UTS UNIVERSITY OF TECHNOLOGY SYDNEY

# Understanding the Factors Influencing the Acceptance and Adoption of Mobile Health Applications by Physicians during the COVID-19 Pandemic: The Case of Saudi Arabia

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under the supervision of

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# CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Sultan Sulaiman J Alsahli, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of Public Health, Faculty of Health at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

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# DEDICATION

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# LIST OF PUBLICATIONS

This thesis is presented in a compilation format, including a collection of papers and abstracts that have been published.

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# GLOSSARY OF ACRONYMS

| | |
|---|---|
| **WHO** | World Health Organization |
| **COVID-19** | Coronavirus disease 2019 |
| **eHealth** | Electronic health |
| **mHealth apps** | Mobile health applications |
| **MOH** | Ministry of Health |
| **UTAUT** | Unified Theory of Acceptance and Use of Technology |
| **DIT** | Diffusion of Innovation Theory |
| **TRA** | Theory of Reasoned Action |
| **TPB** | Theory of Planed Behaviour |
| **TAM** | Technology Acceptance Model |
| **MPCU** | Model of PC Utilisation |
| **SCT** | Social Cognitive Theory |
| **MM** | Motivational Model |
| **PE** | Performance Expectancy |
| **EE** | Effort Expectancy |
| **SI** | Social Influence |
| **FCs** | Facilitating Conditions |
| **BI** | Behavioural Intention |
| **UB** | Use Behaviour |
| **SPSS** | Statistical Package for the Social Sciences |
| **AMOS** | Analysis Moment of Structures Software |
| **AVE** | Average Variance Extracted |
| **CR** | Composite Reliability |

# ABSTRACT

**Background:** The rapid evolution of mobile health applications has become increasingly crucial in enhancing healthcare delivery, particularly during the COVID-19 pandemic. Despite the critical role of these technologies, acceptance and adoption rates among physicians in developing countries, especially Saudi Arabia, have remained relatively low. This highlights the need to explore the determinants of their acceptance and adoption.

**Aim:** This thesis aimed to investigate the key factors influencing Saudi physicians' intentions toward using mHealth applications during the COVID-19 pandemic.

**Methods:** This mixed methods research was conducted in three phases, each addressing specific objective and research question. In phase 1, a systematic review was conducted to present all available evidence of mHealth acceptance and adoption from the perspectives of physicians. Phase 2 applied a quantitative design based on the Unified Theory of Acceptance and Use of Technology (UTAUT) model to investigate key factors influencing physicians' behavioural intentions to adopt mHealth apps. Data were collected via an online survey and analysed using structural equation modeling. Phase 3 employed a qualitative design, exploring additional context-specific factors not accounted for by the UTAUT model through semi-structured interviews. The qualitative data were analysed using template analysis.

**Results:** The systematic review identified technological, individual, and organizational factors affecting physicians' acceptance of mHealth apps during the pandemic. The quantitative study found that performance expectancy, effort expectancy, social influence, and facilitating conditions significantly influenced physicians' intention to use mHealth applications. Qualitative findings highlighted additional factors unique to the Saudi context, such as concerns about data privacy, patient engagement, compatibility with religious and cultural norms, and the impact of COVID-19 pandemic. These factors shaped physicians' perceptions

and adoption behaviours, emphasizing the need for tailored strategies to promote mHealth in Saudi Arabia.

**Conclusions:** This thesis extends the UTAUT model by incorporating context-specific factors relevant to developing countries like Saudi Arabia during the COVID-19 pandemic. The findings emphasize the need for investments in infrastructure, targeted training programs, and policies that address both technological and cultural concerns. By fostering an environment that supports the integration of mHealth applications into routine practice, healthcare organizations can improve both healthcare delivery and patient outcomes during health crises and beyond. The study provides critical insights for policymakers and healthcare managers seeking to enhance the acceptance and use of mHealth technologies in similar global contexts. Future research should examine the perspectives of other healthcare workers and patients for a comprehensive understanding of mHealth adoption while also exploring its long-term impact on patient outcomes and healthcare professionals.

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## CHAPTER 1: INTRODUCTION

## 1.1 Research background

The healthcare sector is a critical domain that affects the global population and is fundamentally linked to the development of any nation. The significance of healthcare in daily life necessitates the delivery of high-quality services (Jonkisz et al., 2021), which are crucial across various facets of society and encompass treatment, care and operational aspects. As asserted by the World Health Organization (2020), access to excellent healthcare can prevent millions of deaths annually from various conditions, including tuberculosis and cardiovascular diseases. Such access is made possible by healthcare facilities equipped with the resources necessary to deliver healthcare services to individuals (Jamil et al., 2020). Nevertheless, healthcare provision is an extremely complicated process that involves diagnosing, treating and preventing diseases, injuries and other physical and mental impairments (Khatoon, 2020; Pereira Detro et al., 2020). Additionally, healthcare systems worldwide are facing several challenges (Dicuonzo et al., 2023; Haimi, 2023), with developing countries particularly struggling to deliver consistent and adequate healthcare services (Ahmed et al., 2020; Chakraborty et al., 2021). For example, accessing healthcare services is difficult particularly for people in remote areas, where there are pronounced disparities between urban and rural healthcare provision (Bristow et al., 2021; Sasaki et al., 2021; Seidu, 2020). Rural populations are often left with limited choices for preventative care, timely diagnoses and the effective management of chronic illnesses, leading to a series of poor health outcomes (Collett et al., 2022). These inequities in access often confront rural populations with significant health issues, including increased rates of disability, cognitive impairment and mortality (Harrison et al., 2020).

In addition to the delivery and accessibility of healthcare services, the increasing prevalence of chronic diseases presents a significant challenge to healthcare systems worldwide (Chudasama et al., 2020; Kendzerska et al., 2021; Meyerowitz-Katz et al., 2020). The global

incidence of chronic conditions has increased dramatically (Al Asmri et al., 2020; Franssen et al., 2020; Han & Palamar, 2020; Kunnumakkara et al., 2023), making these diseases major contributors to morbidity and mortality (Al-Hanawi, 2021; Okoroiwu et al., 2020). Chronic diseases are responsible for 41 million deaths each year, accounting for 74% of all global fatalities (World Health Organization, 2023).

Beyond the existing challenges of the healthcare system, the COVID-19 pandemic has significantly exacerbated pressures on health services all over the world (Barello et al., 2020; Chadwick et al., 2020; Chang, 2020; Chemali et al., 2022; Echelard et al., 2020; Kendzerska et al., 2021; Tysiąc-Miśta & Dziedzic, 2020). The pandemic has affected millions globally, causing multiple waves of infections and leading to a significant increase in mortality rates (Nguyen, 2021; Woods et al., 2020; Zhang et al., 2022). Over 7 million COVID-19 deaths have been reported internationally, underscoring the severe impact of the global crisis on public health (World Health Organization, 2024). The provision and accessibility of healthcare during the pandemic have been met with unique challenges, especially during lockdown periods and the management of COVID-19 cases (Mitra & Basu, 2020; Roy et al., 2021). There was an extreme shortage of beds, personal protective equipment and medical equipment in multiple hospitals due to the tremendous increase in patients needing treatment (Clay-Wililams et al., 2020; Sen-Crowe et al., 2021). Health systems, which were already overburdened, were put under tremendous strain by their obligation to provide healthcare while reducing face-to-face communication to minimise virus transmission (Echelard et al., 2020; Houlding et al., 2021). This shift has necessitated rapid adaptations in healthcare practices and policies, placing further stress on resources and testing the resilience of global health infrastructures.

In this increasingly complex healthcare environment, it is crucial to provide high-quality, effective and accessible healthcare services. Equally essential are efforts to enhance cooperation, communication, coordination and care relationships among all members of a

healthcare team to achieve optimal practice outcomes (Wei et al., 2020). Healthcare outcomes and patient expectations have been significantly improved and elevated by advances in medical technologies, particularly information and communication technology. These advancements include electronic health (eHealth), which has the potential to overcome the problems encountered by healthcare systems amid the increasing complexity of the sector (Alsahli et al., 2023; Farao et al., 2020; Golinelli et al., 2020; Mansour, 2021; Nicholas et al., 2021).

## 1.2 Electronic Health (eHealth)

The term 'electronic health' (referred as eHealth) refers to the capabilities and potentialities of information communication technology in the healthcare setting. It was defined by Eysenbach (2001) as follows:

> *e-health is an emerging field in the intersection of medical informatics, public health and business, referring to health services and information delivered or enhanced through the Internet and related technologies. In a broader sense, the term characterizes not only a technical development, but also a state-of-mind, a way of thinking, an attitude, and a commitment for networked, global thinking, to improve health care locally, regionally, and worldwide by using information and communication technology. (p. 1)*

Shaw et al. (2017) identified three significant purposes of eHealth. The first is to inform, monitor and track, which involves using eHealth tools to regularly observe health parameters. The second is to enable interaction, which includes leveraging eHealth as an opportunity for stakeholder communication in healthcare. The final purpose is data utilisation, which refers to the process of collecting, managing and using health data sources to assist healthcare

professionals in making medical decisions and improving interventions.

eHealth technologies have the potential to enhance healthcare quality and efficiency (Duettmann et al., 2021; Kip et al., 2021; Kwon et al., 2023). These technologies come in many forms, including hospital information systems, electronic health records and mobile health applications (mHealth), but mHealth has received increased attention in recent years (Alkhalifah, 2022; Gromisch et al., 2020; Hu et al., 2022). Such innovations can be leveraged by physicians and patients as tools for healthcare service provision given the widespread use of smartphones (Pires et al., 2020).

## 1.3 Mobile health applications

### 1.3.1 Definition

Mobile health applications, often cited as a key intersection of health and technology (Pires et al., 2020), have proliferated with the increasing use of mobile devices and the expansion of their capabilities for connectivity. Also known as mHealth apps, they are defined as the use of mobile technologies, including smartphones, wearable devices and tablets, to support the delivery of healthcare services by healthcare professionals to patients (Said, 2022; Yang et al., 2021). mHealth technologies are the integration of telehealth and wireless health, as illustrated in Figure 1.1 (Oliveira e Sá et al., 2017). They differ from traditional eHealth technologies in that they are specifically designed for use on mobile devices, thereby eliminating the need to rely solely on computers and wired internet connections (Alkhalifah, 2022). These innovations are therefore more accessible than their conventional counterparts (Alkhalifah, 2022). Their functions are not limited to facilitating medical consultations but cover a broad range of features that extend the scope of counsel sought from healthcare providers. These features include symptom tracking, mental health support, fitness monitoring, medication reminders, personalised support and access to health-related information

(Alkhalifah, 2022; Bendtsen et al., 2020; Chen & Xu, 2022; Ni et al., 2022).

