at almost a personalized level rather than mass drug for a single disease.

Other stakeholders that can also be highly impacted by this new patient information, are insurance companies, which can accurately calculate the risk associated with each person's insurances.

(2) As far as information treatment tech dynamics are concerned, VAs are valuable to the users since they contribute to solve all their health-related problems and get reliable assistance at any time - information about their symptoms, pills reminder, book hospital appointments - among other functionalities. Health professionals get relevant inputs from them, resulting in efficacy and

time saving advantages. The improvement brought by VA to deliver better care is clear. But how is this translated into an opportunity for health services' stakeholders?

It is possible to picture a scenario in which health services provide patients with virtual full-time assistance, as there is evidence suggesting that users are willing to engage in digital solutions and pay for a service that would improves the management of their health. By doing so, health services can begin to invite patients to come in and receive appropriate care for their condition. This controlled atmosphere oriented to the prevention stage, results in very effective management practices that allow as previously mentioned for resources to be allocated accordingly and stocks efficiently managed. Because of this, and has already concluded above, other healthcare suppliers benefit as well.

With regards to the second tech of the cluster, Artificial Intelligence as medical assistant, its impact is translated into effective and reliable treatment of data, thanks to the automation of data processing. This is therefore valuable for health professionals who get help in addressing all the emerging patient data into clinical decision-making, resulting ultimately in cost minimizations.

(3) Lastly, with regards to the experience improvement, telemedicine plays a major role in enabling patient diagnosis via remote consultations, which are valuable to all stakeholder groups in terms of convenience, cost and time saving.

All this can be seen as an opportunity to engage in data-driven business models in which users pay for a health service which assists them full-time from the comfort of their homes (through VA and telemedicine practices) and ideally, also contributing to illness prevention. They would then buy drugs that would more likely be 100% successful and pay for insurance products more suitable to their wellbeing. Because users trust their physicians and healthcare institutions such disruptive service must held by hospitals or similar and they should act as a middleman to the other stakeholders of the life science industry (appendix 3 – visual representation of a healthcare futuristic scenario).

Limitations and further research

Although this dissertation shows the opportunities that tech dynamics may bring to improve care delivery in each medical process step and to each stakeholder group, there are some limitations in the research conducted.

First, the sample size from primary data is not sufficiently significant to grasp a complete understanding of the health services industry's challenges, especially with regard to the stakeholders from the life science industry, such as governmental agencies, insurances or pharmaceuticals. Additionally, this research focuses its impact on medical process steps that are

general and common to all medical specialties within the prevention and diagnosis stages, hence not considering specific challenges which may differ among each of them. This could be a topic for further research, to find in more detail how the different medical specialties are more or less prone to evolve with the tech dynamics. Finally, because the methodology is based on qualitative research, the results cannot measure the quantifiable part of the impact - on cost reduction and the quality of the care delivered. For further research, a quantitative analysis to uncover the impact in productivity, cost differences and the quality of care delivered by the tech dynamics could be undertaken, however it highly depends on a more widespread adoption of these techs throughout health services.

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Appendices

Appendix 1 - Interview guide

I – Enquadramento

As entrevistas a utilizadores, profissionais de saúde (médicos e administrativos) de saúde enquadra-se na fase de coleção de dados primários, sendo este guião, um suporte às conversas com os diferentes stakeholders.

O estudo no terreno irá realizar-se em dois pontos a nível nacional: área metropolitana do Porto e Lisboa sendo importante absorver o contexto global do paciente e dos profissionais de saúde através de encontros com diferentes perfis.

O guião abaixo apresentado é meramente indicativo, o entrevistador deve seguir o entrevistado, encorajando-o a desenvolver o seu pensamento, podendo não ser cumprindo à risca e derivar para zonas de interesse não identificadas previamente.

II – Utilizadores de serviços médicos

(Breve enquadramento a explicar que a entrevista é feita no âmbito de um estudo académico sobre o futuro da saúde e nesta fase em específico sobre a experiência e interação com os serviços médicos, e que o objetivo é encontrar melhores soluções. Pedir autorização para gravar. Deixar o entrevistado falar livremente e responder a perguntas caso ele tenha curiosidade).

1. Perguntas de contexto
    - Com que frequência interage com serviços médicos?
    - Geralmente, para resolver que tipo de problemas? (ligeiros, graves...)
    - Utiliza aplicações de saúde? Quais? Para que?
    - Tem smartphone?

