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THE INFLUENCE FACTORS OF THE PATIENTS' USAGE INTENTION OF AI-BASED PRELIMINARY DIAGNOSIS TOOLS: THE CASE STUDY OF ADA

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Abstract

Title: The Influence Factors of The Patients' Usage Intention of AI-Based Preliminary Diagnosis Tools: The Case Study of Ada

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At present Artificial Intelligence (AI) is transforming the mechanisms and limitations of numerous industries. The healthcare sector is particularly affected with regard to the informative value of processing and analysing patient data through AI-based technologies. Public fund cuts and structural inefficiencies among other reasons, further aggregate the necessity of effectively employing the provided patient information. The majority of healthcare facilities, however, lack the resources or technical knowhow to realize the entire potential of Artificial Intelligence as a mean. As a consequence, emerging companies, that can be theoretically classified as the intermediate form of public and private establishments, have developed new concepts. The structural adaptability of so-called hybrid organizations facilitates the offering of specialized products and services adapted to the needs of patients. In this regard AI-based preliminary mobile diagnostic applications represent a promising opportunity to empower patients and positively influence the average health quality. The influence factors determining the adoption and usage intention of patients are yet unexplored. This dissertation therefore examined the patient's perspective on AI-based preliminary diagnostic tools, in order to firstly expand the scope of present literature within this subject area and to identify the relevant key elements for the marketing and strategy measures of hybrid organizations operating in this field. The implications of this research include the recognition of the patients intended purpose of utilizing similar mobile applications, the consequently deriving strategic inferences, and a guidance for the marketing and communication efforts of comparable vendors.

Sumário

Palavras-chave: Organizações híbridas, Cuidados de saúde, Inteligência artificial, Ferramentas de diagnóstico, Aplicações móveis

Atualmente, a inteligência artificial está a transformar os mecanismos e limitações de diversas indústrias. O sector da saúde é particularmente afetado pelo potencial informativo de processamento e análise de dados de pacientes através de tecnologias de inteligência artificial. Cortes orçamentais públicos e ineficiências a nível estrutural evidenciam a necessidade de, idealmente, empregar os dados de pacientes. Na sua maioria, as instalações de saúde carecem de recursos ou de conhecimento técnico para se inteirarem do potencial da inteligência artificial. Consequentemente, as empresas emergentes, que teoricamente podem ser classificadas como um formato intermédio entre estabelecimentos públicos e privados, definem um novo conceito. A adaptação estrutural das organizações híbridas facilita a oferta de produtos e serviços especializados às necessidades dos pacientes. Neste sentido, aplicações móveis de diagnóstico preliminar recorrendo a inteligência artificial, representam uma oportunidade promissora por conceder autonomia aos pacientes e influenciando positivamente a qualidade do sector da saúde. Os fatores determinantes da adoção e intenção de uso por parte dos pacientes está, ainda, por explorar. A presente dissertação examinou a perspetiva dos pacientes relativamente às ferramentas de diagnóstico preliminar com recurso à inteligência artificial, com o intuito inicial de expandir a literatura referente a esta temática e de identificar elementos fundamentais para as medidas de marketing e estratégia de organizações híbridas que operam neste meio. As implicações deste estudo incluem o reconhecimento de pacientes que tencionem recorrer a aplicações móveis semelhantes e suas subsequentes implicações estratégicas, assim como diretrizes a nível de marketing e estratégia para negócios equivalentes.

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Glossary

AI – Artificial Intelligence

ANOVA – Analysis of Variances

APP - Application

EHR – Electronic Health Records

NGO – Non-Governmental Organization

SERVQUAL – Service Quality

UTAUT – Unified Theory of Acceptance and Use of Technology

1. Introduction

1.1. Problem Definition and Research Questions

The business environment, and consequently the strategic alignment of companies, have recently experienced substantial changes. The increasing awareness on environmental and social issues by the society has disrupted the business landscapes for the majority of commercial organizations (Santos, Pache & Birkholz, 2015). Established companies had to respond to the changing external settings, while the incidence of social entrepreneurship grew (Dey & Steyaert, 2012). The thus emerging hybrid organizations incorporate a social mission into their core identity, while simultaneously pursuing financial objectives as a mean to achieve their altruistic purposes (Davies & Doherty, 2019). Rawhouser, Cummings & Crane (2015) claimed that the growing field of hybrid organizations has been of progressive academic and managerial relevance in this context.

The driving forces behind the expansion of hybrid organizations, have been broadly discussed by academic literature. According to Lee & Jay (2015) the shifting societal mindset is partly accountable for the rising demand in hybrid organizations and subsequently for products and services yielding to a positive social contribution. Haigh, Walker. Bacq, & Kickul (2015) claim, that the rise in expenses combined with an aggravated competitive environment, for receiving grant funds, obliged former non-profit organizations to readjust their financing funds. The civil lack of trust in the competency of governments and businesses to solve complex social challenges has further contributed to the emergence of hybrid organizations.

Governments on the other hand started to delegate some of their public responsibilities towards the private sector (Haigh et al. 2015) in response to public budget cuts and an increasing disparity in social equality (Roy, Donaldson, Baker & Kerr, 2014). Several economic industries, such as the health sector constituting the field of interest of this dissertation, consequently experienced structural changes. Entrepreneurs increasingly recognized the opportunities deducing from societal problems and have developed business models that supply these needs (Zahra & Wright, 2016). According to Millar (2012) the mechanisms and the competitive characteristics of the free market economy, could potentially induce innovation, enhance the overall responsiveness of health-related services and disburden public organizations in the healthcare sector. In regard of transformative technologies, artificial intelligence plays a significant role in providing patients with more affordable and higher

quality health care services (Koh & Tan, 2011). Despite the established potential of artificial intelligence in healthcare, there is yet mistrust by patients concerning the technology as a health delivery vehicle (PwC Report, 2019).

This dissertation therefore thrives to study potential opportunities for autonomous artificial-intelligence-based preliminary diagnosis tools and elaborate the factors influencing their usage intention by patients.

In order to achieve the research objective and to generate purposeful insights, the following research questions (RQ's) are being addressed:

Research Question 1: *What are the opportunities that can be seized by Artificial Intelligence-based preliminary diagnosis tools?*

This dissertation assesses the prevailing attitudes of patients towards healthcare services in general and identifies the perceived deficits. Moreover, the aim has been set to detect opportunities, that can be deducted from the preliminary established deficiencies and to eventually ascertain the functional suitability of AI-based preliminary diagnosis tools to address these challenges for patients.

Research Question 2*: What factors determine the patients' intention of using Artificial Intelligence-based preliminary diagnosis tools?*

It was essential to further investigate the direct relationship between the patient satisfaction and the intention to adopt preliminary diagnosis tools as substitutes or compliments for more traditional healthcare services. Despite the evaluation of external stimuli affecting the usage intention, it was additionally imperative to assess the effects of the perception of AI-based diagnosis tools by patients.

1.2. Methodology

The methodology designed to meet the set research objective comprises of two studies of qualitative and quantitative nature. As for the qualitative approach, this study employed a focus

group with the aim of answering the first research question and to break down the complex research subject for the consecutive quantitative study. The consequently quantitative study was developed through an online survey and intended to answer the second research question and to additionally quantify and confirm the findings of the focus group. The mobile-based health app offered by the 'Ada Health GmbH', which analyses and presents possible causes of symptoms for their users based on artificial intelligence technology, served as the case study for the examination of the set objectives.

1.3. Academic and Managerial Relevance

The utilization of data in healthcare, as an integrated key asset for healthcare providers, has increasingly become the focus of academic and managerial interest (Chen, Hao, Hwang & Hwang, 2017; Raghupathi & Raghupathi, 2014). In practice, the digitalization of data and the establishment of electronic health records (EHR) in many countries, has further facilitated the opportunities of computational science applied to clinical data (Hanauer, Zheng, Ramakrishnan & Keller, 2011). Nevertheless, unstandardized raw data (Koh et al., 2011) and the capability limitations of small-sized healthcare providers among other reasons, still impede the value creation process for patients (Brown, Chui & Manyika., 2011). Private organizations delivering alternative services specialized in data processing and information technology will therefore increasingly gain importance (McKinsey, 2016). In particular, healthcare solutions offered through mobile applications will have a substantial possible reach, as the number of mobile connected devices in use is projected to reach ten billion in 2020 (The Economist, 2011). This will allow healthcare providers to generate new patient touch points and transform highly contextual and dynamic health-related data into personalized recommendations (Chen, Chiang & Storey, 2012). The precondition that needs to be met in order to provide valuable insights, however, is a significant data pool size (Brown et al., 2011). As a result, organizations offering comparable services are reliant on a certain quantity of users.

The factors predicting the individual usage intention of health-related technologies, such as artificial-intelligence-based applications, however, are mostly unexplored. The majority of present studies explore the patients' satisfaction level with public health care services (Jenkinson, Coulter, Bruster, Richards & Chandola, 2002) or the perception of traditional health care services complemented and supported by artificial intelligence (Fast & Horvitz, 2017).

Nonetheless, there is an academic gap in literature researching about AI-based health services as an independent health delivery vehicle. This dissertation will in this context, try to explore the impact of external stimuli, such as perceived inadequacies of traditional healthcare services by patients, as well as the effects of the perception of technology-based services itself.

1.4. Thesis Outline

The successive section will review the relevant present literature on hybrid organizations and artificial intelligence in general and within the scope of the healthcare industry. The established framework and definitions will function as the theoretic reference point for the thematic complex. The third chapter will comprise of the case study 'Ada Health GmbH', applied to accomplish the research objective of this dissertation. The methodology of the two conducted studies will be presented in the fourth chapter. The methodology section will consist of the main research approach, the data collection and sampling, the research design, the employed analysis and lastly the obtained findings intended to answer the two posed research questions. The fifth chapter will discuss and compare the findings of the qualitative and quantitative studies. The sixth and last chapter will eventually draw conclusions to develop practical implications, identify possible limitations for this dissertation and provide suggestions for future research on the subject matter of AI-based preliminary diagnosis tools.

2. Literature Review

This section reviews the present literature on the underlying subjects of this dissertation to provide a theoretical framework endorsing the employed studies and to establish a base for the findings.

2.1. Hybrid Organization

The subsequent academic outline of hybrid organizations is intended to deliver insights for a more wholesome understanding of the thematic complex of hybrid organizations in general and regarding the specific scope of the health care industry.

2.1.1. General Framework

The traditional categorization of companies suggested the separation of two broad organizational types – for-profit and non-profit organizations (Siegner, Pinkse & Panwar, 2018). The theoretical concept of business entities defines organizational success as the accomplishment of commercial and financial objectives (Moore, 2000). In contrast, a non-profit organizations (NGO) reason for existence derives from the endeavour of achieving a social mission. Non-profit organization consequently do not only face differing strategical implications but are thus being confronted with stricter limitations pertaining aspects such as the financing sources (Davies & Doherty, 2019).

As previously established, there has yet been an accelerated demand for social enterprises due to the societal awareness about social and environmental issues and the lack of trust in the competency of governments and public organizations to resolve these complex challenges, among other factors. The aspiration for socially oriented entrepreneurs resulted in an increasing emergence of non-profit organizations, which intensified the competitive environment for institutional and personal funds. To reduce the financial dependency of socially driven organizations, the legal and structural requirements for the funding situation of non-commercial organizations had to be adapted (Haigh et al., 2015). The newly emerging organizational types, that can be composed under the general term ‘hybrid organizations’, would now enable non-profit organizations to integrate commercial activities into their operations in order to pursue a social mission (Siegner et al., 2018). However, the approximation of social enterprises towards traditional businesses is only possible to a certain degree, due to the duality of their alignment. Socially responsible companies need to deduce differing strategical means, that are applicable within their contextual framework. Activities affecting the perceived trustworthiness of hybrid organizations have to be selected carefully. Customers have higher moral standards towards these companies and hold them accountable for it (Smith & Woods, 2015). Consequently, the public perception of the legitimacy of a social enterprise is even more decisive in determining its commercial success, compared to for-profit businesses (Ramus & Vaccaro, 2017). Furthermore, the strategic implications of hybrid organizations are affected by the level of competitiveness within the market (Davies & Doherty, 2019), the interests of stakeholders (Smith et al., 2015) and the organizational structure (Davies et al., 2019).

The corporate governance of hybrid organizations thus depends on the underlying business model. According to Battilana, Lee, Walker & Dorsey (2012) and Ebrahim, Battilana & Mair (2014) two different organizational forms can be distinguished – integrated and differentiated hybrid organizations. Integrated hybrid organizations are being characterized as the attainment of social and financial value creation through collective means. In opposition to differentiated hybrid organizations, where the economic value creation is detached from actions contributing to the accomplishment of the social mission. The unified alignment of integrated hybrids can potentially reduce the risk of mission drifts and prevent possible conflicts of interest regarding the allocation of resources for the dichotomous organizational activities (Davies et al., 2019). Yet even integrated hybrid organizations cannot entirely preclude potential mission drifts. Companies selling products or services that benefit socially disadvantaged groups at low prices for example, could be tempted to change their target group in order to produce higher revenue margins (Ebrahim et al., 2014). Osorio-Vega (2019) however argues that the assumption of the counterproductive plurality in the strategic orientation of hybrid organizations, neglects the constitutive nature of the nexus between the social and economic objectives. The value proposition of Hybrid Organizations can originate from idiosyncratic imperatives of founders and managers and are therefore deep-rooted in the value system of the organization. The economic drivers emerge from the identical idiosyncrasy, proposing that the ethical groundings of entrepreneurial shared value are related to the idiosyncratic imperative, rather than solely to the distinctive social aim.