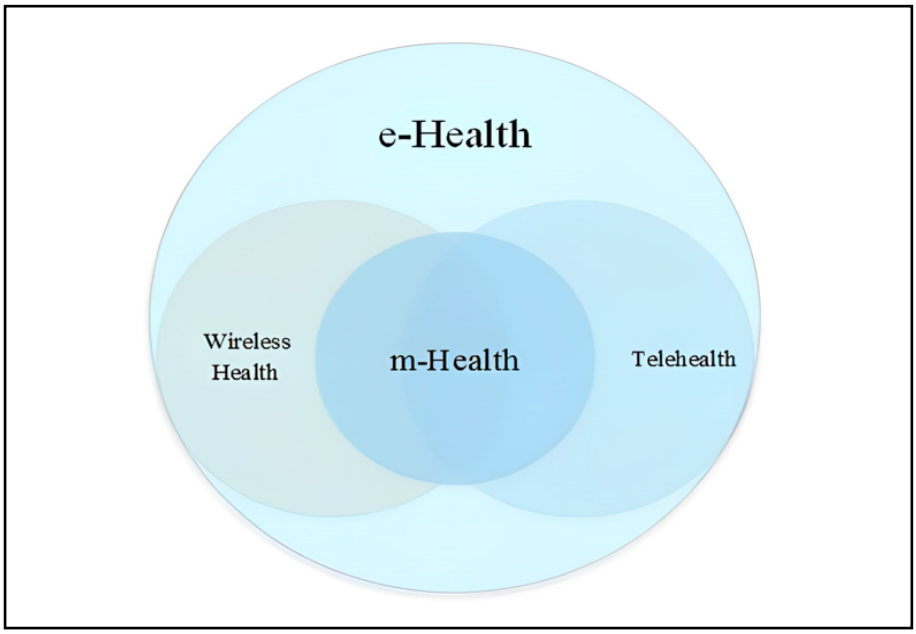


Figure 1.1: eHealth and mHealth (Oliveira e Sá et al., 2017).

### 1.3.2 Advantages of mobile health applications

mHealth apps offer several advantages that contribute to the transformation of healthcare delivery and the improvement of health outcomes. These apps have the potential to support physicians in remotely diagnosing and treating patients (Haleem et al., 2021; Li et al., 2020; Pires et al., 2020). They offer healthcare professionals the chance to rapidly consult and exchange data with their colleagues (Alsahli et al., 2023; Haleem et al., 2021), and they can be used to collect patient data in a manner potentially more effective than that achieved with traditional paper-based methods due to the automation inherent in them (Bond et al., 2020). Ultimately, these innovations give rise to the possibility of improved decision-making among

physicians. Moreover, mHealth apps are advantageous for individuals with limited mobility, affording them access to healthcare services without leaving their homes (Khan et al., 2022). This same portability allows populations in underserved or remote areas to receive medical advice, consultations and ongoing care (Asadzadeh & Kalankesh, 2021; Haleem et al., 2021; Li et al., 2020).

Another benefit of mHealth apps is that they facilitate the delivery of health-related information and educational resources to both healthcare professionals and individuals. These apps can hasten the education of healthcare workers by providing online tutorials that can be accessed through the applications' interfaces (Asadzadeh & Kalankesh, 2021; Kondylakis et al., 2020; Ming et al., 2020). Online education through such platforms is also more effective and flexible (Serrano-Solano et al., 2021). The educational advantages of mHealth applications extend as well to patients, with these technologies helping improve patients' lifestyles and decision-making (Kwon et al., 2023; Pires et al., 2020). A recent systematic review and meta-analysis conducted by Kwon et al. (2023) demonstrated the effectiveness of eHealth interventions in enhancing key health indicators, such as body weight, body mass index and liver enzyme levels in patients with non-alcoholic fatty liver disease (NAFLD). These findings highlight the value of eHealth technologies as effective intervention tools for modifying diet and exercise habits, which are essential for the self-management of NAFLD. Another systematic review and meta-analysis investigated the effects of behavioural weight management via lifestyle mHealth self-monitoring (Cavero-Redondo et al., 2020). The study found that such monitoring reduces weight to greater levels than those achieved with other weight loss measures.

mHealth apps are also favourable in terms of reminders about patient appointments, medications and schedules of medication intake. Such notices increase visits to healthcare facilities, which in turn, improve patient outcomes (Mahmood et al., 2020). Adhering to

treatments is one way of preventing severe symptoms and improving health outcomes among individuals living with chronic illnesses. In a recent systematic review, Pouls et al. (2021) suggested that eHealth interventions significantly improve adherence to long-term medication regimens. They found that even simple eHealth functionalities, such as SMS and telephone capabilities, effectively increase treatment adherence.

Finally, during the COVID-19 pandemic, mHealth apps have significantly contributed to maintaining healthcare services and enhancing patient outcomes. For example, these apps have maximised healthcare provision in situations where face-to-face health consultations are limited—a circumstance that has gained importance during the global crisis (Asadzadeh & Kalankesh, 2021; Kondylakis et al., 2020). By allowing healthcare providers to diagnose, monitor and treat patients remotely, these apps have reduced the need for in-person visits, thereby minimising the risk of virus transmission and enhancing the safety of both healthcare professionals and patients (Asadzadeh & Kalankesh, 2021). This method not only ensures continuous access to healthcare services but also helps maintain the efficiency of healthcare systems throughout challenging circumstances. Furthermore, mHealth technologies equipped with global positioning system (GPS) have substantially facilitated the management of infectious diseases (Altmann et al., 2020; Alzahrani et al., 2022). For instance, they have been crucial in the identification and tracking of infection hotspots. By mapping and analysing the spread of the virus, mHealth apps have delivered real-time data to public health authorities, enabling them to implement targeted interventions and control measures more effectively (Alzahrani et al., 2022).

### 1.3.3 Disadvantages of mobile health applications

Although mHealth apps have many benefits, they also have drawbacks and limitations that must be carefully considered. Data privacy and security are major areas of concern,

particularly because health data are highly sensitive and vulnerable to cyberattacks. The growing reliance of healthcare services on digital technologies comes with an increased danger of breaches and unauthorised access (Asadzadeh & Kalankesh, 2021; Paul et al., 2023). In a scoping review and content analysis, Alfawzan et al. (2022) assessed the privacy policies, data sharing and security practices associated with women's mHealth apps, revealing significant shortcomings in data privacy, sharing and security standards, with many apps failing to adhere to basic ethical and legal guidelines. This concern is particularly crucial in regions with underdeveloped cybersecurity infrastructures, which can expose sensitive patient data to misuse.

Moreover, mHealth app integration into established healthcare systems can be costly and complex. The initial investment needed to establish the essential infrastructure—which includes safe servers, reliable network connections and compatible devices—can be substantial, particularly for developing nations or regions with few resources (Haleem et al., 2021; Istepanian, 2022). Apart from costs related to infrastructure, there are ongoing expenditures associated with mHealth systems, which require constant maintenance and updates to stay secure, operational and compliant with changing laws and technological guidelines (Giebel et al., 2023; Snoswell et al., 2020; Sülz et al., 2021). An additional expense is the cost of comprehensive training programmes. For healthcare providers to successfully integrate mHealth into their everyday practices, they require thorough training and continual professional development (Giebel et al., 2023). This training, aside from covering the technical aspects of utilising applications, should address the ethical and legal implications of digital health, including patient data management and remote diagnostic processes.

## 1.4 Research context: The Kingdom of Saudi Arabia

### 1.4.1 Overview

The Kingdom of Saudi Arabia is an Islamic society with a constitution based on the Islamic Holy Book, the Quran. Article 1 of the nation's constitution indicates that 'God's Book and the Sunnah of His Prophet, God's prayers and peace be upon him, are its constitution' (Bureau of Experts at the Council of Ministers, 1992, p. 3). The government and citizens of Saudi Arabia defer to Islamic values in everything that they do—a practice that differs from that in the majority of secular countries (Almalki, 2020). Saudi Arabia adheres to conservative ideologies, as evidenced, for example, by women's preference for being examined by fellow women when they seek healthcare services (Akkour et al., 2021; Alqufly et al., 2019). When no women physicians are available at a hospital, Saudi women frequently prefer female trainees or students, even if they are less experienced than male physicians (Alqufly et al., 2019). This gender-based norm presents significant challenges to accessing healthcare services for women, particularly given the extremely low number of female healthcare professionals compared with their male counterparts (Aldosari, 2017; Ministry of Health, 2023). An essential requirement for this research, therefore, is to recognise the complex and unique Saudi customs, traditions and values as determinants of technology acceptance and adoption in the country's healthcare sector.

### 1.4.2 The Saudi healthcare system

The Saudi government guarantees free healthcare services to all citizens, as specified in Article 31 of the country's constitution (Bureau of Experts at the Council of Ministers, 1992). The Ministry of Health subsidises 60% of healthcare services, while other government divisions (e.g. the National Guard for Health Affairs and Security Forces Medical Services) and the private sector cover the remaining 40% (Ministry of Health, 2023) (Figure 1.2). The

Ministry of Health provides healthcare services through 286 hospitals, which have a capacity of 44,665 beds, and 2261 primary healthcare facilities across the country. It is also responsible for formulating health policy, supervising healthcare programmes and monitoring the management of all healthcare activities in the country. Other government agencies run 48 hospitals, which have a capacity of 13,177 beds, while the private sector runs 164 hospitals, which have a capacity of 19,146 beds (Ministry of Health, 2023).