2. O utilizador e os seus hábitos de saúde (prevenção, ação)

(dentro da ação)

- Considera-se uma pessoa preocupada com a saúde? (aprofundar hábitos de prevenção) Se sim, quais são os seus hábitos de precaução? (desporto, alimentação, apps de apoio, exames de rotina etc)
- Utiliza apps de apoio? Para quê? Partilha os seus dados de saúde com aplicações que utilize? (testar valor de utilidade)
- Quando sente que eventualmente algo não está bem, em que fase do possível problema, recorre a serviços médicos? (Perceber se resiste ou procura ajuda facilmente) Porquê?
- Costuma procurar por si próprio informação de saúde e possível diagnóstico ao seu problema? Como? (Perceber se o utilizador é informado, valoriza o self-care)
- Quando não é uma situação de urgência, como faz a marcação e gestão de consultas? (Perceber se o utilizador valoriza o self-care)
- Quando interage com serviços médicos (ir ao hospital por exemplo) como corre essa experiência? (avaliar pains – pontos de atrito, rotura ou abandono; e gains – pontos positivos; seguir a conversa com o entrevistado)
- Como se poderia resolver o(s) problema(s) mencionado(s)? (#insights #proposta de valor (ajudar se o entrevistado tiver dificuldade sugerindo hipóteses)

(fora da ação)

- Acha que hoje em dia, com o acesso à informação e as tecnologias/ferramentas digitais as pessoas são mais críticas e mais intervenientes na relação com os serviços médicos?
- É mais fácil monitorizar os seus dados de saúde hoje em dia com as aplicações de apoio e com os dispositivos conectados? Sente-se mais seguro? #check valor de utilidade
- Acha que as pessoas utilizam muito estes meios digitais? Estaria disposto a utilizar? (dar exemplos) #check utilização de Apps

3. O entrevistado e serviços de Saúde

(dentro da ação)

- O que acha dos serviços de saúde de forma global? (Deixar o entrevistado falar de experiências passadas, suas ou de relativos)
- O que valoriza na interação pessoal com os serviços de saúde (testar necessidade de contato físico)
- O que poderia existir nos serviços de saúde que lhe facilitaria a vida?

4. O profissional de saúde e a transformação dos serviços médicos

(dentro da ação)

- Acha que hoje em dia, com o acesso à informação e as tecnologias/ferramentas digitais as pessoas são mais críticas e mais intervenientes na relação que têm com os serviços médicos?
- Utiliza ferramentas digitais para melhores e mais eficientes cuidados de saúde? De que forma é que considera serem uma mais valia para os serviços médicos? (testar valor de utilidade)
- Confia nessas ferramentas digitais?
- Quando interage com pacientes como corre essa experiência? (avaliar problemas e pontos positivos; seguir a conversa com o entrevistado)
- Como se poderia resolver o(s) problema(s) mencionado(s)? (#insights #proposta de valor (ajudar se o entrevistado tiver dificuldade sugerindo hipóteses)
- Do ponto de vista legislativo e de logística, quais podem ser os entraves à adoção de ferramentas digitais?
- De acordo com a sua opinião e experiência, o que espera do futuro da saúde?

Appendix 2 - Expert interviews summary

Expert interview #1

Name: Marisa Morais
Company: Hospital da Luz
Position: Marketing Director

Regarding the frequency users interact with medical services, the participant's opinion is that people are getting more and more interactive, since they now have more knowledge about medicine in general, due to the availability of internet to almost everyone, everywhere, and because there's a tendency of people wanting to be more autonomous and independent. However, the participant was unsure about the possible final outcomes of this increase in interactivity. On one hand, mobile apps make it easier for users to manage their own health and everything they might need, such as booking a medical appointment or canceling/changing one within a short time. On the other hand, there's a dangerous side about people being more interactive and

information being easily available, which is the one where the individual acts as if they were their own doctors and try to solve their problems, which may be complex, by themselves.

The participant´s interaction, is mainly through the hospital mobile app, which enables the user to receive their medical results via mobile, without the need of having to pick them up and to book or cancel medical appointments. Moreover, the app lets the user to manage their own health and serves as a reminder for new appointments.