2.1.2. Context of the Health Care Industry

As previously defined, the purpose of a hybrid organizations is to achieve a social mission and use commercial activities as a mean to attain them (Davies et al., 2019). The theoretical conceptualization of Hybrid Organizations in the health care industry is not as obvious, since the context of the sector seemingly indicates a compulsory social orientation. Despite the altruistic dynamics of the healthcare sector, not every organization or company can be identified as a hybrid organization or a social enterprise. State-owned organizations, such as public hospitals, are merely publicity financed (OECD/EU, 2018) and therefore do not fulfil the commercial aspect of a Hybrid Organization. Profit oriented businesses, such as certain pharmaceutical concerns, in opposition meet the economic component and also contribute to the public health but have not integrated a wholesome social approach into their core. The

aggressive pricing policy (Spinello, 1992) is only one of the aspects not complying with the moral standards of a social enterprise per definition. Other health care companies, such as the Ada Health GmbH, may not be legally registered as a hybrid organization, but are conform with the underlying concept. As Roy, Donaldson, Baker & Kay (2013, p. 57) stated, hybrid organizations of the health care sector supposedly deal with the needs of "more vulnerable communities. By acting to address a social issue trough participation in some broader trading activity". In the case of Ada, the investment funds as the source of revenue, ultimately help supporting anyone in need of personal health information. Moreover, the public and free access of the Ada health app, especially benefits disadvantaged groups by providing health-related knowledge and guidance, improving the overall quality of the medical care for potential patients. However, Roy et al. (2014) also claimed, that the boundaries of defining hybrid organizations in the health care industry will remain to be blurred.

The implications and challenges also essentially differ throughout different industries. The context of the industry majorly shapes the applied strategies of hybrid organizations. Environmentally sustainable retailers for example, that in the case of Cafédirect sell fair-trade coffee, are threatened by the adoption of their unique selling proposition by opposing mainstream brands and a competitive market situation urging them to accept a possible mission drift (Davies and Doherty, 2019). Hybrid organizations in the healthcare sector of the European Union on the other hand are primarily engaged in maintaining the quality of services that are inevitable to ensure a certain level of universal public health. The shortage in qualified nursing staff is induced by the upcoming retirements of the current workforce combined with an insufficient replacement of the vacant positions due to the demographic aging in industrialized countries. The aging population and higher expected lifespans thus constantly increase the demand for health services, aggravating the necessity of well-trained staff. To encounter this trend more nurses have been trained in the majority of European countries, at the cost of lowering the overall qualification of the workforce in the sector. An increasing number of nurses require assistance with the performance of complex tasks, for example (OECD/EU, 2018). The consequences do not only affect older generations in specific, but influence everyone making use of healthcare services. As a result, hybrid organizations within the industry try to provide smart healthcare solutions, for the population as a whole (Roy et al., 2014).

Another problem is the inefficiency of the current health system. While the digital storage of data has gained practical relevance (EHS) and is even legally required in some countries, its processing potential has not been adequately exploited yet. According to a McKinsey report (Henke, Bughin, Chui, Manyika, Saleh, Wiseman & Sethupathy, 2016) the health care industry has captured less than 30 percent of the potential value deriving from data and analytics. To enhance the value chain of medical care, analytical data processing could be used to deliver valuable insights and give concrete recommendations for action (Henke et al., 2016). The expandable interconnection between medical organizations thus omits the opportunity, to create a multifaceted clinical picture and recognize occurring disease patterns (Donaldson, Corrigan & Kohn, 2000).

2.2. Artificial Intelligence (AI)

This section firstly comprises of establishing a definition of artificial intelligence, that will function as a reference for this thesis. Hereinafter, the general framework will outline literature on the different forms and the functionality of the technology.

2.2.1. Definition

The term artificial intelligence, also referred to as AI, has not been universally defined in the present literature yet. According to Konar (2008), one concept of defining AI evolves around the idea, that the human cognitive functions resemble the 'thinking' processes of computing machines (Haugeland, 1989). Further definitions emphasize the ability of computing machines to perform specific tasks, which are situated in the sphere of intelligence (Kurzweil, 1990; Rich & Knight, 1991). Luger (2005) on the contrary states, that artificial intelligence "may be defined as the branch of computer science, that is concerned with the autonomation of intelligent behaviour.". This disambiguation underlines the subordination of AI as the part of the computer science field, that can be characterized through its independent and adaptive behaviour patterns. Nevertheless, both Luger (2005) and Konar (2008) further claim, that the heterogenous definitions throughout present literature possibly derive from the abstractness and complexity in defining the term 'intelligence'. As a consequence, Konar (2008) defines AI as "the stimulation of human intelligence on a machine, so as to make the machine efficient to identify and use the right piece of "Knowledge" at a given step of solving a problem.". Since this

definition integrates a specification of intelligence in this context, it is seemingly the most precise definition of the ones previously mentioned and will therefore function as the reference point for this dissertation.

2.2.2. Functionality and Technical Differentiations

The outline of every individual aspect concerning the functionality and different types of artificial intelligence would go beyond the scope of this thesis. Therefore, this section will only highlight the most relevant concepts, essential for the understanding of the subsequent paragraphs.

According to Russell & Norvig (2010) artificial intelligence is based around the concept of rational computing agents, which "operate autonomously, perceive their environment, persist over prolonged time period, adapt to change, and create and pursue goals.". Konar (2018) understands the main utility function of artificial intelligence as the resolution of pre-existing problem states by achieving the final state of a problem-solving procedure. This is implemented by utilizing algorithms, which Burgess (2018) defines as the "[...] sequence of instructions or a set of rules that are followed to complete a task.". Problem statements, which cannot be remedied by mathematical or logical algorithms, and thus require intuitive approaches, are referred to as AI problems (Konar, 2018). In specific, AI problems exist when there is no formal realization procedure for a given problem set or objective, and the applied algorithm needs to remain adaptive during the solution process. However, for solving an AI problem, both AI and non-AI algorithms may be integrated, depending on the type of the problem state itself. Common problem states or objectives of artificial intelligence involve, inter alia, reasoning, learning or knowledge representation (Konar, 2018; Russell et al., 2010). The means to accomplish these pursued objectives can be divided into various subcategories. The probabilistic reasoning in intelligent systems, representing one of the categories, enables the computing agent to form decisions based on the probabilities of existing data. The Bayesian network approach, a sub form of the thematic complex machine learning, conquers the inability of probabilistic reasoning systems to solely form decisions in certain conditions. The computing agents of Bayesian networks are able to learn from mistakes and therefore benefit from their gained experience (Russell et al., 2010). According to Burgess (2018) a common differentiation in artificial intelligence technology presents supervised and unsupervised learning. In unsupervised learning, agents learn through recognizing patterns in the provided data sets,

independent of external provided feedback loops (Russell et al., 2010). On the contrary, supervised learning agents are opposed to comprehensive data pools, that initially do not possess any meaning for the system and therefore require external classification of the input data. The agents thereafter build a function, scheming the pairs of inputs and provided outputs, through the identification of clusters. Furthermore, connections within the algorithm who seemingly supported the achievement of a desired outcome may be reinforced, while others that did not positively contribute may be neglected. This consequently enables the system to generate predictions for the output levels of newly formed inputs.

2.3. Conceptual Framework and Hypotheses

After establishing the theoretical foundation for this dissertation, the outline of the hypotheses and the resulting conceptual framework of the quantitative research will subsequently be presented. The objective of this dissertation is to ultimately evaluate the influence factors of the patients' usage intention of AI-based preliminary diagnosis tools with the case study of Ada. The novelty of this research field necessitates the contextual adaptation of existing models present in literature for the creation of the variables and hypotheses of this study.

As previous studies indicate there is a causal relationship between the patient satisfaction and the loyalty of patients towards health institutions (Garman, Garcia & Hargreaves, 2004; Kessler & Mylod, 2011; Nelson, Rust, Zahorik, Rose, Batalden & Siemanski, 1992). The satisfaction level of patients with their current health care provider as a result presumably affects the intention to alternate utilized health services for substitutes. Existing literature (Naidu, 2009; Sadiq Sohail, 2003; Parasuraman, Berry & Zeithaml, 1991) further suggested a modified version of the SERVQUAL model as the suiting approach to measure the independent variable 'Patients Healthcare Service Satisfaction' (X1), because it can be specifically adapted to the healthcare context. In order to measure the dependent variable 'Patients' Usage Intention of Preliminary Diagnosis Tools' (Y), a modified version of the Unified Theory of Acceptance and Use of Technology (UTAUT) model was applied. Therefore, the following hypotheses are proposed:

H1a: There is a negative relationship between the patients' level of satisfaction with the *Service Quality* of healthcare services and the patients' *Usage Intention (Y)* of Ada.

H1b: There is a negative relationship between the patients' level of satisfaction with the *Tangibles* of healthcare services and the patients' *Usage Intention* of Ada.

H1c: There is a negative relationship between the patients' level of satisfaction with the *Convenience* of healthcare services and the patients' *Usage Intention (Y)* of Ada.

According to the UTAUT model there are four direct determinants, which significantly affect the acceptance and usage behaviour of information technology. Two of the constructs where relabelled for consistency reasons subsequent to the factorial analysis following in one of the later chapters. The first determinant suggested by the UTAUT model is the 'social influence' (Venkatesh, Morris, Davis & Davis, 2003), that will be labelled as 'relationship expectancy' in further consequence. Present literature on the theory of subjective norm argue, that the behaviour of an individual is influenced by the attitudes of his/her important personal relationships towards a specific subject (Ajzen, 1991; Davis, Bagozzi & Warshaw, 1989; Mathieson, 1991; Taylor & Todd, 1995). This resulted in the following hypothesis:

H2a: There is a positive relationship between the patients' *Relationship Expectancy (X2a)* with Ada and the patients' *Usage Intention (Y)* of Ada.

The second recommended determinant of the UTAUT model is the 'performance expectancy' (Venkatesh et al., 2003). In specific, the relative advantage theory connotes the influence of the perception of the utility value of an innovation compared to its precursor (Moore& Benbasat, 1991), resulting in the following hypothesis:

H2b: There is a positive relationship between the patients' *Performance Expectancy (X2b)* of Ada and the patients' *Usage Intention (Y)* of Ada.

The third determinant of the UTAUT model constitutes the 'effort expectancy' (Venkatesh et al., 2003). In this context the perceived ease of use (Davis 1989; Davis et al. 1989) presents the perceived degree of using a system effortless, which resulted in the subsequent hypothesis.

H2c: There is a positive relationship between the patients' *Effort Expectancy (X2c)* of Ada and the patients' *Usage Intention (Y)* of Ada.

The last direct determinant of the UTAUT model, is the 'facilitating conditions' (Venkatesh et al. 2003), which has been relabelled as the 'privacy expectancy'. The compatibility construct, describes the perceived consistency of an individual with existing beliefs and experiences (Moore et al., 1991), which resulted in the final hypothesis:

H2d: There is a positive relationship between the patients' *Privacy Expectancy (X2d)* in Ada and the patients' *Usage Intention (Y)* of Ada.

The hypotheses **H1a-c** were summarized under the independent variable 'Patients' Healthcare Service Satisfaction' (X1), whereas the hypothesis **H2a-d** were aggregated under the independent variable 'Patients' Perception of AI-based Preliminary Diagnosis Tools' (X2). Lastly, the dependent variable was labelled 'Patients' Usage Intention of AI-based Preliminary Diagnosis Tools' (Y). This resulted in the conceptual framework of the quantitative research summarized in table 1:

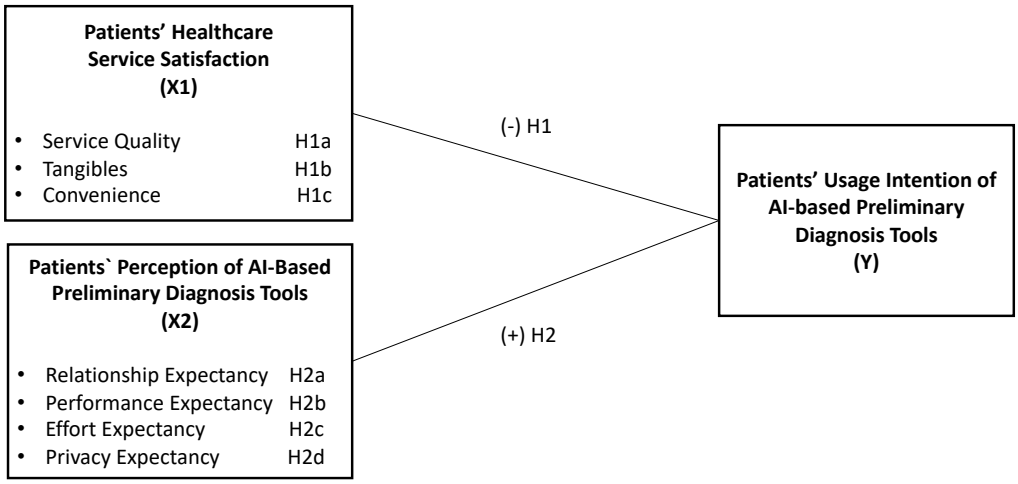


Figure 1 *Quantitative conceptual framework*

3. Case Study – Ada Health GmbH

The global health company 'Ada Health GmbH' was instituted in 2011 in Berlin by the founders Daniel Nathrath, Doctor Claire Novorol and Doctor Martin Hirsch (Ada Health GmbH, 2019a). The founder team was complemented "by doctors, scientists and industry pioneers to create new possibilities for health", in the form of a telemedicine application for smartphones called Ada (Ada Health GmbH, 2019b). By 2019 the company had raised sixty million euros of funding, employed 250 staff members and 60 in-house medical professionals (Ada Health GmbH, 2019b).