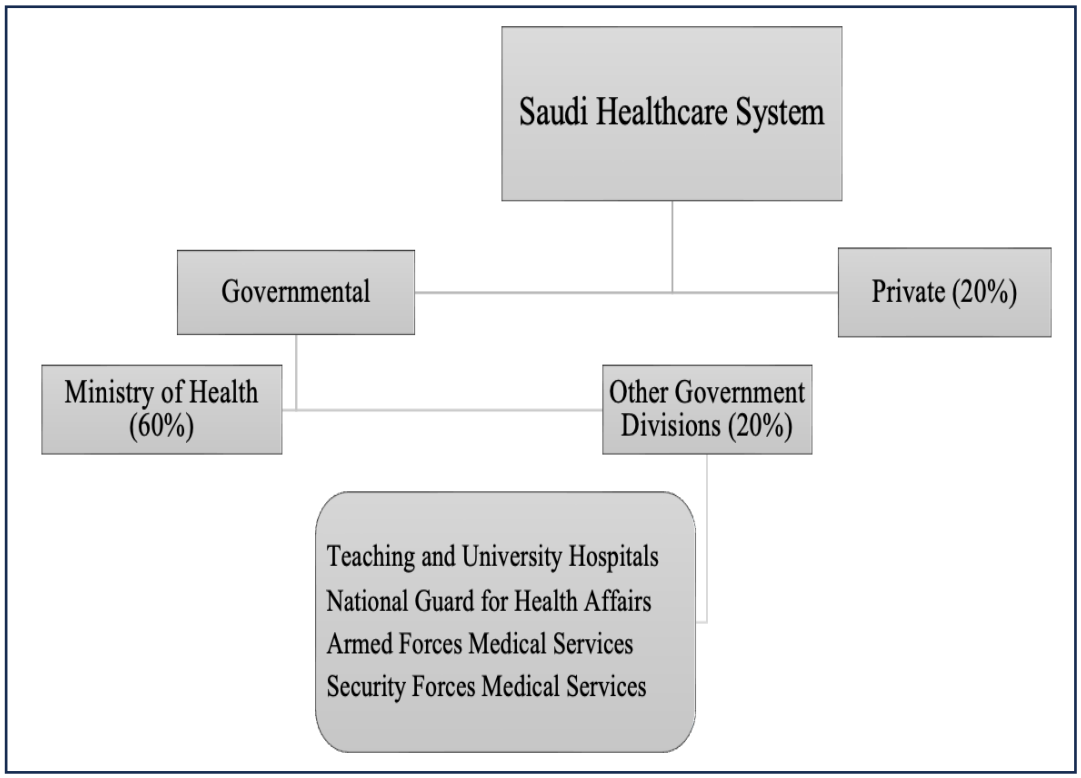


Figure 1.2: Saudi healthcare system.

### 1.4.3 Challenges in the Saudi healthcare system

The healthcare system in Saudi Arabia faces important obstacles that affect its capacity to deliver effective and accessible services to the population. Firstly, the proportion of male

and female physicians practicing in Saudi Arabia reveals a significant gender disparity, with men constituting the majority and women representing a much smaller proportion of the workforce (Ministry of Health, 2023). This imbalance limits healthcare diversity and may hinder meeting female patients' needs in Saudi Arabia's culturally sensitive environment, where same-gender physicians are often preferred (Alsafar et al., 2022; Alyahya et al., 2019). Furthermore, this disparity may affect the adoption of technologies like mHealth, as the expectations and intentions to use such tools could differ between male and female physicians, posing additional challenges for widespread implementation (Gu et al., 2021).

Secondly, Saudi Arabia grapples with a considerable shortage of qualified healthcare employees, including physicians, nurses and allied health workers. According to the Saudi Ministry of Health (2023), only 44% of the 95,336 physicians working in the country are Saudi nationals. This heavy reliance on expatriate physicians creates workforce instability, as these practitioners are unlikely to remain in the country in the long term. Mohammed and Waleed (2022) highlighted the fact that high turnover rates among expatriate healthcare professionals diminish productivity, necessitating the continual recruitment and training of new staff. Against this backdrop, the adoption of mHealth technologies can serve as a solution. Previous studies have revealed that mHealth apps can enhance physician productivity by enabling the remote delivery of services to patients, which in turn, saves time and resources (Haleem et al., 2021; Pires et al., 2020).

Thirdly, the number of people with chronic diseases in Saudi Arabia has increased tremendously in the past decades (Al Asmri et al., 2020; Jarrar et al., 2023). Among these health conditions, diabetes is particularly critical, with Saudi Arabia ranking among the top 10 countries worldwide with the highest prevalence of the disease (Jarrar et al., 2023). These figures are a primary public health concern, as diabetes is associated with increased rates of mortality, morbidity and vascular complications alongside broader public health and quality of

life challenges (La Sala & Pontiroli, 2020; Nanayakkara et al., 2021). The management and treatment of chronic conditions impose a significant burden on the healthcare system because these translate to continuous long-term care for patients (Haque et al., 2020; Paglialonga et al., 2019). This challenge is especially acute for diabetic patients living in rural areas, who may encounter monumental difficulties in accessing consistent medical care due to geographical and logistical obstacles (Aberer et al., 2021). Additionally, the cost of managing such conditions is considerable, exerting financial pressure on both healthcare providers and patients (Al Asmri et al., 2020; Haque et al., 2020). The combination of exorbitant costs and accessibility issues means that innovative solutions are required to enhance the efficiency of healthcare delivery and patient administration in Saudi Arabia. Prior research has demonstrated that, apart from enhancing the outcomes of patients with chronic diseases, mHealth technologies simultaneously reduce the associated costs of managing these illnesses (Abbaspur-Behbahani et al., 2022; Aberer et al., 2021; Said, 2022).

Moreover, ensuring healthcare service provision in Saudi Arabia is potentially impeded by its size—it is the largest country in the Middle East, spanning more than 2,150,000 square kilometres of territory (Al-Hanawi, 2021; Alanazi & Alanazi, 2023; Aldosari et al., 2017). This means that there are inequalities in healthcare provision, with rural regions having under-resourced and fewer facilities than urban localities (Al Asmri et al., 2020; Amin et al., 2020). This makes access to healthcare facilities one of the main problems for rural patients in Saudi Arabia (Al Asmri et al., 2020; Amin et al., 2020). Finally, long waiting times in healthcare facilities in the country are associated with patient dissatisfaction, with some Saudis forgoing healthcare services given worries over long delays in treatment (Alrasheedi et al., 2019). Such experiences may influence continuity of care and subsequently have negative effects on patient outcomes. These access-related difficulties can be addressed through mHealth applications, which afford individuals remote access to healthcare services as well as important information

and prescriptions (Amin et al., 2020; Kondylakis et al., 2020; Said, 2022).

### 1.4.4 Health Sector Transformation Program

Saudi Arabia launched *Saudi Vision 2030*, a strategic framework aimed at diversifying the economy, reducing the Kingdom's reliance on oil and developing public service sectors, such as health, education, infrastructure, recreation and tourism (Saudi Vision, 2016). Saudi Arabia's vision comprises various strategic objectives that serve as a road map for economic and national development. These strategic objectives are designed to be achieved through Vision Realization Programs (VRPs) (Saudi Vision, 2017) (Figure 1.3), under which one of the core initiatives is the Health Sector Transformation Program.

The Health Sector Transformation Program is aimed at carrying out reform in the Kingdom's health sector to convert it into a comprehensive, effective and integrated system centred on the health of individuals and society (Saudi Vision, 2020). This programme is founded on value-based care, which promotes public health and illness prevention while ensuring financial sustainability and implementing a new approach to preventative disease care. It is intended to increase access to health services by ensuring optimal coverage and fair geographical distribution, increasing the provision of e-health and digital solutions and enhancing the quality of healthcare services.


Figure 1.3: Vision Realization Programs (Saudi Vision, 2017).

The programme likewise promotes customer satisfaction by implementing and adhering to the best evidence-based international standards, forming and facilitating integrated healthcare systems that encompass the Kingdom's regions, activating meaningful service procurement and raising societal awareness about traffic and safety (Saudi Vision, 2020). The objectives of the Health Sector Transformation Program are meant to be achieved through the implementation of strategic reform initiatives, including eHealth (Saudi Vision, 2020) (Figure 1.4). The eHealth initiative is considered a significant enabler of the transformation programme, with this endeavour projected to achieve several benefits that cover the

improvement of healthcare professionals' productivity, the establishment of an effective and integrated healthcare system, the implementation of a reliable approach and the cultivation of flexible individual experiences (Saudi Vision, 2020) (Figure 1.5). Recently, the Saudi Ministry of Health has launched various smartphone applications as part of the country's eHealth initiatives (Ministry of Health, 2021a).


Figure 1.4: Strategic objectives of the transformation program (Saudi Vision, 2020).

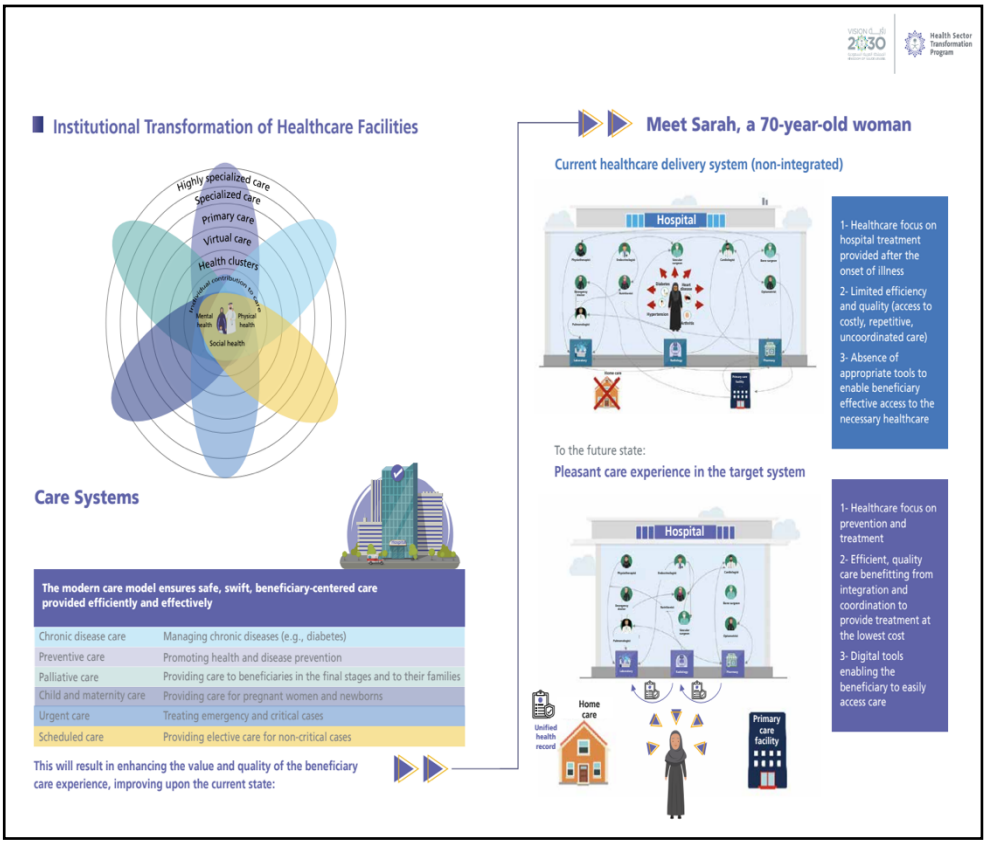


Figure 1.5: Institutional transformation of healthcare facilities (Saudi Vision, 2020).