Although the participant didn't used any monitoring app or device, she thought that those tools were of great importance for patients who need that regular monitoring, since their doctors would have more information and thus would be capable of a better diagnose capacity. The main drawback about these tools, according to the participant, was the difficulty of integrating the monitored data into usable data for doctors. Another big obstacle, in the participant's opinion, is the need of a large investment to reach the next level. There is a huge offer in number of software's that receive, treat and integrate data to medical services, but no software has yet been considered the one, so it takes time to choose the best and invest on it.

Concerning the participant's experience with medical services, the participant recognizes the common problem of having to wait for the doctor, but has never felt disrespected or poorly treated. She recognizes the fact that doctors are also human beings, with good and bad, with their own personality, and with their own concerns. But none of that will ever have any effect on the way people are treated, because despite all they are professionals in what they do.

Looking at the future, the participant thinks that automatization will lead the change. Just as it has already happen in other industries, like fast-food or airports, automatization will reach healthcare, it is not sustainable to have the number of people we have today at reception desks in the future, processes need to be changed and it will start with internal processes first. The future of healthcare is based on the prevention of diseases, rather than on their treatment, because it is not possible to treat every single person individually with a personalized care plan, it's not economically sustainable and it will never be. We will have a larger and long-lasting population, different and complex diseases will surge, and so healthcare services must be prepared to be the more efficient possible, by clearly identifying what each person needs and prevent future problems, otherwise the healthcare system won't be able to answer to everyone's problems.

Expert interview #2

Name: Miguel Martins
Company: José de Mello Saúde
Position: Health Manager – CUF Cascais

Regarding the frequency users interact with medical services, the participant's opinion is that the internet was the main enabler of all questions and answers user may have. Nowadays at a distance of one click we have the answer even to the most difficult questions, but the real questions is – are we really making the right questions? From one point of view, people are more informed and gain a sense of direction of where to go or what to do. On the other side, doctors really hate the power internet enabled people to have. The equilibrium is reached when people know where and what information to seek and doctors adapt to that, for instance they could be the ones to say to their patients where to look for trustworthy answers on the internet. One side needs to be more controlled (patients) and the other has to adapt (doctors).

The participants opinion about the future of user experience is that everything needs to be automatic, specially the very slow "check-in" part of medical services. This experience in specific, must be easy-going and uniform between hospitals, in order to reduce waiting times. Regarding the doctor-patient experience, this will vary a lot depending on the type of doctor you will face. The "old school" doctors are the majority and the new generation of doctors is still powerless. From his experience, the participant admitted that It was already hard the change from paper to digital (information on computers) and doesn't believe in something beyond that to happen naturally without any mandatory legislation.

Looking at the future of healthcare services, the participant thinks this will be about the quality of pre-diagnosis based on the patient self-diagnosis. One of the major healthcare revenue streams comes from the exhaustive number of clinical exams patients are told to do by doctors, this is something that in the participant's opinion will end in the future. In the participant's example, in the interaction will be more direct and automatic, the patient knows he/she has this x problem, that needs x1 and x2 exams to be done and that's all automatic, the information logistic has to flow flawlessly. Taking out specific and more complex problems the patient may have, patient screening must be based on a very clear set of criteria where check ins and check outs should happen on the same day.

With regard to the general regulation on data protection, the participant's opinion is that today's new technology takes us to share more and more of our own data, but at the same time this data is regularly more and more protected, so there's here a big conflict to solve. Besides this problem, the participant also pointed out that at a bureaucratic level, in Portugal we have ancient laws that do not apply or work along with the treatments and the tools we have today.

This share of data, intends to create personalized plans for every person, but the participant was very clear on saying that no matter how fast or how incredible the things which new technology improvements will let us do in the future, we as natural human beings, will always have the need to go to the hospital and to talk to another human being. Because no matter how accurate or how good the information we can get by ourselves is, we will always have the need to confirm it with a person of matter, the medical doctor.