The original vision of the company was to support doctors to track their patients' symptoms over time. Since 2016 (Brodwin, 2018), the application Ada functions as a diagnostic support tool to increase the patients understanding of their health and enhance the medical precision of health professionals (Ada Health GmbH, 2019b). Ada was launched on the Apple App store in November 2016 and on the Google Play store for Android devices in March 2017 (Ada Health GmbH, 2019a). The company states that Ada has 8 million users and 15 million health assessments have been completed (Ada Health GmbH, 2019b). Additionally, the application is available in seven different languages, has won awards such as the German Innovation Award 2019, has been certified with the ISO/IEC 27001 and is in compliance with the EU General Data Protection Regulation, among other others (Ada Health GmbH, 2019b).

Ada is designed with an AI-powered conversational interface that provides users with possible diagnosis for their symptoms (Milburn, 2017). The machine-learning-based bot therefore firstly asks the users questions regarding their age, gender and type of the symptom. The subsequent conversation then focusses on the specific conditions of the symptom such as the area of the pain or when it primarily occurs. The software ultimately provides a report with the possible causes for the symptom based on a comparison of the generated information with the data base, consisting of thousands of people that match the age and gender of the user and learns from the provided feedback. Ada therefore helps ascertaining the cause through statistical likelihood, rather than diagnosing or treating the symptoms independently of other healthcare providers. Depending on the severity of the cause, the application may advise users to seek for medical advice from a doctor (Brodwin, 2018).

4. Methodology

The methodological approach of this dissertation includes a mixed method, employing both qualitative and quantitative research to respond to the posed research questions. According to Molina-Azorin, Bergh, Corley & Ketchen (2017) the mixed method approach enables a more integrated comprehension of intricate research subjects. Edmondson & McManus (2007) in addition claimed, that a mixed approach can enhance the understanding of present mechanisms of quantitative findings for mostly undeveloped fields of research. Thus, in this study the exploratory qualitative design built the foundation for the variables and scope of the quantitative research.

The qualitative research was conducted in the form of a focus group and had the intention of gaining a first understanding of the attitudes of participants towards the complex subject matter and identify possible connections between the variables of the quantitative research. The quantitative research was conducted in the form of an online survey and had the objective of analysing the effects of the satisfaction level of patients and the perception of the app Ada, as the independent variables, on the intention to adopt Ada, as the dependent variable.

4.1. Focus Group

4.1.1. Main Research Approach

The fields of interest of the qualitative research were to discover the patients' perception on potential deficiencies of traditional health care services and to evaluate the hence deriving opportunities for AI-based preliminary diagnosis tools. Furthermore, due to the rising privatization (Roy et al., 2014) and innovation disruption of the health care sector (Hwang & Christensen, 2008), patients are confronted with substantial changes. It is thus inevitable to conduct research that integrates the individuals' perspective, to understand practical implications for healthcare organizations. The findings of this study are therefore of particular relevance for hybrid organizations directly delivering health services to patients through technology. In order to meet this purpose, the in-depth group interview was selected as the adequate approach, since it does not fully limit the thoughts of respondents and thus provides more specific insights concerning the attitudes or experiences of patients (Kitzinger, 2005).

Furthermore, the interactive discussion between participants can yield to lines of argumentation, that reveal complex and subconscious thinking processes (Morgan, 1996). According to Wong (2008) focus groups are in addition a well-suited research method for fields related to public health.

4.1.2. Data Collection and Sampling

To collect the qualitative data, one focus group has been run in the form of a semi-structured group interview by one moderator complemented by two transcript writers. A non-probability convenience sampling method was used for the acquisition of participants (Etikan, Musa & Alkassim, 2016).

The sample size of the group interview consisted of six participants, who were between the age of 21 and 26 and were equally distributed in terms of their gender. All of the respondents were inscribed as Master students (see Appendix 1a).

4.1.3. Research Design

The focus group took place in a calm and relaxed atmosphere, allowing participants to feel more comfortable and share their thoughts more openly. The session started with an explanation of the guidelines of focus groups in general, an overview of the subject and a brief introduction of the participants. Subsequently the audio recording of the discussion began. The duration of the group interview amounted to one hour and ten minutes. The interview protocol (see Appendix 1b) was subdivided in two broad themes – health services in general and artificial intelligence. The first part aimed at understanding what the overall perception of the healthcare system was, to detect possible deficiencies and therefore derive opportunities for current healthcare providers and emerging health service models. The interview protocol of the first part was consequently built with the following topics: general attitudes, habits and performance and judgements of the healthcare services. The latter part had the objective of understanding the thinking processes and perception of respondents concerning artificial intelligence in general and based on the example of Ada. The participants were therefore initially asked about their knowledge and attitudes towards artificial intelligence. Before asking the participants

questions regarding Ada, the concept was briefly explained and participants were shown a PowerPoint presentation of the app's usage process on a projector, to facilitate the accuracy of their attitudes. The interview protocol for AI-based health services and the case of Ada integrated the following topics: experience and attitudes, image and feelings and perception of practical relevance of the concept. To ensure unbiased results regarding the images and feelings, the participants had to note their answers on a paper without a preceding discussion.

4.1.4. Data Analysis

The systematic method used for the analysis and interpretation of the obtained data was the thematic analysis (Marshall & Rossman, 1999). This approach bears the advantage of narrowing down the complexity and extracting the key information of the qualitative data. According to Braun & Clarke (2006) the thematic analysis can additionally be applied more independently from theory and epistemology, allowing for greater flexibility and less constrained insights. Since the focus group is also intended to deliver a first reference point for the subsequent quantitative research this analysis will primarily focus on the first two steps of the thematic analysis – organisation and identification of a thematic framework (Rabiee, 2004).

Before reducing the data set, the transcribed text first had to be organised. The organisation of the data was initiated by the familiarisation with the transcript and the simultaneous recognition of commonalities to develop preliminary broad themes. The consulted reading method for these processes was of interpretive nature (Mason, 2002). The conceptualisation of the data was therefore partly conducted by the unaltered substance of the responses, as well as by the moderators' inference of the coherences. The preliminary broad themes, developed with the statements of participants and the questionnaire structure, were 'Perception of Healthcare Services', 'Deriving Opportunities', 'Perception of Ada' and 'Applications of Ada'. The second step of the analysis was to generate categories within the previously established subjects (Rabiee, 2004). This was done by recognizing patterns concerning the addressed topics by participants. The common contextual patterns of the perception of healthcare systems for example were the categories quality, availability and accessibility.

4.1.5. Results and Findings

As previously established, the findings are based on the obtained insights of the qualitative primary data collection (e.g. non-random convenience sample) and can therefore not be considered representative (Malhotra & Birks, 2007). The thematic framework can be broadly divided into four interconnected broad themes: 'Perception of Healthcare Services' 'Deriving Opportunities'. 'Perception of Ada' and 'Applications of Ada', as illustrated in the subsequent figure 2:

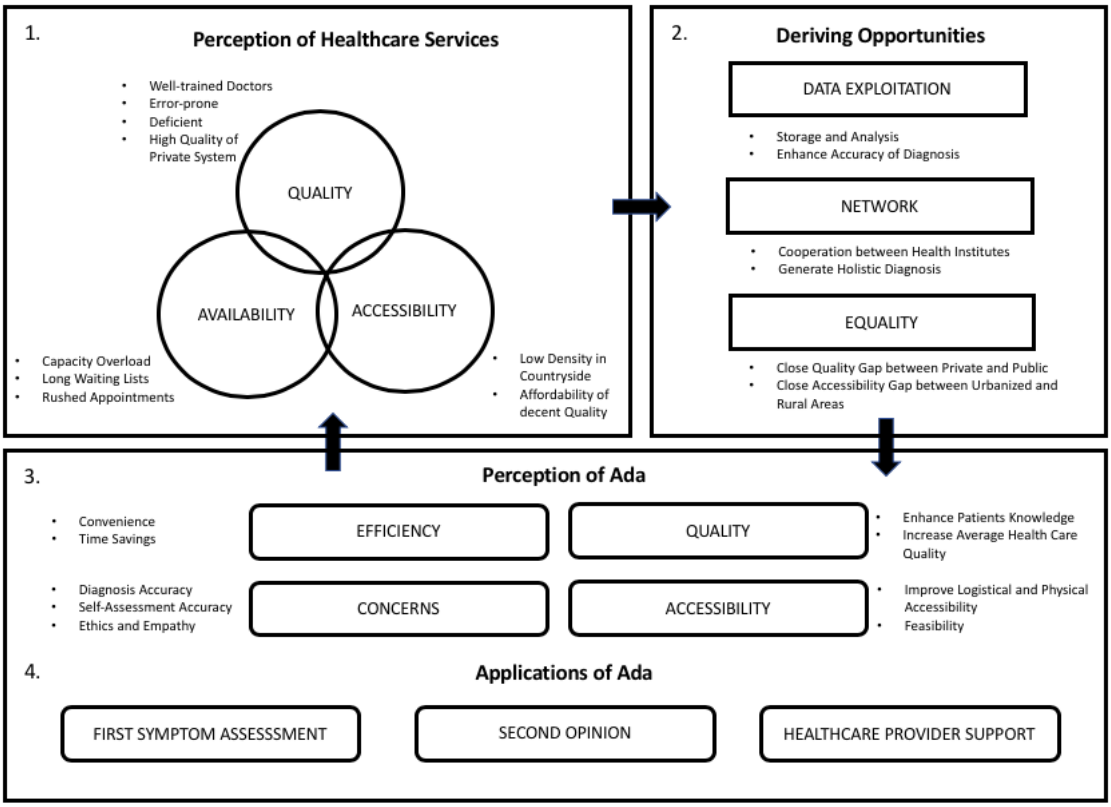


Figure 2 *Thematic framework derived from the qualitative analysis*

The responses of the interviewees analogously implied the division of the perception of healthcare services in three main categories – Quality, Availability and Accessibility.
Respondents indicated, that the Quality of healthcare services, significantly varies between public and private services. Despite the perception of well-trained doctors overall, the quality of public healthcare services was categorized as deficient and error prone. This finding is substantiated by the Institute of Medicine report stating that "[…] deaths due to medical errors exceed the number attributable to the 8th-leading cause of death". The deficiency of public

hospitals and doctor offices could primarily be reduced to structural inefficiencies and poor management. Especially the deficient structure of the process chain and the lack of interconnectivity between different healthcare providers are contributing to the error susceptibility (Tucker & Edmondson, 2003). Private healthcare providers in contrast were attributed with smooth operations, a sophisticated treatment quality and positive experiences. The availability of healthcare services also showed a qualitative gap between private and public healthcare providers. The participants indicated a capacity overload of public healthcare providers deriving from the high demand of healthcare services and the decreasing human and financial resources on the organizational side. As a consequence, the waiting lists for appointments are long and the appointments itself are rushed. The last emerging category, the accessibility, can be subdivided in financial and logistical accessibility. Respondents evaluated that a decent quality of services is affordable for the majority of treatments. In addition, minor and frequent diseases are mostly dealt with effectively. The logistical access however was particularly difficult for people living in less urbanized areas, due to the low density of healthcare services on the countryside.

The dissatisfaction of respondents concerning certain aspects of the current healthcare system, in return facilitates opportunities for private and public organizations and in further consequence for innovative hybrid organizations such as Ada. The three general terms, describing potential opportunity fields, that could be extracted from the respondent's healthcare assessment were Data Exploitation, Network and Equality.

As part of the Data Exploitation, the storage and analysis of data seemingly offers potential for improvement. The loss and confusion of data is one of the perceived drivers of the error rates of healthcare providers. In addition, public healthcare providers are partly overstrained with more complex health issues. The storage and analysis of data could reduce the error probability (DesRoches, Campbell, Rao, Donelan, Ferris, Jha, … & Blumenthal, 2008). Another prospect for healthcare providers is the establishment of an integrated network. The cooperation of different healthcare providers could generate positive network effects and ease the transmission of the patient's data between interfaces. As a consequence, the loss of relevant patient information, when switching between differing healthcare facilities, could be reduced. This could not only avoid potential mistakes but produce more holistic and accurate diagnosis and therefore raise the value proposition for providers and patients. The final opportunity deriving from the perception of the participants concerns the equality within the healthcare services. The quality gap between the private and the public service providers offers a chance for

organizations conceptualized to provide access and improve the quality of health services for everyone. These organizations can function as a supportive mean for public healthcare services or replace their task for less severe health issues.