### 1.4.5 The smartphone applications of the Saudi Ministry of Health

The smartphone applications developed by the Saudi Ministry of Health (e.g. Seha, Sehhaty, Anat, Tawakkalna and Tabaud) provide healthcare services to patients regardless of location (Ministry of Health, 2021a). For instance, the Seha 'health app' enables physicians to engage in medical consultations with Saudi citizens through audio/video conferencing. The application allows for consultations on a given week and sometimes during weekends, as long as patients and physicians have smartphones and internet access. The platform also enables citizens to talk with physicians whose practice is overseen by the Ministry of Health, and these practitioners then diagnose and treat patients remotely. Sehhaty 'my health app' offers numerous healthcare services to all individuals in Saudi Arabia. In addition to online medical consultations, it enables booking a COVID-19 test, arranging appointments, searching for

medicines, applying for sick leaves, acquiring e-prescriptions and securing guidance on infection prevention and control. Tawakkalna is an mHealth app equipped with global positioning system technology that monitors and regulates individuals' mobility within curfew hours and generates permits for exceptional circumstances (Alanzi, 2021; Hassounah et al., 2020). The Anat app, which is designed for healthcare professionals, supports health practitioners by enhancing work efficiency and quality as well as facilitating procedural practices (Ministry of Health, 2020). Through this app, healthcare professionals can share experiences with their colleagues, search for career opportunities and find out about specialised conferences and courses. The Tabaud 'distancing app' transmits de-identified data to those who have been in close proximity to individuals confirmed to be COVID-19 cases (Alanzi, 2021; Hassounah et al., 2020) (Figure 1.6).

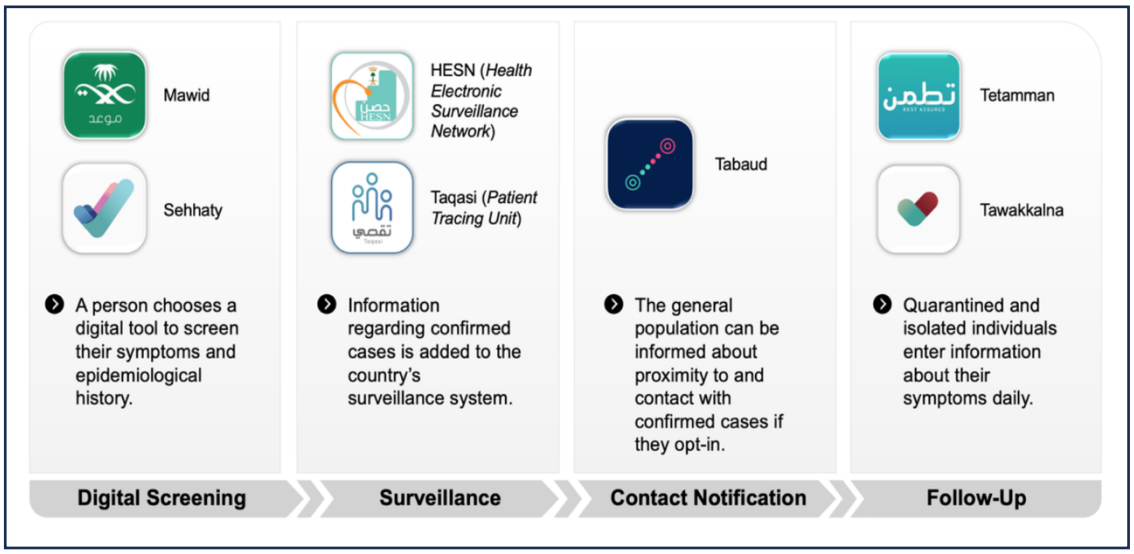


Figure 1.6: mHealth apps in Saudi Arabia (Hassounah et al., 2020).

## 1.5 Rationale for the study

Despite the potential benefits of mHealth technologies, their rates of acceptance and adoption among healthcare providers remain relatively low, particularly in developing countries (Addotey-Delove et al., 2023; Alam, Hu, et al., 2020; Jezrawi et al., 2022; Palas et al., 2022; Wu et al., 2022). This has prompted researchers to address potential deterrents to the use of such technologies. For example, Dahlhausen et al. (2021) and Li et al. (2021) highlighted a general consensus among physicians on the integration of mHealth apps into standard care and identified barriers to adoption, such as the lack of information and medical evidence, legal concerns, challenges related to patient engagement and financial implications. The willingness of healthcare providers to adopt mHealth services is also significantly influenced by their knowledge of and experience with these applications (Dahlhausen et al., 2021; Jackson et al., 2021). As indicated by Kong et al. (2020), many physicians are open to adopting mHealth, but they often lack the necessary know-how and expertise, which prevents them from recommending these technologies to their patients. These challenges underscore the critical need for healthcare organisations to consider perceptions and attitudes towards mHealth technologies for effective implementation.

Existing research has provided considerable insights into the factors affecting physicians' behavioural intention to use mHealth apps, but important gaps remain unaddressed. Notably, most studies have focused on developed countries, deriving findings that might be insufficiently applicable to the context of developing nations. Correspondingly, this translates to a gap in the understanding of physicians' attitudes towards mHealth adoption at the global level. This deficiency has been underscored in a recent systematic review conducted by Alsahli et al. (2023), who noted that the majority of research on mHealth acceptance among physicians during the COVID-19 pandemic has been conducted in developed countries. This one-sided concentration is concerning because the dynamics underlying the sociocultural, economic and

healthcare systems in developing countries vary markedly from those characterising their developed counterparts (Ayukekbong et al., 2017; Bojanic & Tan, 2021). Cultural and contextual factors play a crucial role in the acceptance and adoption of mHealth apps (Deng et al., 2018; Hamidi & Chavoshi, 2018). For example, Saudi Arabia is a religiously and socially conservative country with extensive cultural homogeneity stemming from Islamic and tribal affiliations—features that contribute not only to the cultural uniqueness of the country but also to its complexity (Alghamdi & Ernest, 2019; Binsahl et al., 2020). Understanding these unique determinants is essential for effectively addressing the gaps in mHealth adoption research within the Saudi context.

In the Saudi Arabian setting, which is the focus of the current thesis, most existing studies have explored patients' behavioural intention to adopt mHealth technologies (Aljohani & Chandran, 2021c; Alsswey et al., 2021). Limited attention has been paid to the perspectives of physicians, despite these professionals being a vital link in treatment pathways for patients (Della Vecchia et al., 2022). This oversight is significant, as the limited involvement of practitioners can hinder the effectiveness and widespread adoption of mHealth apps (Addotey-Delove et al., 2022; Wu et al., 2022). Physicians are often key to driving change in healthcare, substantially influencing the acceptance and adoption of mHealth technologies based on their own usage decisions (Yoon et al., 2022). For instance, physician advocacy for mHealth apps can influence patients' choice to use them, with the latter being more likely to accept and adopt these innovations upon recommendation by the former (Cajita et al., 2018; Chahal et al., 2021).

Despite the importance of physician engagement, the factors influencing their acceptance and adoption of mHealth technologies remain underexplored in Saudi Arabia (Aljohani & Chandran, 2021b; Alsswey et al., 2021). To address this gap, this thesis employed a mixed-methods approach to investigating the key determinants of Saudi physicians' intention to use mHealth applications. In doing so, it contributes to a deeper understanding of how

information and communication technologies can be more effectively integrated into the Saudi healthcare system.

## 1.6 Theories and models of technology acceptance

### 1.6.1 Overview

Understanding the factors that influence technology acceptance is a vital research topic in the field of information technology (Yadegari et al., 2022). Technology acceptance can be regarded as the acceptance and popularity of use of a technology (Yadegari et al., 2022), and it relates to an individual's initial decision to interact with a technology (Venkatesh et al., 2004). Information technology acceptance is significant to the successful adoption of new technologies (Rho et al., 2014), but it is an attitude towards technology that can be influenced by several factors (Renaud & Van Biljon, 2008; Yadegari et al., 2022). Thus, it is critical to evaluate user acceptance to minimise the chances of failure while implementing new technology.

Theories and models of technology acceptance have been developed to understand and predict the adoption and usage of new technologies by individuals and organisations (Momani, 2020). In the rapidly evolving world of technology, a crucial requirement is to comprehend why some innovations are embraced enthusiastically while others face resistance or indifference (Momani & Jamous, 2017; Sohn & Kwon, 2020). These theories and models serve as valuable frameworks for researchers to illuminate the complexities of technology adoption and usage. By applying these frameworks, stakeholders can design more user-centric technologies, tailor implementation strategies and address barriers to adoption, leading to increased acceptance and more successful technology integration.

The years have witnessed the recommendation of various theories and models, each offering unique perspectives on technology acceptance. Some of the most notable include

diffusion of innovation (DOI) theory, the theory of reasoned action (TRA), the theory of planned behaviour (TPB), the technology acceptance model (TAM) and the unified theory of acceptance and use of technology (UTAUT). DOI theory, formulated by Everett Rogers in 1962, stands as one of the earliest pivotal perspectives on technology acceptance (Rogers, 1962). It explains how new innovations, including technology, are adopted and spread within a social system, proposing the adoption process as following a bell-shaped curve and involving different adopter categories: innovators, early adopters, early majority, late majority and laggards.

The TRA, created by Martin Fishbein and Icek Ajzen in 1980, emphasises the importance of individual attitudes and subjective norms in forecasting behavioural intentions (Ajzen & Fishbein, 1980). According to the TRA, an individual's intention to perform a given behaviour is influenced by their attitudes towards that behaviour and the subjective norms that give rise to the perception of social pressure from significant others to engage in the behaviour. The theory also assumes that individuals are rational decision-makers who consider the implications of their actions before making choices and that their behavioural intentions are the best predictors of their actual conduct.

The TPB, an extension of the TRA, was originally formulated by Icek Ajzen (Ajzen, 1985). It encompasses an additional construct, perceived behavioural control, which refers to an individual's perception of their ability to perform a behaviour successfully. The inclusion of this construct is an acknowledgement that even if individuals have positive attitudes and perceive social pressure to adopt a behaviour, they may still be constrained by their perceived control over the behaviour. To sum up, the TPB posits that behavioural intention is influenced by attitudes, subjective norms and perceived behavioural control.

The TAM is a prominent theory in the field of technology acceptance and was developed by Fred Davis in 1989 on the basis of the TRA (Davis, 1989). It also extends the

TRA by focusing specifically on technology adoption and usage. Instead of revolving around general behaviours, the TAM applies TRA's concepts to technology-related conduct, wherein the behaviour of interest is the intention to use a particular technology. This model suggests that two primary factors influence use intention: perceived usefulness and perceived ease of use. A positive attitude towards both usefulness and ease of use reinforces the intention to use a technology.