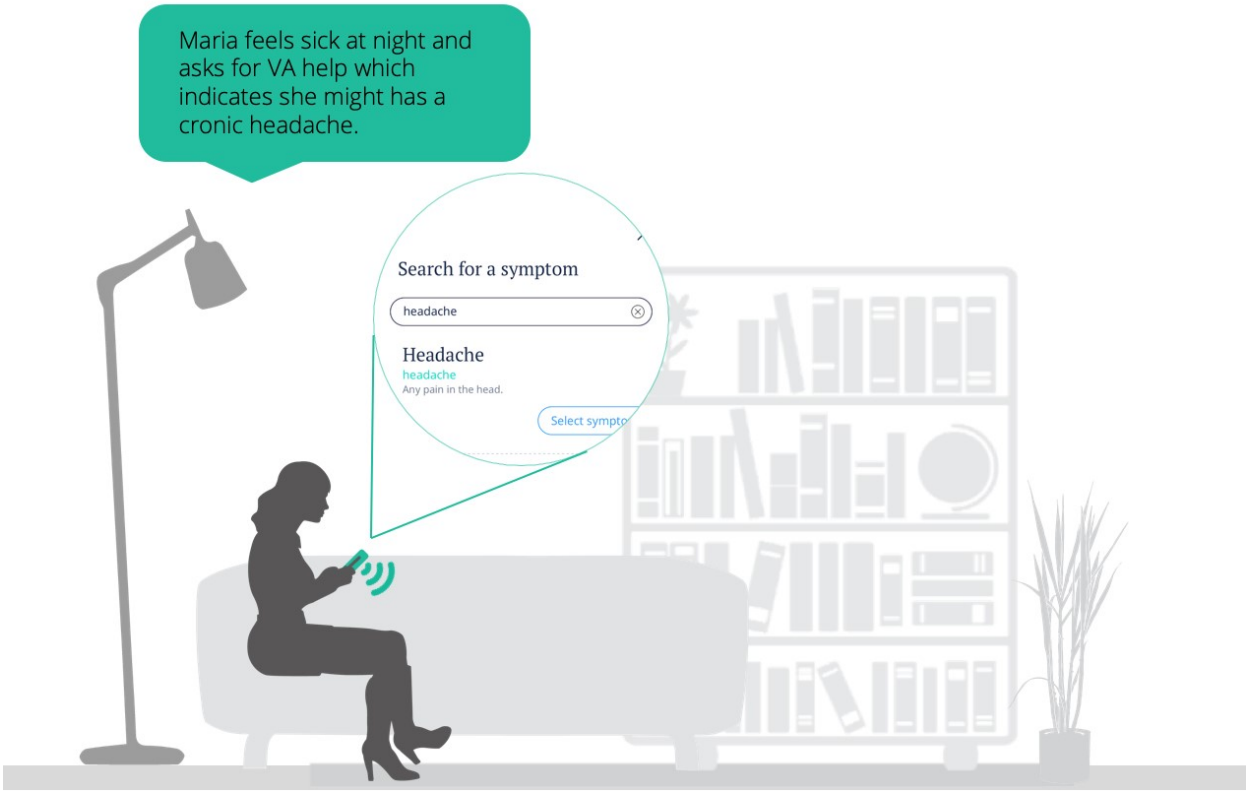
Expert interview #3

Company: Pfizer
Position: Quality Controller

Concerning the participant's own health awareness, this was something of great importance and it was reflected in healthy eating habits and annually medical check-ups always with the same doctors, the ones the participant trusts. Given the fact the participant works in a pharmaceutical company, the participant has a greater knowledge than the average person on what to do or what pills to take when something isn't right and thus doesn't rush to the hospital every time a problem occurs, first tries to solve it alone and only in case of failure seeks medical attention. However, the participant alerts that people shouldn't self-medicate, since most are right about their symptoms and don't have a clue on what they are reading on the internet.

Regarding the future of pharmaceuticals, the participants opinion is that pills will be fully personalized. Each person will have an individual treatment along with an individual high cost for that treatment. From a legislation point of view, Infarmed is the official regulator of all medicine that goes in and out of the market. Consequently, this personalized future will have a lot of conflicts considering the strict rules Infarmed has on what new medicine it approves or not.

Appendix 3 – Visual representation of the future of healthcare




At the hospital the physician get the nformation about Maria's condition, and sends her an invitation to book a consultation, while managing the drug stock Maria might need.


In the next morning, Maria has the consultation with the doctor which already has access to all her information. He confirms the diagnosis and gives her a set of preventive measures, as well as the prescription of a drug that is suitable to her specific condition.


Back to her normal life, Maria gets a message from an inssurance company offerining a product tailored to her life-style and wellbeing.