To assess, whether Ada is suited to exploit the identified opportunities the next section focusses on the findings of the participants' perception and applications of the app.
As previously mentioned, one of the major quality insufficiencies of traditional healthcare providers, was the inefficiency of their services. Ada was perceived as being able to reduce the doctor appointments of patients with minor health problems and therefore relieving traditional healthcare providers. This finding is approved by a report of Deloitte (2016), stating that AI could reduce unnecessary medical interventions. Another benefit of Ada would be the time saving, due to the simplicity and quickness of the health assessment. Nonetheless, the respondents also had concerns about the app Ada. The diagnosis accuracy was perceived to be less precise when compared with the diagnosis of doctors. The respondents consequently agreed on not using the service Ada for serious health issues, if it was not for getting a second opinion. The perceived credibility and trust in the app were interdependent with the size of the user base. The larger the customer base, the higher the perceived accuracy on account of the broader data pool. The precision of the diagnosis was yet not only related to the expertise of the service, but also to the respondents' concern of a false self-assessment of their symptoms. The ethics and the empathy of Ada also played an important role for participants. Some interviewees were worried about the forwarding of their disclosed information to third parties such as insurance companies, who could in correspondence charge higher rates for their services. The opposing side however, argued that their information is available to third parties already. According to the respondents Ada nevertheless possesses the potential to improve the overall healthcare quality. The expertise of Ada could help enhance the quality of the first assessment of patients. The participants common first step to inform themselves about their symptoms was online research. The enquiry through browsers like Google could negatively influence the patient's health because of false information and self-diagnosis. The unlimited availability and simple access to the app additionally allows for a more dynamic health pattern evaluation. Since traditional healthcare provider are being visited less frequently by patients, they will only capture specific moments along the disease progression. Ada could therefore support traditional healthcare providers with their diagnosis and subsequently treatments. Furthermore, the usage of Ada could improve the dialogue between patients and healthcare providers, since users would already have a competent first assessment of their issues.

4.2. Online Survey

4.2.1. Main Research Approach

The quantitative primary data collection was conducted through a nonexperimental design in the form of an online survey (Malhotra et al., 2007). The research design was conclusive and causal (Malhotra et al.,2007) , since the main objective of the quantitative study was understand the relationship between the two independent variables 'Patients' Healthcare Service Satisfaction' (X1) and 'Perception of AI-based Preliminary Diagnosis Tools' (X2) on the dependent variable 'Patients' Usage Intention of AI-based Preliminary Diagnosis Tools' (Y).

4.2.2. Data Collection and Sampling

The data collection process of the online survey can be characterized as formal, direct and structured (Malhotra et al., 2007). The survey was constructed with the web-based survey tool Qualtrics and has been accessible for participants from the 2nd until the 13th of November 2019. The survey link was distributed through direct messaging as well as through social media groups, such as Facebook and WhatsApp. The employed sampling method was therefore a non-probability sampling in the form of a convenience sample, due to the limitation of resources and a higher accessibility of the population (Etikan et al., 2016). As a result, the obtained insights can consequently not be generalized and are not representative for the population. The target population of the survey was defined as any young adult person between the age of 18 and 34 years. Young adults were selected as the target population since they possess the highest smartphone ownership rates among the different age groups, with 93 to 94 percent (Deloitte, 2019).

4.2.3. Research Design

A pre-test was done preceding to the publishing of the questionnaire, to optimize the procedure and quality of the survey (Malhotra et al., 2007). The questionnaire was sent to five people and evaluated according to the criteria 'layout', 'structure' and 'clarity'. As a result of the pre-test, certain elements such as the timer in the second part were implemented. Furthermore, the

wording was occasionally adapted. The term ‘Doctors Office’ seemed to be better understandable than ‘Office Clinic’ for example.

The survey was subdivided in three different parts for each individual variable. The first part focused on the satisfaction of respondents with the average healthcare services they make use of. Participants were therefore initially asked which type of healthcare services they frequently use, to deduce their level of satisfaction with specific providers. In addition, respondents were requested to state their most common first reaction after noticing symptoms of diseases. This should ultimately enable assessing the potential of implementing Ada in the beginning of the patients’ journey. Lastly participants were asked to rate attributes of healthcare services according to their level of satisfaction on a matrix table. The independent variable ‘Patients Healthcare Service Satisfaction’ was measured with a modified version of the SERVQUAL model, since it has been found suitable for the adaptation to particular settings within the healthcare context (Naidu, 2009, Parasuraman, Berry & Zeithaml, 1988, Parasuraman et al., 1991). The model finally included three of the relevant determinants: Service Quality, Tangibles and Convenience. This variable is relevant for the developed conceptual model, since previous studies show that there is a causal relationship between the patient satisfaction and the loyalty of patients towards health institutions (Garman et al., 2004; Kessler et al., 2011; Nelson et al., 1992), which could affect the dependent variable ‘Patients’ Usage Intention of AI-based Preliminary Diagnosis Tools’. All of the attributes were measured with a 7 Point Likert Scale (Naidu, 2009).

The second part of the survey had the objective of introducing the concept of Ada to respondents and subsequently obtaining information regarding their perception of the service. Initially respondents were asked, whether they knew Ada and if and how frequently they have used it before. Participants were subsequently shown a description of Ada complemented by screenshots of the usage process of the app. The respondents could only continue after thirty seconds to ensure that they captured the provided information. The subsequent matrix tables requested respondents to indicate their level of agreement with statements concerning their perception of Ada. The second independent variable ‘Perception of AI-based Preliminary Diagnosis Tools’ derived from a part of the UTAUT model, that explores the acceptance and usage of technology (Venkatesh et al., 2003). The selected four relevant determinants for this study are the Relationship Expectancy Performance Expectancy (Davies, 1989; Davis et al. 1989, Moore & Benbasat (1991), Effort Expectancy (Davies, 1989; Davis et al. 1989) and the

Privacy Expectancy, which were summarized under the independent variable 'Perception of AI-based Preliminary Diagnosis Tools'. Again, all of the attributes were measured with a 7 Point Likert Scale (Venkatesh et al., 2003).

The last part of the survey intended to measure the samples' Usage Intention of Ada. The dependent variable `Usage Intention of Preliminary Diagnosis Tools' was also adapted from the UTAUT model (Venkatesh et al., 2003). The design of the employed matrix table and the scale were identical to the one used in the second part of the questionnaire. The used constructs for the final conceptual model are summarized in the following table 1:

Table 1 *Variables of the quantitative research*

Construct	**Model**	**Scale**	**Literature Source**
Patients' Healthcare Service Satisfaction (X1)	Modified SERVQUAL	7 Point Likert Scale	Naidu (2009)
Patients' Perception of AI-based Preliminary Diagnosis Tools (X2)	Modified UTAUT	7 Point Likert Scale	Davies (1989), Davis et al. (1989), Moore & Benbasat (1991)
Patients' Usage Intention of AI-based Preliminary Diagnosis Tools (Y)	Modified UTAUT	7 Point Likert Scale	Venkatesh et al. (2003)

4.2.4. Data Analysis

The quantitative data was exported from Qualtrics to the IBM software package SPSS used for statistical analysis. The successive analysis of the obtained data is divided into the sample characterization, general findings and the hypothesis testing. The sample characterization was analysed by using the descriptive statistics tool in SPSS. The general findings were generated with the frequency and descriptive statistics tool. The purpose of the general findings was to facilitate the insights of the hypothesis testing and to generate a holistic understanding of the subject. Lastly, the Multiple Linear Regression (SPSS) was selected as the statistical analysis tool for the hypothesis testing.

4.2.4.1. Sample Characterization

The sample size consisted of 119 respondents, with 42 percent being male and 58 percent female. The majority of the sample indicated 'Student' as their current status of employment with 62,2 percent, followed by 'Employed full time' with 28,6 percent. Furthermore, the predominant highest level of education of participants was a bachelor's degree with 54,6, as summarized in the table below:

Table 2 *Sample Characterization*

	Demographics	**Total Sample**
Gender	Male / Female	42 % / 58 %
Age	18 - 24	61,3 %
	25 - 29	38,7 %
Status of Employment	Employed full time	28,6 %
	Employed part time	10,9 %
	Unemployed looking for work	4,2 %
	Freelancer	1,7 %
	Student	62,2 %
	Unemployed due to Disability	0,8 %
Highest Level of Education	High school graduate	9,2 %
	Bachelor's degree	54,6 %
	Master's degree	36,1 %

4.2.4.2. Factorial Analysis and Scales Reliability

Before proceeding to the analysis, the data had to be prepared. The data preliminary analysis preparation process included excluding outliers, deleting incomplete responses and respondents inconsistent with the characteristics of the target sample (Field, 2013). This reduced the target sample from 138 to 119 respondents.

Subsequent to the preparation process, a factorial analysis was implemented for each of the variables to evaluate the relevant dimensions of the items for the hypothesis testing. Items, that fit neither of the ascertained factors were excluded from the analysis.

The factorial analysis for the independent variable 'Patient Healthcare Satisfaction' (X1) suggested three different dimensions labelled 'Service Quality', 'Tangibles' and 'Convenience'. The factorial analysis of the second independent variable 'Perception of Ada' (X2), indicated the classification of five factors. The established constructs from the research design had to be partly redefined, due to the implication of the factorial analysis and to preserve consistency within the identified dimensions. The final factors used for the hypothesis testing were the 'Relationship Expectancy', 'Performance Expectancy', 'Effort Expectancy', 'Credibility' and 'Privacy Expectancy'. Lastly, the dependent variable 'Usage Intention' (Y), remained one factor.

None of the items showed a correlation value of above 0,8, therefore not indicating a multicollinearity of the variables. KMO and Bartlett's test values of the factorial analysis all exceeded 0,8 and were significant with p=0,000. The results of the factorial analysis are summarized in the table 2 below:

Table 3 *Factorial Analysis*

Variable	KMO and Bartlett's Test	Total Variance Explained	Eigenvalues	Dimensions
X1	0.803	67.10	4.273	Service Quality
			1.329	Tangibles
			1.108	Convenience
X2	0,825	66.05	7.113	Relationship Expectancy
			2.082	Performance Expectancy
			1.576	Effort Expectancy
			1.301	Credibility
			1.139	Privacy Expectancy
Y	0,861	61.256	4.288	Usage Intention

Furthermore, it was essential to test the reliability of the variables, due to the slight alterations from their original models. According to Bonett & Wright (2015), the Cronbach's alpha reliability sample value is an appropriate tool to measure scale reliability and internal consistency, if complemented by a non-restricted confidence interval. The Cronbach's alpha values exceeded 0.7 for all the constructs, except for the `Credibility` factor of X1 (0.330),

which was consequently precluded from the analysis. The 95% confidence intervals of the two-way mixed model indicated a high significance, therefore validifying the reliability of all the remaining constructs. The results of the Cronbach's alpha reliability test of the independent and dependent variables are summarized in the table 4 below:

Table 4 *Cronbach's Alpha Test*

Variables	Cronbach's Alpha	Inter-Item Correlation	F-Test
(X1a) Service Quality	0,719	No correlation above 0,5	p = 0,001
(X1b) Tangibles	0,869	No correlation above 0,8	p = 0,000
(X1c) Convenience	0,748	No correlation above 0,6	p = 0,000
(X2a) Relationship Expectancy	0,829	No correlation above 0,8	p = 0,000
(X2b) Performance Expectancy	0,897	No correlation above 0,8	p = 0,000
(X2c) Effort Expectancy	0,704	No correlation above 0,6	p = 0,000
(X2d) Privacy Expectancy	0,806	No correlation above 0,7	p = 0,000
(Y) Usage Intention	0,891	No correlation above 0,8	p = 0,000

4.2.4.3. Results and Findings

4.2.4.3.1. General Findings

This section intends to provide insights not being directly addressed by the hypothesis testing. In specific the analysis of the participants' habits concerning health care providers and their awareness and user rate of Ada.

The evaluation of the participants utilization of healthcare providers showed, that 61,3 percent of the respondents most frequently make use of the doctor's office, followed by public hospitals with 24,4 percent and private hospitals with 19,3 percent. 13,3 percent of the participants stated, that they do not make us of any of the healthcare providers mentioned above. The findings are illustrated in the figure 3 below:

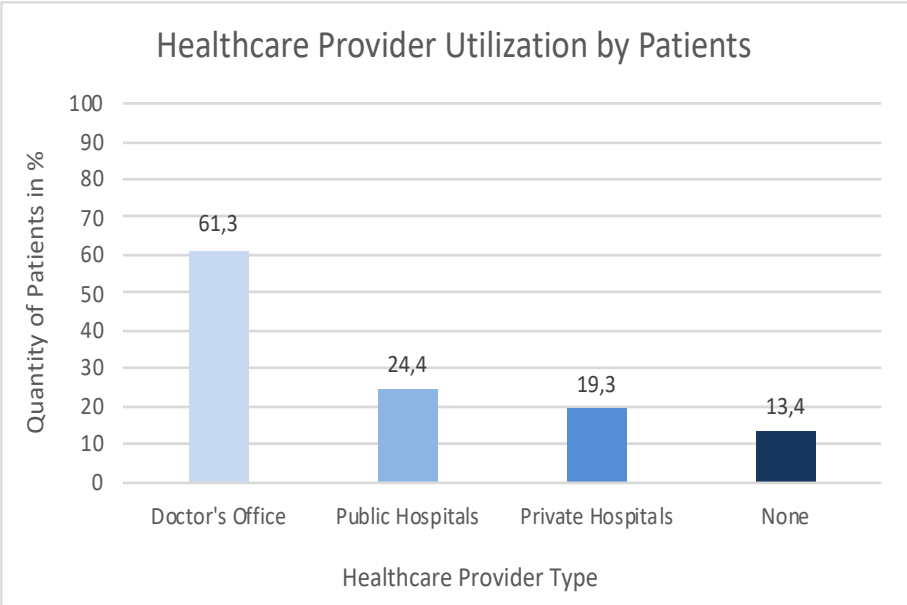


Figure 3 *Healthcare Provider Distribution of Patients*

In addition, participants were asked to indicate their most common first steps after noticing disease related symptoms. The respondents were allowed to select a maximum of two choices. With 61,3 percent, the majority of the target sample indicated 'Consult Family or Friends' as their most common reaction to noticing disease related symptoms, followed by 'Internet Research with 58 percent.