The UTAUT is a comprehensive and widely recognised model proposed by Venkatesh et al. (2003). It integrates elements from various technology acceptance theories, including the DOI, the TRA, the TPB, the TAM, the model of PC utilisation, social cognitive theory and the motivational model. Its main objective is to provide a unified and robust framework for understanding the factors that influence individuals' acceptance and use of technology within an organisational setting (Venkatesh et al., 2003). The UTAUT identifies four key determinants of technology acceptance: performance expectancy (which is similar to perceived usefulness), effort expectancy (which is similar to perceived ease of use), social influence (which combines subjective norms and social factors) and facilitating conditions (which is related to perceived behavioural control). Additionally, it considers moderating factors such as gender, age, experience and voluntariness of use.

### 1.6.2 Selection and justification of theory

The Unified Theory of Acceptance and Use of Technology (UTAUT) was selected for this research due to its exhaustive and integrative nature as well as its proven effectiveness in capturing the complexities of technology adoption in professional settings (Momani, 2020; Tamilmani et al., 2022). Various technology acceptance models have been developed over time to shed light on the factors that influence users' intentions to use new technologies. Although these earlier models have offered valuable insights, they were primarily designed for academic

or educational contexts and frequently focus on simple information systems for student or general consumer populations (Venkatesh et al., 2003). Consequently, they are limited in their capacity to address the multifaceted organisational, professional and social dynamics that are associated with the adoption of technology in more complex environments such as healthcare (Venkatesh et al., 2003).

Recognising these limitations, Venkatesh et al. (2003) established the UTAUT model by integrating constructs from eight effective theories and models on technology adoption, resulting in what is now considered the most comprehensive framework for elucidating technology acceptance and adoption within the field of information systems (Momani, 2020; Venkatesh et al., 2003; Wu et al., 2022). The UTAUT addresses the complexities of professional and organisational environments by explicitly considering performance expectancy, effort expectancy, social influence and facilitating conditions. These constructs are critical in understanding how professionals, such as physicians, evaluate and decide to adopt new technologies within their work environments. In contrast to previous theories and models that primarily focus narrowly on individual attitudes and perceptions, the UTAUT model takes into account the wider organisational and sociocultural determinants of decisions regarding technology adoption, making it highly relevant for studies involving employees, such as physicians (Sharifian et al., 2014; Venkatesh et al., 2003; Wu et al., 2022).

One of the standout features of the UTAUT is its robust explanatory power. Research has shown that the model accounts for up to 70% of variances in users' intention to adopt technology—a figure considerably higher than the percentage achieved with earlier models, which explain only 17% to 53% of such differences (Momani, 2020; Sultana, 2020; Venkatesh et al., 2003). This makes the UTAUT one of the most reliable frameworks for exploring the adoption of new technologies. Its applicability has been continually verified in a range of organisational situations, including healthcare. For example, Sharifian et al. (2014) applied the

UTAUT to examine the adoption of hospital information systems among nurses. The authors demonstrated how the UTAUT effectively predicts the intention of nurses to use hospital information systems and how it explains 72.8% of the variances in their behavioural intentions.

The relevance of the UTAUT is particularly pronounced in the Saudi healthcare environment, where unique challenges, such as disparities in technology infrastructure and varying sociocultural attitudes towards digital health, are prevalent. The effectiveness of the UTAUT in incorporating facilitating conditions and social influence into analyses translates to a valuable lens for scrutinising these dynamics (Venkatesh et al., 2003). For instance, in Saudi Arabia, where professional practices are often shaped by cultural norms and peer behaviours, the impact of colleagues and organisational leadership can critically determine whether physicians adopt new technologies. Saudi society is a collectivist culture, with the expectations and opinions of the collective—be it families, communities, colleagues or tribes—frequently taking precedence over individual preferences (Alotaibi & Campbell, 2022). Furthermore, the role of facilitating conditions—such as the availability of technical assistance, training and sufficient IT infrastructure—cannot be overstated, especially in a setting where digital transformation is still developing. These realities make the UTAUT an optimal choice for probing into the factors that influence the acceptance and use of mHealth apps among healthcare professionals in the Saudi context.

## 1.7 Thesis questions, aim, and objectives

### 1.7.1 Thesis questions

The main research question that guided the thesis was as follows:

*What are the key factors influencing Saudi physicians' intention to use mHealth applications during the COVID-19 pandemic in Saudi Arabia?*

The investigation was further informed by the following sub questions:

1) What are the key factors that influence the acceptance and adoption of mHealth applications among physicians?
2) What are the associations between UTAUT factors and Saudi physicians' intention to use mHealth applications?
3) From the perspectives of Saudi physicians, what factors other than those covered by the UTAUT might influence their intention to use mHealth applications?
4) What theoretical model can be developed based on the UTAUT to explain Saudi physicians' acceptance and use of mHealth applications?
5) What recommendations and practical implications can be proposed to promote the future acceptance and use of mHealth applications in Saudi Arabia?

### 1.7.2 Aim and objectives

The overall aim of this thesis was to investigate the key factors influencing Saudi physicians' intention to use mHealth applications during the COVID-19 pandemic. To this end, the following objectives were pursued:

- To systematically review and synthesise the scientific literature on the influencing factors for the acceptance and adoption of mHealth among physicians
- To examine the associations between UTAUT factors regarding the acceptance and use of mHealth applications among Saudi physicians
- To explore other factors that are unaccounted for in the UTAUT that might affect the acceptance of mHealth applications among Saudi physicians
- To propose a theoretical model based on the UTAUT

- To put forward recommendations and practical implications for promoting the future acceptance and use of mHealth applications in Saudi Arabia.

## 1.8 Significance of the study

As previously stated, the healthcare sector has encountered urgent and critical challenges during the COVID-19 pandemic. In response, technological solutions, particularly mHealth apps, have emerged as vital tools (Alam et al., 2021; Asadzadeh & Kalankesh, 2021). These apps have been recognised globally for their effectiveness in preventing the spread of COVID-19 by optimising service delivery, enhancing safety and supporting the geographical tracing of infections (Asadzadeh & Kalankesh, 2021; Kondylakis et al., 2020). They also improve chronic disease management and reduce healthcare costs (Abbaspur-Behbahani et al., 2022; Alhasan et al., 2022; Said, 2022; Salas-Groves et al., 2023). Despite their benefits, however, adoption remains low in developing countries, and research has primarily focused on developed regions and patient perceptions (Alsahli et al., 2023; Li et al., 2021).

On the grounds of the aforementioned issues, this thesis was conducted in a way that makes significant contributions to both practice and theory. In terms of practice, it extends knowledge on the acceptance and adoption of mHealth technologies in Saudi Arabia, a developing country facing several healthcare challenges. These include a shortage of medical professionals, the rising prevalence of chronic diseases and limited access to healthcare services (Al Asmri et al., 2020; Amin et al., 2020; Jarrar et al., 2023; Ministry of Health, 2023). mHealth apps have the potential to enhance the productivity of healthcare professionals, improve patient outcomes for individuals with chronic diseases and clear the way for increased access to healthcare (Alsahli et al., 2023; Haleem et al., 2021; Li et al., 2020; Pires et al., 2020). This thesis also determined the factors that influence Saudi physicians' willingness to accept and adopt mHealth applications, providing a comprehensive analysis of both the barriers and

facilitators to adoption. By exploring these factors, this research makes a valuable contribution to policy development at both the governmental and institutional levels. Policymakers can leverage these findings to formulate targeted strategies that address specific barriers to adoption. Simultaneously, the research highlights critical facilitators that can be amplified to foster greater acceptance and integration of mHealth solutions into everyday clinical practice. Furthermore, the practical implications of this thesis extend beyond merely identifying adoption factors. By outlining a clear path for overcoming barriers and capitalizing on facilitators, the findings will play an instrumental role in shaping the digital health strategies of Saudi Arabia. This is particularly relevant as the country undergoes its ambitious healthcare transformation under *Vision 2030*, where digital health solutions, including mHealth, are integral to enhancing the quality and accessibility of healthcare services.

With respect to theoretical contributions, this study enhances our understanding in two significant ways. Firstly, while previous research has predominantly applied the UTAUT model within developed countries (Esber et al., 2023; Gu et al., 2021; VanDeWiele et al., 2023), the present study extended its application to a developing nation—Saudi Arabia. This extension is important because the determinants influencing mHealth adoption can vary significantly between different socioeconomic and cultural contexts (Alsahli et al., 2023). In developed countries, the adoption of mHealth apps is often driven by well-established infrastructure, higher levels of digital literacy, and fewer concerns over data security due to more robust privacy regulations. In contrast, in developing nations like Saudi Arabia, technological infrastructure, sociocultural norms, healthcare system limitations, and varying levels of digital readiness significantly shape the adoption process. By applying the UTAUT model to Saudi Arabia, this research not only validated the robustness of the model in an underexplored and culturally different setting but also expanded its global applicability.

Secondly, this study use of a mixed-methods approach expands investigations into

factors that are perhaps unique to the developing world (Gu et al., 2021; Swidi & Faaeq, 2019; Venkatesh et al., 2013). By combining quantitative survey data with qualitative insights from semi-structured interviews with Saudi physicians, this study provides a deeper, more nuanced understanding of the adoption process. The qualitative component, in particular, allowed for the exploration of context-specific barriers and facilitators to mHealth adoption that may not have been captured by quantitative measures alone. Additionally, the integration of these quantitative and qualitative findings led to the development of a new model that not only incorporates the established UTAUT factors but also introduces novel elements specific to the Saudi context. This enhanced framework reflects the complexities of healthcare in developing countries, where systemic challenges such as infrastructure gaps, resource limitations, and cultural attitudes toward technology can significantly affect adoption rates. By identifying and integrating these additional factors, this study advances the theoretical understanding of mHealth adoption, providing a more holistic and context-sensitive model that can be applied not only in Saudi Arabia but also in other developing nations with similar healthcare and sociocultural dynamics.

## 1.9 Thesis structure

- **Chapter 1: Introduction**

Chapter 1 provides a background on the healthcare systems in developing countries and the challenges confronting them. It discusses eHealth and mHealth, highlighting the advantages and disadvantages of these technologies. The chapter then focuses on the Saudi healthcare system, detailing its structure, challenges and the need for technological advancements before proceeding to a review of technology acceptance theories and models as well as the justification of the selected framework. Finally, it outlines the thesis research questions, aim and objectives, and discusses the study's significance and potential impact on policy and practice, particularly

within the Saudi healthcare system.

- **Chapter 2: Research methodology**

Chapter 2 outlines the comprehensive methodology employed in this study, beginning with an overview of the research stages and the specific approaches and techniques used in data collection and analysis. It details the research setting and describes the population of interest and sampling methods. This chapter also presents the research model and hypotheses, including an explanation of how relevant theories were integrated to provide a structured approach to illuminating the research questions.