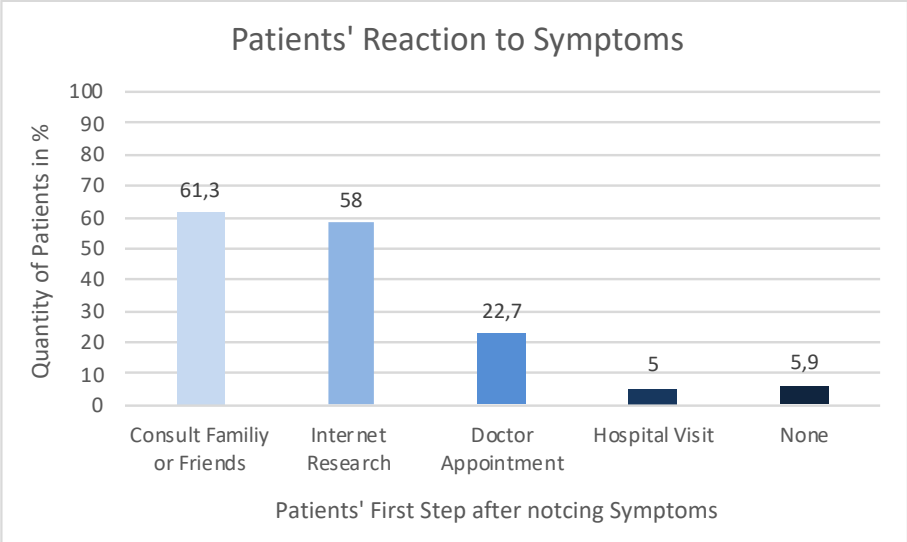


Figure 4 *Patients' Initial Reaction to Symptoms*

Furthermore, participants were asked for which occasion they would intend to use Ada. The patients' usage intention 'For minor diseases' had the highest average mean (4.91) in this

regard, followed by the intention to use Ada ‘Instead of researching my symptoms online’ (Mean = 4.66). The sample had the least intention to use Ada for helping their doctors to diagnose their symptoms (Mean = 3.80).

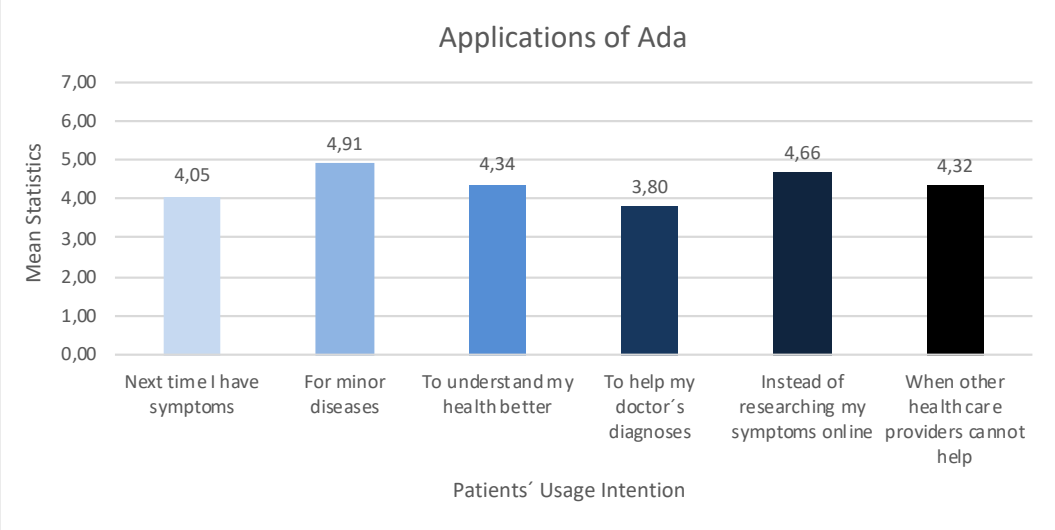


Figure 5 *Patients' Application of Ada*

4.2.4.3.2. Hypothesis Testing

To precisely assess the relevant factors affecting the patients’ intention to use Ada, hypothesis have been constructed and tested.

The relationship between the patients’ level of satisfaction with certain dimensions of health care services (X1) and their usage intention of AI-based preliminary diagnosis tools’ (Y) has been tested with the hypothesis H1a-c. The hypothesis H2a-d focused on the relationship of the perception of different constructs regarding AI-based preliminary diagnosis tools by patients (X2) and their intention to use such tools (Y). The multiple linear regression was identified as the suitable test for the hypothesis testing, since all of the variables are metric. The items of the matrix of the dependent variable ‘Behavioural Intention to use Ada’ (Y) had to be transformed into one variable prior to the regression. The multiple linear regression was run with the stepwise method, in order to solely include the predictors accounting for most of the variation in the dependent variable and to additionally check the model for multicollinearity.

Hypothesis 1

The first part of the analysis focusses on the relationship between the level of satisfaction of patients and the intention to use Ada. Based on the findings of previous studies (Naidu, 2009; Sadiq Sohail, 2003; Parasuraman et al. 1991), the following hypotheses have been formulated:

H1a: There is a negative relationship between the patients' level of satisfaction with the *Service Quality* of healthcare services and the patients' *Usage Intention (Y)* of

The mean of the perceived Service Quality (X1a) amounted to 4.84, indicating that patients tend to be 'Slightly satisfied' with this dimension of health care services. Patients were most satisfied with the 'Competency' of the health care staff (Mean = 5.13) in this regard, while the 'Duration of appointments' (Mean = 4.52) was the least evaluated item. The entered predictor of the regression model was solely 'Competency' with an R Square value of 0.032, indicating that the item explains for only 3.2 percent of the variance of the Usage Intention (Y). The unstandardized coefficient exhibited, that an increase of one point in the 'Competency' of the health care staff, resulted in 0.169 of positive change in the Patients Usage Intention (Y) of Ada. The B value hence connotes, that patients would me more likely to use Ada, the higher the level of satisfaction with the competency of health care physicians is. Since the model additionally exhibited a significance level of p=0.005. the hypothesis H1a had to be rejected.

The positive relationship between the variables could be explained by the patients' perception of Ada as preliminary complement to traditional health care services, rather than a substitutive diagnostic tool. This theory is substantiated by the findings of patients intending to use Ada for research purposes instead of researching their symptoms online (Mean = 4.66). However, patients do not intend to use Ada as a mean to directly support their doctors with detecting the correct diagnosis (Mean = 3.80), but to rather obtain initial insights on their health condition (Mean = 4.34). A higher perceived competency of physicians could thus result in an increase in appointments by patients, who would use Ada to precedingly inform themselves about their symptoms.

H1b: There is a negative relationship between the patients' level of satisfaction with the *Tangibles* of healthcare services and the patients' *Usage Intention* of Ada.

The linear regression for the hypothesis H1b did not suggest a significant relationship between the patients' level of satisfaction with the tangibles of healthcare services and the intention to use Ada. Consequently, the hypothesis has to be rejected.

> **H1c:** There is a negative relationship between the patients' level of satisfaction with the *Convenience* of healthcare services and the patients' *Usage Intention (Y)* of

The entered predictor for the multiple linear regression was 'Ease of getting an appointment' (Mean = 4.13) and the R Square value of the model suggested, that the item explained 4,2 percent of the variance of the Usage Intention (Y). The positive unstandardized coefficient of 0.153 and the significance level of 0.025 resulted in the rejection of the hypothesis H1c. This finding once more suggested the complementary usage intention of Ada by patients for appointments with more traditional health care services. Therefore, the easier it is for patients to schedule an appointment, the higher the Usage Intention (Y) of Ada.

The R Square value for the overall model of the 'Patient Healthcare Service Satisfaction' (X1) was 0.042 and model was significant with p = 0.025.

Hypothesis 2

The second section of the quantitative analysis intends to identify the relationship between the patients' perception of the AI-based preliminary diagnosis tool Ada and the patients' intention to use Ada. Based on the findings of previous studies (Venkatesh et al., 2003), the following hypotheses have been formulated:

> **H2a:** There is a positive relationship between the patients' *Relationship Expectancy (X2a)* with Ada and the patients' *Usage Intention (Y)* of Ada.

The entered predictors of the Relationship Expectancy (X2a) model were the items 'I would trust Ada's consistency' (Mean = 4.43), 'My family would have a positive perception of me using Ada'(Mean = 3.94) and 'I believe that I would be able to correctly describe my symptoms' (Mean = 4.72). The R Square of the Relationship Expectancy amounted to 0.412, with the strongest predictor 'I would trust Ada's consistency' explaining 32.9 percent of the Usage

Intentions (Y) variance. The unstandardized coefficients of the predictors were all positive and significant, therefore confirming the hypothesis H2a. The model indicates a strong relationship concerning the patients' Relationship Expectancy (X2a) and the intention to use Ada. In this regard, the patients trust in the consistency and consequently the reliability of the app, is especially decisive in determining the usage intention. Disregarding of the patients' indifference about how their family would perceive them when using Ada (Mean = 3.94), the judgement of relatives even has a bigger impact on the adoption of the app then the perception of friends (Mean = 4.49). The patients seemed to be less doubtful concerning their ability to describe their symptoms correctly (Mean = 4.72), however it was still essential for their Usage Intention of Ada.

H2b: There is a positive relationship between the patients' *Performance Expectancy (X2b)* of Ada and the patients' *Usage Intention (Y)* of Ada.

The Performance Expectancy (X2b) model was significant with a value of p=0.003 and accounted for 34.9 (R Square=0.349) percent of the variance of the dependent variable (Y). The two entered predictors of the model were 'Ada would make it more convenient to find a correct diagnosis' (Mean = 5.07) and 'Ada would be helpful for improving my health' (Mean = 4.36). The unstandardized coefficients for both of the items were positive and significant, consequently confirming H2b. The most substantial predictor of the model was the convenience of detecting the correct diagnosis for symptoms, which explained 29.6 percent of the variance of the Usage Intention (Y). More precisely, the convenient process of finding the correct diagnosis, constitutes the most relevant inducement to adopt Ada, regarding the Performance Expectancy. Patients would furthermore have a higher likelihood of adoption of Ada, if they were to believe in a positive contribution to their health by the app (Mean = 4.36). The patients' belief of Ada functioning as a supportive instrument for their doctors, was not entered as a predictor, therefore suggesting patients attribute a higher competency to doctors and also rather perceive Ada as a mean to improve their individual health-consciousness.

H2c: There is a positive relationship between the patients' *Effort Expectancy (X2c)* of Ada and the patients' *Usage Intention (Y)* of Ada.

The entered predictor of the Effort Expectancy (X2c) was the item 'I think that it would be easy to use Ada' (Mean = 5.94). The R Square value presented an explained variance of 15,3 percent

of the Usage Intention (Y). The model was significant, and the unstandardized coefficients indicated a positive relationship between the predictor and the dependent variable (Y). As a result, H2c can be confirmed. As a result, the ease of using Ada is a positive contributing factor for the Usage Intention (Y) of patients. A complex usage interface and symptom evaluation process would consequently decrease the patient's willingness of using Ada.

H2d: There is a positive relationship between the patients' *Privacy Expectancy (X2d)* in Ada and the patients' *Usage Intention (Y)* of Ada.

The relevant predictors for the Privacy Expectancy (X2d) model were 'I would feel comfortable with sharing my data with Ada' (Mean = 3.84) and 'I would trust Ada to only use my data for the diagnosis' (Mean = 4.09). The model explained for 22.1 percent of the variance in Usage Intention (Y). Both of the predictors B values were positive and significant, hence confirming the hypothesis H2d. The low mean (3.84) of the first predictor combined with a R Square value of 0.188 suggests that patients are uncomfortable with sharing their disease related data with Ada. This might be explained by the fact, that the provided information is highly personal and private, and the majority of people could not yet feel comfortable with sharing sensitive information online. The medium mean (4.09) of the second predictor indicates certain reservations of patients concerning the application of their data by Ada. As a consequence, a better perception of Ada's data privacy, would increase the willingness of patients to use Ada.

The R Square value for the overall model of the 'Perception of AI-based Preliminary Diagnosis Tools' (X2) was 0.557 and was significant with $p = 0.010$.

Rerunning the multiple linear regression with the items of the hypothesis testing for H1 and H2, indicated that the conceptual model explained 55.7 percent of the variance in the Patients' Usage Intention (Y). The entered predictors of the model according to the stepwise method solely included items from the independent variable 'Perception of AI-based Preliminary Diagnosis Tools' (X2). The Patient Healthcare Satisfaction (X1) consequently does not have a relevant effect on the Usage Intention (Y) within the boundaries of the conceptual model, presented in the conceptual framework section.