- **Chapter 3: Phase 1 (Systematic Review)**

This chapter describes the systematic critical review and synthesis of the scientific literature on the factors that affect physicians' acceptance and adoption of mHealth. The insights gained from this review were aimed at addressing the first research question, offering a thorough understanding of the existing knowledge in this field. This chapter is presented as a paper that has been published, contributing to the academic discourse on mHealth adoption.

- **Chapter 4: Phase 2 (Quantitative Study)**

Chapter 4 presents the examination of the key factors that influence the acceptance and adoption of mHealth by physicians in Saudi Arabia, addressing the second research question. It is also presented as a paper that has been published, underlain by a quantitative approach and with data collected using an online survey.

- **Chapter 5: Phase 3 (Qualitative Study)**

This chapter recounts the exploration of the additional factors that may impact the

acceptance and adoption of mHealth applications among Saudi physicians during the COVID-19 pandemic. It is intended to address the third research question. Similar to the last two chapters, this one is presented as a paper that has been published, with a qualitative approach employed and with data collected through interviews.

- **Chapter 6: Discussion**

Chapter 6 combines the key findings and insights from the systematic review, quantitative study, and qualitative exploration to provide a mixed-method perspective on the results, clarifying how they contribute to enhancing the usage of mHealth apps in Saudi Arabia. This chapter discusses extending the UTAUT model for developing countries from a Saudi Arabian perspective, offering a tailored framework to reflect the specific sociocultural and healthcare dynamics in Saudi Arabia. It also outlines the theoretical and practical implications for policy and practice within the Saudi healthcare system and beyond.

- **Chapter 7: Conclusion**

This chapter summarises the overall findings of the research, emphasizing its contributions to both academic knowledge and practical applications in the healthcare sector. It also acknowledges the limitations of the study and provides recommendations for future research. The chapter ends with a reflection on the potential long-term impact of the research on mHealth adoption and healthcare policy in developing countries. The thesis structure described here are presented in Figure 1.7.

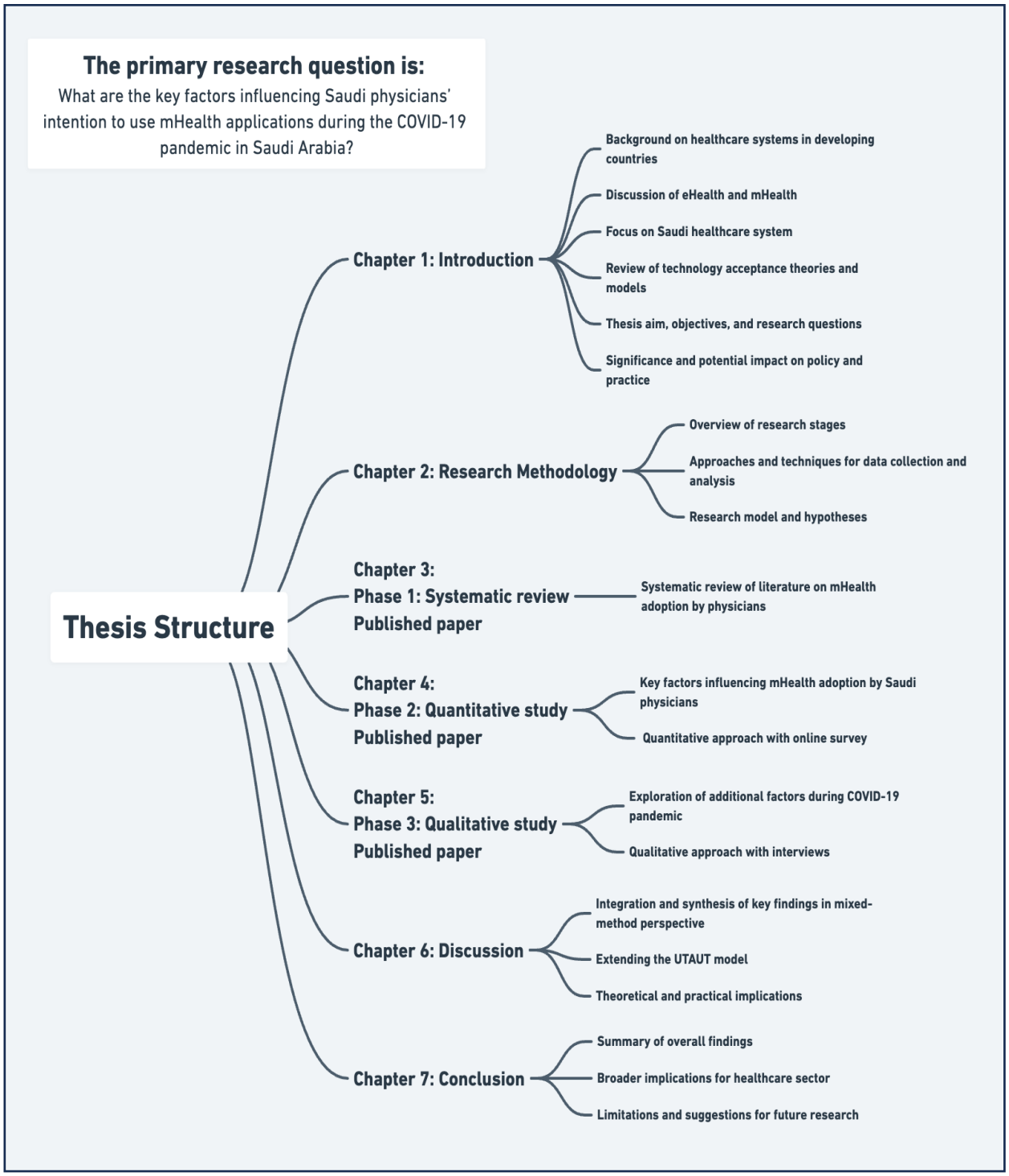


Figure 1.7: Thesis structure.

# CHAPTER 2

## CHAPTER 2: RESEARCH METHODOLOGY

## 2.1 Overview

A research methodology is a systematic and structured approach to investigating and gathering knowledge in various fields of study. It offers a framework for conducting scientific explorations, guaranteeing that such pursuits are conducted rigorously and systematically. The research methodology is aimed at ensuring that studies are reliable, valid and capable of producing meaningful results (Creswell & Plano Clark, 2018). It involves making deliberate choices about research designs, data collection methods, sampling techniques, data analysis procedures and interpretations of findings. By following a well-defined methodology, researchers can minimise bias, enhance the credibility of their work and contribute to the advancement of knowledge in their respective fields.

## 2.2 Research stages

The overall aim of this thesis was to investigate the key factors influencing Saudi physicians' intentions regarding the use of mHealth applications. The thesis was completed in three phases, each targeting a specific research objective and addressing the corresponding research question (Figure 2.1). The following subsections provide a general discussion of each phase.

The first phase of this thesis focused on presenting all available evidence of mHealth acceptance and adoption through a systematic review carried out based on the perspectives of physicians. This review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, ensuring a rigorous and structured approach to identifying, selecting, and synthesizing the relevant literature. More information about this phase is provided in Chapter 3.

The second phase was a quantitative investigation of the factors that influence physicians' acceptance and adoption of mHealth in Saudi Arabia. The theoretical framework

was constructed on the basis of the UTAUT model, and the associations between the UTAUT factors of interest and the acceptance and use of mHealth applications were determined via a survey. This phase and the UTAUT model are discussed in more detail in Chapter 4.

The third phase of the thesis was a qualitative exploration of the factors that are unaccounted for in the UTAUT model that might influence the acceptance and adoption of mHealth applications among Saudi physicians. Data were collected through semi-structured interviews. More details about this phase can be found in Chapter 5.

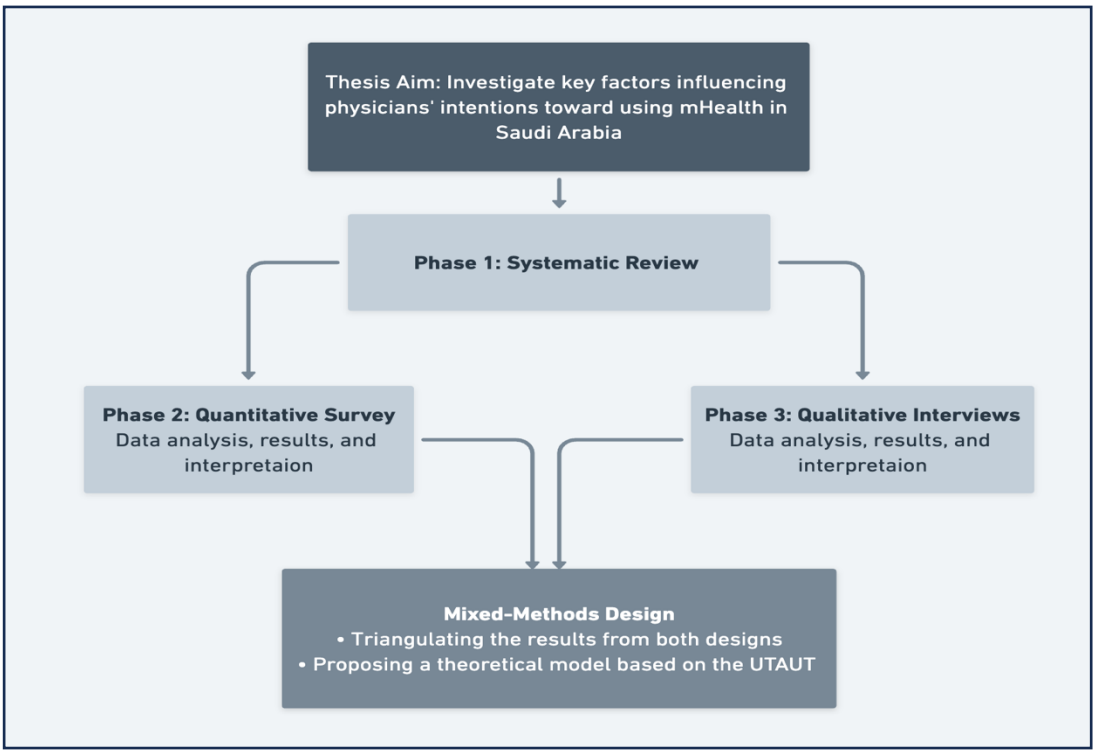


Figure 2.1: Thesis phases.

## 2.3 Phase 1: Systematic review

### 2.3.1 Overview

A systematic literature review is a vital method for supporting evidence-based decisions in healthcare and research (Muka et al., 2020). It can be defined as a comprehensive and

rigorous approach to summarising and analysing the extant literature on a specific question or topic (Desai et al., 2019; Gough et al., 2017; Muka et al., 2020), which produces an unbiased synopsis of such literature and allows for the identification of gaps in knowledge that may guide future research efforts (Munn et al., 2018).