4.2.5. Summary of results

The following table 5, summarizes the results of the hypothesis testing.

Table 5 *Hypothesis Testing Summary*

Hypothesis	Predictors	Mean	R Square	Significance Level	Result
(H1a) Service Quality	Competency	5.13	0.032	p = 0.005	Rejected
(H1b) Tangibles	/	/	/	/	Rejected
(H1c) Convenience	Ease of getting an appointment	4.13	0.042	p = 0.025	Rejected
(H2a) Relationship Expectancy	'I would trust Ada's Consistency' 'My family would have a positive perception of me using Ada' 'I would be able to correctly describe my symptoms'	4.43 / 3.94 / 4.72	0.412	p = 0.000	Confirmed
(H2b) Performance Expectancy	'Ada would make it more convenient to find a correct diagnosis' 'Ada would be helpful for improving my health'	5.07 / 4.36	0.349	p = 0.003	Confirmed
(H2c) Effort Expectancy	'I think it would be easy to use Ada'	5.94	0.153	p = 0.000	Confirmed
(H2d) Privacy Expectancy	'I would feel comfortable with sharing my data with Ada' 'I would trust Ada to only use my data for the diagnosis'	3.84 / 4.09	0.221	p = 0.000	Confirmed

5. Conclusion

The following paragraphs will discuss the discovered findings of the qualitative and quantitative studies employed to respond to the initially formulated research questions. The findings will subsequently be compared to deduce academic and practical implications.

5.1. Discussion

The purpose of this dissertation was to study potential opportunities for autonomous artificial-intelligence-based preliminary diagnosis tools and understand the factors influencing their usage intention by patients. The research employs a mixed method, namely a qualitative and quantitative approach. The objective of the qualitative research was to assess the individual's perspective on the opportunities derived from the perception of traditional healthcare services and the concept of Ada. The underlying objective of the quantitative study was to reinforce the findings of the conducted focus group and identify possible influences affecting the usage intention of patients.

The following paragraphs will discuss the discovered findings of the qualitative and quantitative studies employed to respond to the initially formulated research questions. The findings will subsequently be compared to deduce academic and practical implications.

> **RQ1**: "*What are the opportunities that can be seized by Artificial Intelligence-based preliminary diagnosis tools?"*

The collected information of the focus group indicated an inequitable quality distribution of healthcare services on various levels. Private services were accredited with a universal satisfactory quality, whereas public services especially lacked proficient management, efficient structures and sufficient availability. The resulting consequences range from substantial error susceptibilities over rushed appointments. The low density of medical facilities in rural areas further aggravates the imbalance of an even access to qualitative healthcare services. The detected deficits consequently derive possibilities for improvements for pre-existing physicians and simultaneously opportunities for newly emerging health providers. The enhanced exploitation of the patient's data, the establishments of beneficial networks between healthcare

institutions and the reduction of quality disparities among different services were primarily identified in this regard. In order to evaluate the potential of Ada to address the ascertained challenges, the perception and application of the preliminary diagnosis tool by the participants were assessed. Ada was perceived as being efficient, quality improving and accessibility increasing. Ada's attributed abilities to improve the individual's health and enhance the average accessibility for health care services, positively contribute to closing the quality gaps for publicly and privately insured patients, as well as to approximating the access gap for citizens of rural and urbanized areas. The concerns of an inaccurate self-assessment and possibly receiving a misdiagnose, prevented participants from perceiving Ada as a suited mean to enhance the accuracy of diagnoses. Some respondents were further worried about the privacy of their data, despite acknowledging the potential of exploiting health related data through AI-based technologies. The indicated applications of Ada reflect the concerns regarding the expertise behind the health assessment. Participants primarily intended to use Ada as first symptom evaluation instead of researching their symptoms in the internet. The app was additionally seen as a last resort, if conventional healthcare physicians could not provide solutions for the present symptoms. Although less unanimously, participants considered using Ada as a tool to support their doctors, since the app potentially captures the dynamics of disease patterns.

RQ2: "*What factors determine the patients' intention of using Artificial Intelligence-based preliminary diagnosis tools?"*

The first part of the analysis of the quantitative data indicated, that respondents broadly categorize their level of satisfaction with healthcare services into three different dimensions: service quality, tangibles and convenience. The competence of traditional healthcare providers was found as the most decisive attribute of the service quality contributing to the usage intention of the preliminary diagnosis tool Ada. The positive relationship suggests, that a higher competency level increases the appointments with classical physicians and therefore accordingly increases the usage intention of Ada. In contrast to the findings of the focus group, the patients rather intended to use Ada as a preliminary source of information, than as a supportive mean for healthcare providers directly. The ease of getting an appointment represented the most important attribute of the convenience aspect of healthcare services. The effect on the usage intention of Ada was again positive reinforcing the possible explanation of

a complementary usage intention of the app. The level of satisfaction with the tangibles of healthcare institutions on the other hand, did not have any significant effect on the usage intention of the app.

The perception of Ada can be subdivided into four relevant dimensions being the relationship expectancy, performance expectancy, effort expectancy and privacy expectancy. The relationship expectancy contained the external perception of family members when using Ada and the perceived relationship between the participants and the app. In this regard the trust in Ada's consistency represented the most important characteristic for the sample and explained 32.9 percent of usage intention of the preliminary diagnostic tool. The performance expectancy also proved to be highly relevant for determining the usage intention. Especially the convenience of finding a diagnosis positively contributed to the intention of using Ada in the future. The effort expectancy also indicated a significant impact on the usage intention of Ada, although it merely explained 15.3 percent of it. The relevance of the ease of using therefore seems to be outweighed by the perceived health contribution and the expected image by others when using the application. What concerns the privacy expectancy, Ada specifically has to establish a trustful and transparent base with patients and reduce their concern about sharing their data. The expectancy of Ada only using the provided data for the diagnosis itself is consequently highly relevant.

5.2. Contributions to Theory and Practice

The successive paragraphs will put emphasis on the theoretical and managerial contributions of the conducted research within this thesis.

5.2.1. Theoretical Contribution

The proposition of hybrid organizations intervening market failures deriving from government cuts, decreasing workforces and inefficient structures in the healthcare sector is broadly discussed in present literature (Addicott, 2011; Baines, Bull & Woolrych, 2010; Roy et al. 2014). The utilization of AI-based decision-making and medical technology in general present effective means to counteract arsing inequality trends (Wahl, Cossy-Gantner, Germann &

Schwalbe, 2018) and further increase the accessibility of health care services (Chen et al., 2012). In this regard, digital applications illustrate one possible form of health-improving vehicles. The acceptance and perception of such applications, however, are mainly unexplored, despite being useful indicators for the utility value for patients.

The findings of this study therefore contributed to literature on the theory of the subjective norm (Ajzen, 1991; Davis et al., 1989; Mathieson, 1991; Taylor et al., 1995), the relative advantage (Moore et al. 1991), the perceived ease of use (Davis 1989; Davis et al. 1989) and the model of organizational trust (Schoorman, Mayer & Davis 2007) related to the user acceptance of information technology (Venkatesh et al. 2003).
The subjective norm theory emphasizes the social influence on an individual's behaviour. The conducted study revealed the significant importance of a positive attitude of family members on the usage intention of information technology. The findings of this dissertation therefore further confirm the subjective norm theory within the context of AI-based information technology. The relative advantage theory describes the perception of an innovation being superior compared to its precursor. As the study indicated, the perceived advantage of the preliminary diagnosis tools over traditional health care providers in some dimensions has an impact on the decision-making of users. Furthermore, the effect of the perceived ease of use on adopting information technology was further consolidated by the findings, as well as the relevance of organizational trust in this regard.

5.2.2. Managerial Contribution

Taking all of the findings into consideration, Ada is perceived congruently to its actual purpose – functioning as a preliminary diagnosis tool. The app is not attributed with a sufficient level of expertise to substitute traditional healthcare providers. The external setting of the satisfaction level consequently is currently not decisive for the usage intention of Ada. As established in the focus group a higher acceptance for AI-based preliminary diagnosis tools within society, however, would facilitate the adoption of services such as Ada. The findings of the quantitative research, indicating the influence of the family members perception when using Ada, confirms the importance of social acceptability. Marketing efforts should therefore not merely be concentrated on a younger and digitally competent target group, but also establish acceptance among the influencing social contacts of the target group.

The usage intention of Ada is the highest for utilizing the application for minor diseases and as a substitute for researching symptoms on browsers online, as approved by both studies. The service of Ada therefore serves as an interface function for specific moments along the patient journey, primarily of preliminary nature. Ada's communication strategy with potential users should consequently focus on the specific utility functions identified and highlight the added value for the target group. Data privacy concerns also influence the decision-making of patients about whether to adopt Ada or not. The company therefore has to create transparent structures understandable for consumers and establish a base of trust.

Furthermore, although the simplicity of the usage interface is important, potential users were confident in their ability to correctly use the service. What is more evident for Ada is the emphasis of the expertise component of the application. The fact that patients, do not intend to use Ada for more severe diseases or as a supportive mean for their doctors, suggests a lack of belief in the competency of the application. The company should as a result put emphasis on the functionality and the data base compiled by medical experts. As participants of the focus group mentioned, certificates would raise the trust in the accreditation of the service. The intended applications of the app might alter mid-term, due to a broader database, and therefore higher competency, and an increasing social acceptance regarding similar services. The underlying strategies would have to be adapted according to the progress of the capability of the app and perception of potential users.

Regarding the implications for the healthcare industry itself interconnectivity issues descending from a lack of cooperation between health institutions (Kickbusch & Gleicher, 2012), are not likely to yet be solved through digital applications for the beneficiaries. Patients intend to utilize the application to enhance their individual understanding of their health, rather than to benefit from positive network effects through forwarding their health records. The inefficiency and capacity of healthcare providers will moreover also not be approached by autonomous health applications for patients. The preliminary diagnosis tools do not substitute classical services and are merely utilized for less severe diseases, which most commonly do not necessitate appointments with physicians. Challenges regarding the preservation of the healthcare quality, in contrast, could potentially be enhanced through AI-based applications. Patients would intend to shift their researching activity from a fluctuating competency of webpages to recommendations based on statistical likelihood and substantiated in the expertise of medical

professionals. The resulting health benefits combined with the high accessibility for everyone in the possession of a smart phone, would hence decrease the quality gaps between publicly and privately insured patients, as well as for rural and urbanized areas.

5.3. Limitations and Future Research

Despite the conducted research yielding to additional insights in a yet limited research domain, present limitations have to be considered. Firstly, the non-probability sampling of the implemented quantitative research does not permit representative conclusions (Malhotra et al., 2007). Nonetheless, the convenience sampling method is academically accepted and broadly employed, due to the restricted resources of many researchers and a higher accessibility to the population (Etikan et al., 2016). Furthermore, the implemented studies merely investigated the perception and behavioural intention of the age group ranging from 18 to 34 years old. The identified findings hence solely apply for potential users of that age class. In addition, the majority of the sample were university students, of which the majority potentially has a somewhat wealthy background. This might affect the relevance of the patient satisfaction as predictor for the usage intention of Ada, due to a better access to qualitative medical services for the sample.

Moreover, the chosen constructs founding the conceptual framework of the analysis had to be re-evaluated. The UTAUT model identified four relevant constructs for the evaluation of the usage intention of technologies. The factorial analysis of the quantitative research however, implied the alteration of two of the dimensions. Firstly, the social influence component was altered into the ‘Relationship Expectancy’ construct. The sole integration of the interpersonal perceptions from the social environment of patients, did not capture the importance of the expected relationship with the application itself. The evident adaptation possibly derives from an increased responsiveness of AI-based computational devices. The complexity of the interaction with interfaces of AI-based technologies has risen, therefore almost resembling interpersonal dialogues (Kietzmann, Paschen & Treen, 2018), enabling users to form deeper relationships. As Morgan & Hunt (1994) claimed, one of the foundations of committing relationships is the establishment of trust, which indicated by the findings of the qualitative and quantitative research also is a major factor in determining the adoption of artificial-intelligence-based technologies. Consequently, the UTAUT model should be modified for research in this

context and integrate dimensions regarding the relationship expectancy with technologies. Furthermore, the particularly sensitive context that Ada operates in, lead to amending the dimension ‘facilitating conditions’, to ‘Privacy Expectancy’. The rising significance of data is increasingly causing privacy concerns regarding the utilization of technologies (Okazaki, Li & Hirose, 2009).

The conducted research of this dissertation identified the relevant constructs concerning the perception of preliminary diagnostic tools and rejected the relevance of the patient’s healthcare dissatisfaction as an incentive to switch to technology-based alternatives. However, it remains unclear what determines the detected dimensions. Integrating the adjustments concerning the UTAUT model precedingly mentioned, future research should therefore further investigate what influences the relationship of users with artificial intelligence and evaluate the establishment of trust. Furthermore, the issue of data privacy concerns should be examined more precisely, due to the sensitive context of healthcare information. The findings could eventually support the rising number of organizations, which deliver technology-based alternatives for patients, in their strategic decision-making to improve the adoption rate of their services. This would not only have a practical relevance for the organizational side, since an increase in users would expand the present databases and consequently improve the diagnosis accuracy for the patients. The established insights of this dissertation should therefore already help contributing to the understanding of a newly developing field of research, with a high practical relevance for the future.