The systematic review carried out in this work was intended, firstly, to present robust evidence of the status of mHealth acceptance and adoption among physicians on the grounds of PICO-based components: physicians (population); the use of mHealth technologies, including smartphones, portable digital devices and tablets (interventions); and mHealth acceptance and adoption (outcomes). Secondly, the review was aimed at identifying knowledge gaps in the literature and, finally, at providing guidance for the next phases of the thesis.

### 2.3.2 Systematic review protocol registration

The registration of protocols for systematic reviews refers to the process of publicly documenting and registering the detailed plan and methodology underlying a review before its implementation (Gough et al., 2017). It entails submitting a protocol to a recognised registry or platform that specialises in hosting and publishing the protocols of systematic reviews. One of the main aims of registration is to avoid the duplication of efforts by enabling researchers to identify ongoing or completed reviews on a given topic (Tawfik et al., 2020). Registration platforms often provide guidelines and templates to help researchers develop comprehensive and standardised protocols, thereby ensuring that procedures cover essential components and adhere to best practices for systematic reviews (Dos Santos et al., 2020). One of the most common platforms for such registration is PROSPERO (International Prospective Register of Systematic Reviews) (Tawfik et al., 2020). Accordingly, a systematic review protocol was registered prior to commencing the systematic review process. This protocol is elaborated in Chapter 3.

## 2.4 Research approaches

Research approaches encompass a range of strategies and processes employed in the conduct of research, covering general assumptions to specific methods employed for data collection, analysis and interpretation (Creswell & Creswell, 2018). Such approaches can be organised into three key categories: quantitative, qualitative and mixed-methods approaches. The selection or adoption of a research methodology is dependent upon several factors, including the nature of a research question, available resources and the goals of a study (Creswell & Creswell, 2018). The aforementioned approaches, including their definitions, strengths and limitations, are described in the following paragraphs:

### 2.4.1 Quantitative approach

Broadly, quantitative research approaches focus on the collection and analysis of numerical data to identify patterns, relationships and cause–effect associations among variables (Creswell & Creswell, 2018). Quantitative research relies on data that can be measured and expressed numerically (Chandra & Hareendran, 2018). The process commonly entails the use of data collection instruments such as surveys to systematically and consistently collect data. This process is meant to reduce subjectivity and bias given that a predetermined study design is followed and standardised methods of data collection are used (Creswell & Creswell, 2018; Queirós et al., 2017). Quantitative research also involves statistical analyses, including descriptive statistical and inferential statistical examinations, thus enabling researchers to draw conclusions and make generalisations about a population (Baran & Jones, 2016; Creswell & Creswell, 2018). Typically, quantitative research employs a deductive approach, beginning with a theory or hypothesis that is tested using empirical data (Kyngäs, 2020; Perri & Bellamy, 2012).

Given the strengths above, there are several limitations to quantitative research that scholars should consider when planning their studies and interpreting their results. A primary deficiency is its focus on specific, pre-determined, variables and how they relate to each other, which may limit the depth of understanding of other factors influencing a research topic (Baran & Jones, 2016; Rahman, 2016). Correspondingly, quantitative research tends to favour generalisability over contextual specificity (Bawack & Kala Kamdjoug, 2018; Queirós et al., 2017)—a constraint that can prevent researchers from exploring unanticipated variables or unforeseen phenomena that may emerge over the duration of an investigation. Such research may therefore fail to capture the complexities of the individual attitudes, beliefs and social influences that are key to mHealth acceptance and adoption (Lee et al., 2021). Large sample sizes and extensive statistical analyses can generate broadly applicable findings, but they may also impede a consideration of the unique characteristics and circumstances of particular populations or settings. Previous research has shown that the factors influencing mHealth acceptance and adoption might vary significantly across different regions and socioeconomic backgrounds (Alsahli et al., 2023; Lee et al., 2021; Wang et al., 2021)

### 2.4.2 Qualitative approach

Qualitative research, broadly, involves methodological approaches employed to explore and understand complex phenomena through in-depth examinations and interpretations of nonnumerical data (Creswell & Creswell, 2018). Qualitative methodologies emphasise the examination and comprehension of subjective experiences, meanings, perspectives and social processes through methods such as interviews. It is also intended to uncover insights, patterns and underlying reasons behind human behaviours, social interactions and cultural phenomena (Busetto et al., 2020). In qualitative research, an inductive method is often adopted, which

means that theories or hypotheses are developed on the basis of collected data rather than established beforehand (Creswell & Creswell, 2018; Kyngäs, 2020).

Similar to quantitative investigations, qualitative enquiries also have drawbacks. Qualitative research commonly employs small sample sizes and emphasises comprehensive investigations of a specific context or group, thus potentially limiting the generalisability of findings to a larger population (Leung, 2015). A further limitation of qualitative research is that it can be time-consuming and resource-intensive, especially in data collection and interpretation (Anderson, 2010; Rahman, 2020). Furthermore, the presence of a researcher during the data collection process has the potential to impact participant responses and behaviours, possibly driving participants to provide socially desirable answers or modify their behaviours (Anderson, 2010).

### 2.4.3 Mixed-methods approach

As previously discussed, quantitative and qualitative research approaches differ significantly in their goals, methods, and outcomes. Quantitative research focuses on gathering and analysing numerical data to uncover patterns, relationships, and examine cause-and-effect associations between variables (Creswell & Creswell, 2018). This approach is particularly suitable for studies that require statistical rigor, objectivity, and generalizability, allowing researchers to test hypotheses and extrapolate findings to larger populations. However, its reliance on predetermined variables and structured methodologies may restrict the exploration of complex, nuanced human experiences (Baran & Jones, 2016). In contrast, qualitative research focuses on understanding complex phenomena through the analysis of nonnumerical data such as narratives, observations, and cultural contexts (Creswell & Creswell, 2018). This method provides detailed insights into individual perspectives, social processes, and motivations, offering valuable explanations for underlying reasons and behaviours. While

qualitative research excels in depth and contextual richness, its smaller, context-specific samples often limit its generalizability to broader populations.

Mixed-methods research involves using both quantitative and qualitative approaches in carrying out a study or research project (Creswell & Creswell, 2018; Lee et al., 2022). It entails collecting, analysing and integrating data from various sources and employing a variety of methods to answer research questions or achieve research objectives. Mixed-methods studies have become increasingly popular in many disciplines, including health sciences (Lee et al., 2022; McBride et al., 2019; McKenna et al., 2021). Such studies are frequently conducted when a single method is inadequate to thoroughly address research objectives or when combining different perspectives and types of data can advance a more robust and nuanced understanding of a research topic (Creswell & Creswell, 2018; Dawadi et al., 2021). The strength of mixed-methods research lies in its ability to integrate the benefits of both quantitative and qualitative approaches, thereby addressing the limitations inherent in each (Creswell & Creswell, 2018). Quantitative research offers structured data collection and analysis, yielding results that are generalizable and statistically robust. Conversely, qualitative research provides deep, context-rich insights into phenomena that may not be captured by numerical data alone. By combining these methods, mixed-methods research achieves a comprehensive, balanced approach that enhances the validity, depth, and applicability of findings, making it an indispensable tool for addressing multifaceted research questions.

Mixed-methods research can be carried out using various designs, including convergent, explanatory sequential and exploratory sequential designs (Creswell & Plano Clark, 2018). In a convergent design (also known as a triangulation design), quantitative and qualitative data are collected in parallel but analysed separately before they are merged during the interpretation phase (Creswell & Plano Clark, 2018). Its primary aim is to expand and enhance quantitative results with qualitative insights, ensuring a more enriched perspective on matters of scholarly

interest. This design not only offers complementary views but also reinforces the credibility and depth of findings through the convergence of evidence from both quantitative and qualitative methods. For example, a researcher surveys consumers about their attitudes toward mobile health apps and also conducts in-depth interviews on the same topic. The quantitative survey data and qualitative interview data are analysed separately and then combined to provide a comprehensive understanding of consumer attitudes.

In an explanatory sequential design, research begins with collecting and analysing quantitative data, followed by collecting and analysing qualitative data (Creswell & Plano Clark, 2018). The quantitative phase is geared towards establishing patterns, relationships or associations, while the qualitative phase is targeted at explaining or exploring the quantitative results in more depth. For example, after discovering an unexpected relationship between consumers' attitudes and their use of mobile health apps in a survey, the researcher conducts follow-up interviews with a select group of consumers to explore the reasons behind this surprising relationship.

Finally, in an exploratory sequential design, a study commences with the collection and analysis of qualitative data, followed by the collection and analysis of quantitative data (Creswell & Plano Clark, 2018). The qualitative phase focuses on enquiring into a research topic, generating hypotheses or identifying key variables to be measured quantitatively. The quantitative phase entails testing and validating the hypotheses formulated in the qualitative phase. For example, a researcher gathers personal stories from consumers about their experiences using mobile health apps. Based on these insights, the researcher develops a survey to assess how common these experiences are among a larger group of mobile health app users, helping to identify key trends and patterns. Figure 2.2 shows the data collection sequence and integration for each design.

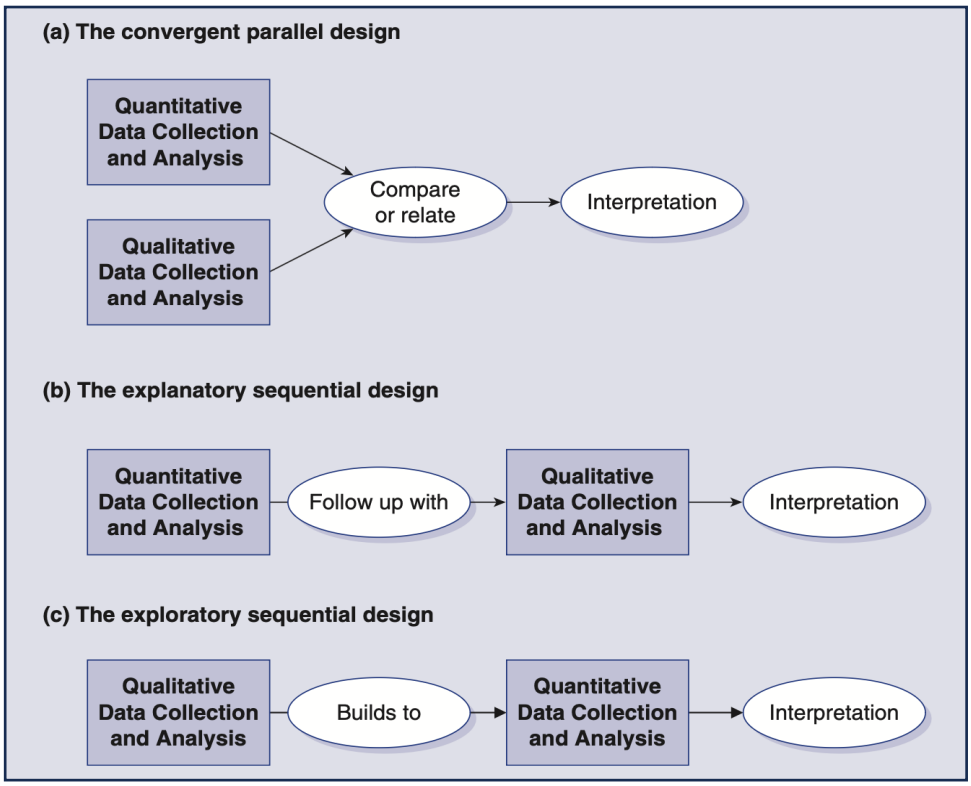


Figure 2.2: Mixed methods design (Creswell & Plano Clark, 2018).