6. Appendix

Appendix 1: Focus Group

Appendix 1a: Participants

Name	Abbreviation	Age	Country of Origin	Country spent majority of adulthood
Kieran Genovese	K	25	Ireland	Ireland
Bastian Neubacher	B	26	Austria	Austria
Marta Andrade	MA	21	Portugal	Portugal
Maria Freire	MF	22	Portugal	Portugal
Vanessa Kläschen	V	26	Germany	Germany
Youssef Ben Ahmed	Y	24	Tunisia	Tunisia

Appendix 1b: Questionnaire

Focus Group Guidelines

1. **Briefing**

   a. Presentation of the participants (name, age, country of origin and where did you spend the majority of your adulthood) and broad introduction of the topic of the focus group

   b. Guidelines of the Focus Group
      i. What is a focus group and how does it work
      ii. Rules: don't interrupt, talk one at the time
      iii. There are no right or wrong answers
      iv. Always be honest
      v. Duration
      vi. Let's find out more about each other in a friendly atmosphere

A. General Health Services

2. **General Attitudes towards healthcare services / healthcare system**

   i. How would you describe healthcare services in your country?

   ii. What do you like about the healthcare services in your country?

   iii. What do you dislike about the healthcare services in your country?

   iv. What could be improved?

3. **Habits with Using Healthcare services**

   i. How would you describe your journey, after you start to feel disease-related symptoms?

ii. What are the problems that occur for you when trying figure out the cause of your symptoms?

iii. What are the problems that occur for you when trying to find the right medical department to treat your symptoms?

4. Performance and Judgements

a. Performance

i. How would you describe the logistical accessibility of health care service in your country?

ii. How would you describe the interconnectivity of different health services in your country?

iii. How would you describe the availability of healthcare services in your country?

b. Judgments

. How would you evaluate the overall quality of your received health services and why?

i. How would you evaluate the efficiency of the process of getting a diagnosis or treatment and why?

ii. How would you evaluate the simplicity of getting the right solution to your medical problems and why?

iii. What are the biggest weaknesses of the health care system in your country and why?

iv. What are the biggest strengths of the health care system in your country and why?

B. Artificial Intelligence

5. Knowledge & Attitudes towards Artificial Intelligence

i. What is the definition of Artificial Intelligence for you?

ii. What are your thoughts on AI?

iii. Have you had any touchpoints with AI and if so what where those?

iv. What do you think are the best suited applications for Artificial intelligence?

v. In what industries does AI fit best?

Explain Ada:

Ada is a global health company founded by doctors, scientists, and industry pioneers to create new possibilities for personal health trough an App. Ada asks simple, relevant questions and compares your answers to thousands of similar cases to help you find possible explanations for your symptoms. The patient-friendly information is based on artificial intelligence (machine learning & chatbot) and is intended to help you understand and manage your health better.

6. Experience with and Attitudes towards Ada / AI based Health Services

i. Has anyone here used a similar AI based health service before? If so, which one and for which purpose?

ii. When would you consider using a service like Ada?

iii. What are occasions where you definitely would not like to use a service like

iv. What are the benefits of such a service in your opinion?

v. What are your concerns regarding this service?

7. Image & Feelings towards Ada (in order to not be influenced by others following 3 answers are noted on paper)

i. Please write down the first 3 adjectives that come to your mind, when thinking of Ada or a similar AI based health service.

ii. How would you feel while using the service? (2 adjectives)

iii. Note the biggest benefit and the biggest doubt that come to your mind when thinking of the service?

8. Perception of Practical Relevance of Ada

i. What are the advantages compared to more traditional in-person health services and why?

ii. What are the disadvantages compared to more traditional in-person health services and why?

iii. Why is Ada practically relevant in your opinion?

iv. Which gaps do services like Ada fill?

v. Why isn't Ada practically relevant in your opinion?

vi. What should be added to change that?

Appendix 1c: Tables of Content

Perception of Healthcare Services		
Quality	**Well-trained Doctors**	V: *"Most of the doctors are going to be good."* Y: *"When you actually get to your appointment, Tunisia has very good doctors. So when you get a treatment in Tunisia, then it will be good. Public as well in private."* Y: *"Biggest strength: Training"* *"Biggest strength: Skilled (ref. to doctors)".*
	Error-prone	V: *"My grandpa fainted a lot because of his back pain, and the hospital sent him home and just gave him some medication. And only now they found out his whole back was torn up."* V: *"So much data getting lost and switched up."* K: *"My grandfather also got misdiagnosed with osteoporosis in the public service. He had to go to the private hospital, and they told him not to believe the public or he could get paralyzed."* V: *"Hospitals lose information when people go from one specialty to the other."*
	Deficient	MF: *"Poorly managed"* V: *"It is more difficult, when something comes up that is not treated every day."* V: *"They lose a lot of time because the service is so inefficient."* MA: *"Biggest weakness: Efficiency"* K: *"Biggest weakness: Efficiency"* V: *"Biggest weakness: Efficiency"*
	High Quality of Private system	V: *"The private healthcare system operates more smoothly, better treatment (ref. to Germany)."* K: *"I had nothing but bad experiences with the public healthcare, but all good in private (ref. to Ireland)."*
Availability	**Capacity overload**	B: *"People do not get their medicine in time"* B: *"In Austria, there is a lack of doctors especially in the countryside."* Y: *"Under-staffed"*
	Long waiting times	MF: *"Huge waiting lists."* Y: *"I am on the waiting list in Portugal since months."* B: *"People are on waiting lists for their appointment in Austria… some people call the ambulance to get their appointment faster"* V: *"It can be very easy or very annoying depending on the time you get there (ref. to waiting time)."*
	Rushed appointments	MF: *"Doctors are in time pressure. They have like 10 mins to see a patient. Not enough time to properly see the patients."* V: *"Public hospitals rush people due to money issues."*
Accessibility	**Low Density in Countryside**	B: *"In Austria, there is a lack of doctors especially in the countryside."* K: *"There is a lack of doctors in the countryside especially. A lot of doctors come to Ireland to replace older ones and English is not their main language."*

		K: *"My grandma had a stroke, we called the ambulance and waited two hours for them to come."*
	Affordability of decent Quality	MF: *"We can get the majority of treatments anytime for little costs (ref. to Portugal)."* V: *"Easy topics are dealt with very fast and the hospital runs smoothly."*

Deriving Opportunities		
Data Exploitation	**Storage and Analysis**	V: *"So much data getting lost and switched up."* V: *"It is more difficult (ref. to diagnosis), when something comes up that is not treated every day."*
	Enhance Accuracy of Diagnosis	V: *"My grandpa fainted a lot because of his back pain, and the hospital sent him home and just gave him some medication. And only now they found out his whole back was torn up."* K: *"My grandfather also got misdiagnosed with osteoporosis in the public service. He had to go to the private hospital and they told him not to believe the public or he could get paralyzed."*
Network	**Cooperation between Health Institutes**	V: *"Hospitals lose information when people go from one specialty to the other."* MF: *"Every clinic you go to, you tick a box that says that your info is being shared within other hospitals for easier diagnoses. They don't need to ask again for info."* B: *"In Austria, we had a discussion about if other doctors should be able to see all your data when you show your ecard. But the government declined. So every time you go to a different doctor you have to tell the whole story again of your diseases. Usually, you always go to the same department."* MF: *"My dad had huge pain while walking. He went to the family doctor (private) and they found out it was a tumour. He was transferred to the department (private) and it worked smoothly. But public and private clinics don't work well together. Data is not shared."*
	Generate Holistic Diagnosis	MF: *"My dad had huge pain while walking. He went to the family doctor (private) and they found out it was a tumour. He was transferred to the department (private) and it worked smoothly. But public and private clinics don't work well together. Data is not shared."* B: *"… the Diagnosis process depends on the disease. If you have some issues with your back, there can be many reasons for it. Therefore, it is super hard to diagnose you. Maybe, then you have to go to another department."*
Equality	**Close Quality Gap between Private and Public**	MF: *"It depends where you are (ref. to quality of healthcare services in private and public facilities)."* MA: *"I agree with Maria (ref. to sentence above). I had a bad experience in private, but it was an exception."* V: *"The accuracy of the diagnosis depends (ref. to private and public services).*
	Close Accessibility Gap between Urbanized and Rural Areas	B: *"In Austria, there is a lack of doctors especially in the countryside."* K: *"There is a lack of doctors in the countryside especially. A lot of doctors come to Ireland to replace older ones and English is not their main language."*

		K: *"My grandma had a stroke, we called the ambulance and waited two hours for them to come."*

Perception of Ada		
Efficiency	**Convenience**	MF: *"It might improve the waiting times. So it will be time saving."* MF: *"When I can't go to the doctor (ref. to using Ada)."*
	Time Savings	MF: *"Time-saving"* B: *"Time-saving"* Y: *"Fast"* K: *"In theory, it's more efficient."* V: *"It is faster (ref. to Ada compared to traditional healthcare services)."* MA: *"It is way easier to do it, so simplicity."* MF: *"It is quicker."*
Concerns	**Diagnosis Accuracy**	MA: *"Misdiagnose."* V: *"Algorithm will be inaccurate in the beginning."* MF: *"Misdiagnosed"* B: *"You cannot rely as much as on a doctor."* V: *"The app cannot ask certain questions."* Y: *"It will need credibility."* K: *"I will rely on how many people use it. If it does not gain that kind of traction, it will be just another app. It needs to gain traction and people need to recommend it."* Y: *"I would not use it, when I feel very sick. Serious diseases."* M: *"… missed diagnoses. (…) They are going to take tests, like doing x-ray and take blood samples. The app cannot do that."* Y: *"…collect as much data as possible. So the more time passes, the better the service will get. It will get better (ref. to Ada)."*
	Self-Assessment Accuracy	M: *"What if I put the wrong symptom, or I don't know how to describe it? I mean, the app might be useful, but maybe I do mistakes."*
	Ethics and Empathy	V: *"Insurance can be more expensive, if they have access to everything you are looking up."* K: *"My data is already out there. Of course it is a concern, but what can you really do about it."* V: *"Cautious"* Y: *"No face to face contact."* B: *"Privacy Issues"* K: *"No empathy in an app. There is no human interaction, only with a machine."* V: *"People could not trust it."* *"The app makes no mistake, but people might misuse the information they get from the app."* B: *"Maybe I would use it, when it is socially accepted. If it is common to use it, I probably would use it as well."* B: *"I think the older generation needs more empathy than the younger people."* MF: *"Older generations tend to trust doctors more."*

Quality	**Enhance Patients' Knowledge**	V: *"Provides a general idea of the cause"* Y: *"In general, about Ada it does not feed the peoples paranoia (ref. to comparison to Online Research). They will tell you specific actions and then ask you yes or no questions."* Y: *"It is better than googling stuff. Ada might be more accurate than google. On google everybody can put information. Ada is more beneficial than google."*
	Increase Average Healthcare Quality	V: *"Accurate (ref. to Ada)"* V: *"Availability everywhere"* Y: *"Diagnoses are based on doctors expertise."* V: *"It is probably more accurate and gives you more than just one diagnose."* Y: *"I used it and the app got 3 out of 3. First went to a doctor and he missed the diagnosis. I went back to the doctor after using the app and asked the doctor if he can check it, and it was correct."* V: *"When it is something difficult, the app would give a few diagnoses and the doctor could compare it with his diagnoses."* B: *"If you know the symptoms a computer can tell you a more precise diagnosis. A doctor cannot remember everything he learned."*
Accessibility	**Improve Logistical and Physical Accessibility**	B: *"Availability all around the world."* MF: *"Easy Access."* B: *"Everyone with a smart phone can use it."* MA: *"Super useful and practical."* V: *"It is accessible everywhere."* Y: *"People on the countryside could easier access health services through the app. So they do not depend on cities and the next hospitals close by."* B: *"... and the next generation will be more used to use smartphone and those apps."*
	Feasibility	K: *"Is it free? I would probably use it."* Y: *"Free and fast, so feasibility."* Y: *"Free (ref. to salience when thinking about Ada)"*
Application	**First Symptom Assessment**	MF: *"I would use it for myself and then when I would go to the hospital I could know before what I could have."* Y: *"It is better than googling stuff. Ada might be more accurate than google. On google everybody can put information. Ada is more beneficial than google."* MF: *"When I really cannot go to the doctor (ref. to time constraints), I would maybe use it. Rather to inform myself."*
	Second Opinion	Y: *"I would use it when I go to the doctor, and my condition does not get better. For a second opinion."* B: *"I would use it just, when the treatment is bad (ref. to traditional healthcare services)."* V: *"I would use it if the doctor has no idea of what it is. For example, in the case of my grandfather, they did not know what he had."* MA: *"I would use it for some cases. Most of the times doctors just go for what is most common and try different medicine until they found what works and get to the right results."*

	Healthcare Provider Support	MF: *"It can be used by doctors. It will be easier for me to explain my problem to the doctor."* Y: *"I used it and the app got 3 out of 3. First went to a doctor and he missed the diagnosis. I went back to the doctor after using the app and asked the doctor if he can check it, and it was correct."* V: *"When it is something difficult, the app would give a few diagnoses and the doctor could compare it with his diagnoses."*

Appendix 2: Online Survey

Appendix2a: Questionnaire

AI in Medical Care Survey

Start of Block: Default Question Block

Q1 Dear Participant,

I am a Master Student from Católica, who is currently developing his Dissertation. Your answers will build the base for the analysis and conclusion of my thesis, therefore I kindly ask you to answer the questionnaire as accurate and honest as possible. There are no right or wrong answers!

The provided answers and data of this survey will be anonymised and treated confidentially. The necessary time to complete this survey will be approximately 7-8 minutes.

I greatly appreciate your time and participation!

In case you should have any questions or comments please feel free to contact me: thurner.thomas@gmx.de

Thomas Thurner

Page Break

Q2 The first part of the survey will focus on your perceived quality of healthcare services.

Q3 What types of healthcare providers do you frequently use?

- [ ] Doctor's Office (1)
- [ ] Public Hospitals (2)
- [ ] Private Hospitals (3)
- [ ] Pharmacies (4)
- [ ] None of them (6)

Q4 Please select your most common first step after noticing symptoms of diseases? (up to 2 choices possible)

- [ ] Internet Research (1)
- [ ] Hospital Visit (2)
- [ ] Doctor Appointment (3)
- [ ] Consult Friends or Family (5)
- [ ] Nothing (6)

PS Please indicate your satisfaction level with the following attributes regarding the services of the healthcare sector

	Extremely dissatisfied (1)	Moderately dissatisfied (2)	Slightly dissatisfied (3)	Neither satisfied nor dissatisfied (4)	Slightly satisfied (5)	Moderately satisfied (6)	Extremely satisfied (7)
Waiting time (1)	○	○	○	○	○	○	○
Convenience (2)	○	○	○	○	○	○	○
Ease of getting an appointment (3)	○	○	○	○	○	○	○
Competency (4)	○	○	○	○	○	○	○
Costs (5)	○	○	○	○	○	○	○
Staff friendliness (6)	○	○	○	○	○	○	○
Duration of appointments (7)	○	○	○	○	○	○	○
Physical Facilities (8)	○	○	○	○	○	○	○
Equipment (9)	○	○	○	○	○	○	○
Modernity (10)	○	○	○	○	○	○	○

Page Break

Q6 The second part of the survey will consist of questions regarding your perception of **Artificial Intelligence (AI)** and the **free health app Ada**, which works with AI technology. Ada was founded by doctors, scientists and industry pioneers. The app takes reported symptoms, matches them with symptoms of patients of similar age and gender, and reports the statistical likelihood that the patient has a certain condition. The detailed report, compiled by Ada, can be sent to a doctor as a PDF. (example shown below does not show the full process!)

Q7 Have you heard of Ada before?

- Yes (1)
- No (2)

Q8 Have you used Ada before?

- Yes (1)
- No (2)

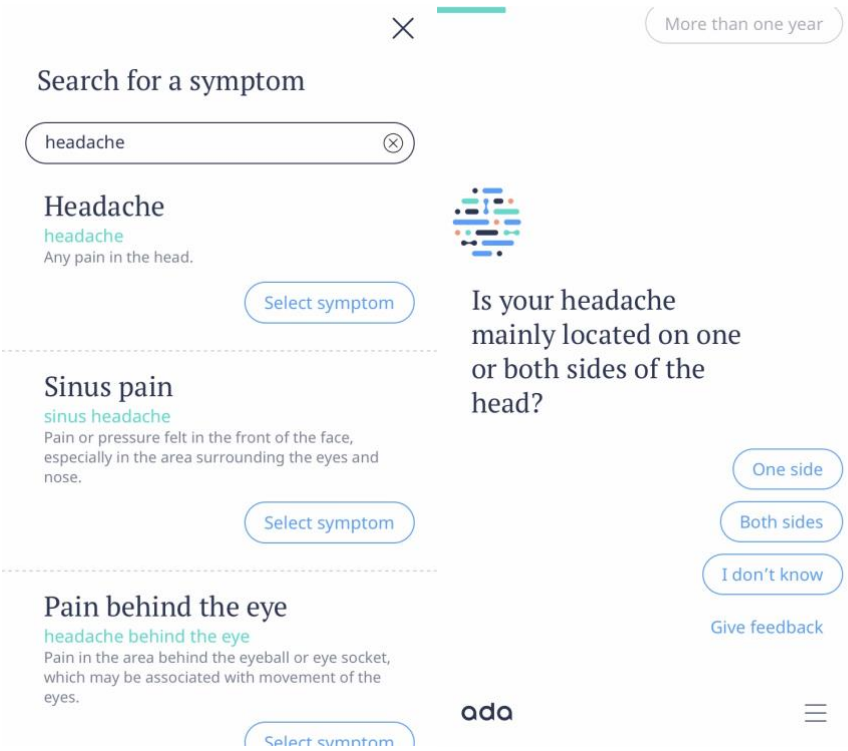
Display This Question:

If Have you used Ada before? = Yes

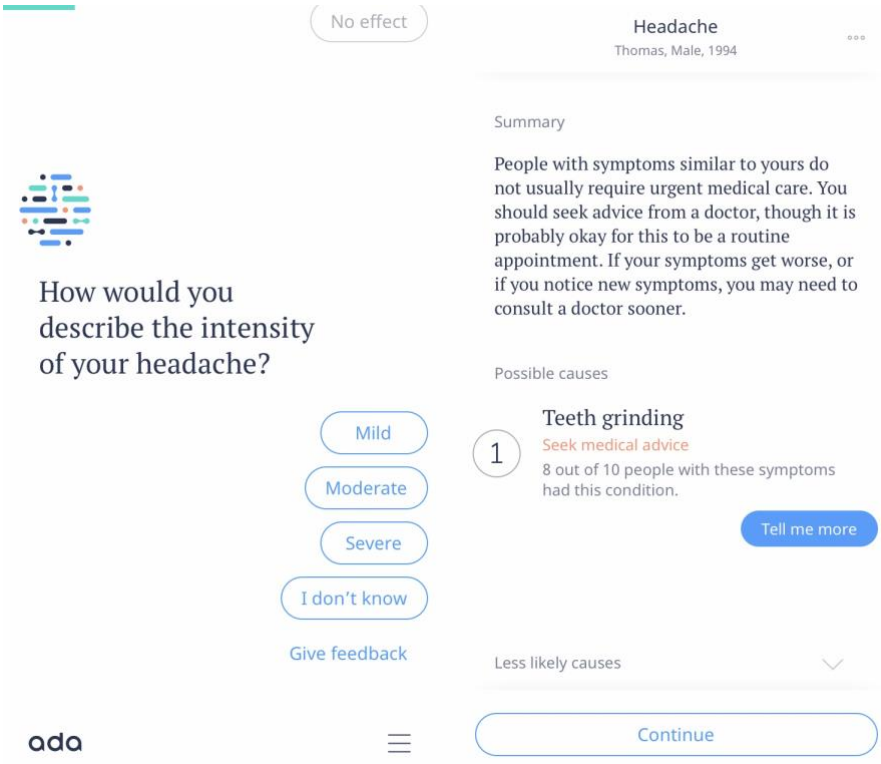
Q9 How frequently do you use Ada?

- Weekly (1)
- Monthly (2)
- Every 6 months (3)
- Annually (4)
- Only once (5)
- Never (6)

Q10, Q11



Q12, Q13



Q14 Timing
#EditSection, TimingFirstClick# (1)
#EditSection, TimingLastClick# (2)
#EditSection, TimingPageSubmit# (3)
#EditSection, TimingClickCount# (4)

Page Break

Q15 Do you know what Artificial Intelligence (AI) is?

- Yes (1)
- No (2)
- Probably not (3)

Display This Question:

If Do you know what Artificial Intelligence (AI) is? = Yes

Or Do you know what Artificial Intelligence (AI) is? = No

Or Do you know what Artificial Intelligence (AI) is? = Probably not

Q16 Artificial Intelligence (AI) describes a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation.

Page Break

Q17 Please indicate how much you agree with the following statements regarding your **perceived performance** of the Ada app

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I believe that using Ada would help me understand my personal health better (1)	○	○	○	○	○	○	○
I believe that using Ada would help doctors to diagnose me more accurately (2)	○	○	○	○	○	○	○
I believe that using Ada would make it easier to find a correct diagnosis (3)	○	○	○	○	○	○	○
I believe that using Ada would make it faster to find a correct diagnosis (4)	○	○	○	○	○	○	○
I believe that using Ada would make it more convenient to find a correct diagnosis (5)	○	○	○	○	○	○	○

I believe that using Ada would be helpful for improving my health (6)	○	○	○	○	○	○	○

Q18 Please indicate how much you agree with the following statements about the Ada app

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I believe that I would understand how to use Ada (1)	○	○	○	○	○	○	○
I think that it would be easy to use Ada (2)	○	○	○	○	○	○	○
I think that Ada would react flexible to my input (3)	○	○	○	○	○	○	○
I believe that I would be able to correctly describe my symptoms (8)	○	○	○	○	○	○	○
My family would have a positive perception of me using Ada (4)	○	○	○	○	○	○	○
My friends would have a positive perception of me using Ada (5)	○	○	○	○	○	○	○
People who use Ada are smart (6)	○	○	○	○	○	○	○
People who use Ada are naive (7)	○	○	○	○	○	○	○

Q19 Please indicate how much you agree with the following statements about your **attitudes** towards the Ada app

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I would trust Ada's expertise (1)	○	○	○	○	○	○	○
I would trust Ada's consistency (2)	○	○	○	○	○	○	○
I would feel comfortable with sharing my data with Ada (3)	○	○	○	○	○	○	○
I would trust Ada to only use my data for the diagnosis (4)	○	○	○	○	○	○	○
I had bad experiences with sharing my data online (5)	○	○	○	○	○	○	○
I would recommend Ada to a friend (6)	○	○	○	○	○	○	○

Page Break

Q20 The last part of the survey is about your intention of using Ada.

Q21 Please indicate how much you agree with the following statements

	Strongly disagree (1)	Disagree (2)	Somewhat disagree (3)	Neither agree nor disagree (4)	Somewhat agree (5)	Agree (6)	Strongly agree (7)
I intend to use Ada the next time I have symptoms (1)	○	○	○	○	○	○	○
I intend to use Ada for minor diseases (2)	○	○	○	○	○	○	○
I intend to use Ada for sever diseases (3)	○	○	○	○	○	○	○
I intend to use Ada to understand my health better (4)	○	○	○	○	○	○	○
I intend to use Ada to help my doctor diagnosing symptoms more accurately (5)	○	○	○	○	○	○	○
I intend to use Ada instead of researching about my symptoms online (6)	○	○	○	○	○	○	○
I intend to use Ada, when other health care providers cannot help me with my symptoms (7)	○	○	○	○	○	○	○

Page Break

Q22 What is your gender?

- Male (1)
- Female (2)

Q23 What is your age?

- 18 - 24 (2)
- 25 - 34 (3)
- 35-55 (4)
- above 55 (5)

Q24 What is your current status of employment?

- Employed full time (1)
- Employed part time (2)
- Unemployed looking for work (3)
- Freelancer (4)
- Retired (5)
- Student (6)
- Unemployed due to Disability (7)

Q61 Click to write the question text

- Click to write Choice 1 (1)
- Click to write Choice 2 (2)
- Click to write Choice 3 (3)

Q25 Please indicate your highest level of education?

- Less than high school (11)
- High school graduate (12)
- Bachelor Degree (13)
- Master Degree (14)
- Doctorate (17)

Q26 Please indicate your insurance type?

- Private insurance (1)
- Public insurance (2)
- Public and private insurance (4)
- Prefer not to say (3)

Q27 What is your nationality?

▼ Afghanistan (1) ... Zimbabwe (1357)

Q28 In which country did you have the most contacts with healthcare services?

▼ Afghanistan (1) ... Zimbabwe (1357)

Page Break

End of Block: Default Question Block

Start of Block: Country

Appendix 2b: Hypothesis Dimension/Items

Dimensions	**Items**
Service Quality	Q5.4: Competency Q5.5: Costs Q5.6: Staff friendliness Q5.7: Duration of Appointments
Tangibles	Q5.8: Physical Facilities Q5.9: Equipment Q5.10: Modernity
Convenience	Q5.1: Waiting time Q5.2: Convenience Q5.3: Ease of getting an Appointment
Relationship Expectancy	Q18.3: I think that Ada would react flexible to my input Q18.4: I believe that I would be able to describe my symptoms correctly Q.18.5: My family would have a positive perception of me using Ada Q.18.6: My friends would have a positive perception of me using Ada Q19.1: I would trust Ada's expertise Q19.2: I would trust Ada's consistency
Performance Expectancy	Q17.2: I believe that Ada would help doctors diagnose me more accurately Q17.3: … Ada would make it easier to find a correct diagnosis Q17.4: … Ada would make it faster to find a correct diagnosis Q17.5: … Ada would make it more convenient to find a correct diagnosis

	Q17.6: … Ada would be helpful for improving my health
Effort Expectancy	Q18.2: I think that it would be easy to use Ada
Privacy Expectancy	Q19.3: I would feel comfortable with sharing my data with Ada
	Q19.4: I would trust Ada to only use my data for the diagnosis
Usage Intention	Q21.1: I intend to use Ada the next time I have symptoms
	Q21.2: I intend to use Ada for minor diseases
	Q21.4: I intend to use Ada to understand my health better
	Q21.5. I intend to use Ada to help my doctor diagnosing symptoms more accurately
	Q21.6: I intend to use Ada instead of researching about symptoms online
	Q21.7: I intend to use Ada, when other health care providers cannot help me with my symptoms

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