## 2.5 The methodology of the current research

The overall aim of this thesis was to investigate the key factors influencing Saudi physicians' intention to use mHealth applications during the COVID-19 pandemic. To achieve this aim, the following objectives were pursued:

- To systematically review and synthesise the scientific literature on the influencing factors for the acceptance and adoption of mHealth among physicians
- To examine the associations between the UTAUT factors and Saudi physicians' acceptance and use of mHealth applications

- To explore other factors that are unaccounted for in the UTAUT that might influence the acceptance of mHealth applications by Saudi physicians
- To propose a theoretical model based on the UTAUT
- To propose recommendations and practical implications for promoting the future acceptance and use of mHealth applications in Saudi Arabia

A convergent (triangulation) mixed-methods design is the most well known in mixed-methods research (Creswell & Creswell, 2018). Following on from phase 1 (systematic review), a convergent mixed-methods design was chosen as an appropriate methodology for the current study for a number of reasons. Firstly, research based on convergent mixed methods aids the enhancement of the validity of results by minimising the potential biases and limits that may arise from relying on a single approach (Alexander, 2020; McCrudden et al., 2019). For example, quantitative methods may be able to offer statistical rigour and generalisability, which were crucial for identifying broad trends in the acceptance and use of mHealth applications among Saudi physicians. However, a key limitation of quantitative research is its inability to fully capture the complexities of individual attitudes, beliefs, and social dynamics, which are crucial factors in mHealth adoption. Therefore, relying solely on quantitative data would have provided an incomplete picture of the phenomenon under investigation. To address this limitation, qualitative exploration was integrated into the quantitative investigation. Qualitative methods excel at providing contextual insights into personal experiences and the nuanced social factors that influence mHealth adoption, offering depth that quantitative data alone cannot provide. Nevertheless, the limitation of qualitative research lies in its smaller sample size, which reduces its generalizability. Combining the two methods allowed me to offset these limitations by leveraging the complementary strengths of both approaches. Quantitative data identified key associations between the UTAUT factors, while qualitative

interviews provided a deeper understanding of factors not captured by the model. This complementary approach provided a holistic view of the issue, balancing the need for generalizable findings with the need for in-depth exploration of individual perspectives.

Secondly, research that uses convergent mixed methods can improve the refinement of theories relevant to mHealth acceptance and adoption. Quantitative data are powerful tools for pinpointing associations between variables (Burns et al., 2015), while qualitative data can derive explanatory insights and generate new theoretical constructs (Lyons, 2007; Venkatesh et al., 2013). The integration of these data has the potential to elevate the comprehension of relationships between theories and empirical findings as well as facilitate the refinement of theories (Östlund et al., 2011). Venkatesh et al. (2013) asserted that if the purpose of research purpose is to determine the factors influencing information system acceptance and adoption in a developing country using the UTAUT, a mixed-methods design might cast light on determinants that seldom occur in a developed country in the West. As the present study adopted the UTAUT model to identify, quantitatively, the determinants of physicians' intention to use mHealth applications in Saudi Arabia (a developing country), there is a need for a qualitative approach to exploring other factors that may not arise in developed countries. Research grounded in convergent mixed methods can help identify both common and unique factors for mHealth acceptance and adoption. Although quantitative surveys may identify general trends, qualitative methods allow researchers to probe deeper into the specific reasons behind certain attitudes and behaviours. Overall, mixed-methods research offers a flexible and integrative approach that allows researchers to employ quantitative and qualitative methods in a complementary manner, enhancing the quality and depth of research findings (Creswell & Creswell, 2018; Fetters et al., 2013).

Finally, triangulation mixed-methods design was employed as a key strategy to validate and integrate the findings of the quantitative and qualitative phases (Creswell & Plano Clark,

2018). This process involved systematically comparing quantitative results, which identified significant relationships between UTAUT factors and mHealth adoption, with qualitative findings, which explored contextual and cultural factors beyond the UTAUT framework. Convergence analysis revealed consistent themes, such as the importance of performance expectancy and social influence, across both methods, strengthening the validity of these findings. Divergence analysis highlighted areas where the two methods differed, such as the emergence of cultural and religious compatibility in the qualitative phase, which was not captured in the quantitative data. This divergence underscored the value of integrating qualitative insights to capture context-specific factors.

Given the potential of a convergent mixed-methods design to harness the strengths and overcome the weaknesses associated with quantitative or qualitative approaches alone (Alexander, 2020; Creswell & Creswell, 2017; Creswell & Plano Clark, 2018; Schoonenboom & Johnson, 2017), this design was deemed most suitable for this research. To answer the research questions, we adapted a survey meant to examine the associations between the UTAUT factors of interest and the acceptance and use of mHealth applications by physicians in Saudi Arabia. Additionally, we conducted semi-structured interviews with Saudi physicians to explore other factors that might not have been covered by the UTAUT model.

## 2.6 Research setting, population, and sample

A research population refers to an entire group of individuals, cases or entities that share common characteristics and are of interest to a study (Kalton, 2021; McNabb, 2021). It is the larger group to which researchers intend to generalise their findings. However, because covering an entire population is costly, inaccessible and impractical (Baran & Jones, 2016; Gill & Johnson, 2010), researchers draw a sample, which is a subset of the population of interest, from which they can collect empirical data and make generalisations about their findings

(Baran & Jones, 2016; Kalton, 2021; McNabb, 2021). In the current work, the population in question is constituted by physicians in Saudi Arabia.

Sampling methods refer to the procedures or techniques employed to choose a subset of individuals from a broader population (Baran & Jones, 2016; McNabb, 2021). Proper sampling is essential in studies, as it enables researchers to make accurate inferences about a population based on observed sample characteristics. Sampling methods can be categorised into probability and nonprobability sampling (Kalton, 2021; McNabb, 2021). In probability sampling, the units of a sample (e.g. people, parts, cities, organisations) are chosen in a random manner, ensuring that each unit has an equal opportunity of being selected (Kalton, 2021; McNabb, 2021). Conversely, nonprobability sampling involves the selection of individuals or cases from a given population on the basis of non-random criteria (Kalton, 2021; McNabb, 2021).

## 2.7 Phase 2: Quantitative study

### 2.7.1 Overview

As described above, quantitative research is a systematic study of phenomena through the collection, analysis and interpretation of numerical data (Creswell & Creswell, 2018). It is used by researchers to draw inferences about a large population through suitable statistical techniques and representative samples (Baran & Jones, 2016). To address the second research question, a quantitative study was carried out to examine the associations between the UTAUT variables and the behavioural intention of Saudi physicians to accept and adopt mHealth applications. Using statistical analysis, the study derived empirical evidence on the factors influencing physicians' acceptance and adoption of these technologies.

### 2.7.2 Sampling method and sample size

Simple random probability sampling was adopted in this work for several reasons. First, it offers an equitable probability of selection to all members of a population, thus ensuring an unbiased opportunity for each individual or instance to be included in a sample (Kalton, 2021; Latpate, 2021). To enhance the generalisability of findings, researchers cannot consciously or unconsciously favour certain individuals over others if an objective approach to participant selection is to be guaranteed (Baran & Jones, 2016). Since each member of a population has an equal chance of being chosen, the sample is more likely to be representative of the population. This allows for valid statistical inferences and extrapolation of findings to a larger population (Sharma, 2017). Finally, simple random sampling is adaptable to a wide range of research contexts and target populations (Thompson, 1997).

Sample size refers to the number of participants or observations included in a study (Bager-Charleson & McBeath, 2023). It is important to choose a sample size that adequately represents the population of interest and ensures the statistical power, reliability and generalisability of findings (Creswell & Creswell, 2018). The required sample size may differ based on various aspects, including research designs and questions, statistical analysis methods and desired levels of precision (Baran & Jones, 2016). In this research, the appropriate sample size was a minimum of 200 respondents, as recommended for structural equation modelling (SEM), which ensures the statistical robustness and reliability of model estimates (Boomsma & Hoogland, 2001; Dash & Paul, 2021; Kline, 2015).

### 2.7.3 Research model and hypothesis development

As previously discussed, the research model used in this study was adapted from the UTAUT, which is widely recognised for its effectiveness in predicting user acceptance and usage related intentions and behaviours with respect to technology in various contexts (Al-

Mamary, 2022; Deryl et al., 2023; Momani, 2020). Given the unique setting of Saudi Arabia, the UTAUT model was adapted to focus on its core constructs while considering the sociocultural and technological factors that influence the acceptance and adoption of mHealth apps by physicians. This adaptation involved a targeted examination of how the UTAUT constructs operate in the Saudi healthcare sector, as well as an acknowledgement of the rapid evolution of healthcare technologies and the increasing importance of digital health solutions.

Although extensive research has been devoted to technology adoption models across industries and global contexts, there is a notable lack of understanding regarding the dynamics behind adoption, specifically within the healthcare contexts of developing nations such as Saudi Arabia. These dynamics encompass the unique sociocultural influences, technological infrastructure challenges and specific behaviours and attitudes of healthcare professionals towards technology adoption. As previously stated, the majority of such studies have concentrated on developed countries or the perspectives of patients, frequently neglecting the crucial involvement of healthcare professionals in the process of adoption (Aljohani & Chandran, 2021c; Alsahli et al., 2023; Alsswey et al., 2021). This oversight is critical because these professionals not only serve as primary users but also play a major role in influencing and promoting the adoption of technology in healthcare environments. This deficiency was addressed in the current work by investigating how the adapted UTAUT constructs—performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FCs)—influence Saudi physicians' intention to adopt mHealth technologies and by exploring the moderating effects of demographic variables, such as age, gender and experience, on these relationships. The constructs used in this research and the adapted hypotheses are discussed in the following sections (Figure 2.3).

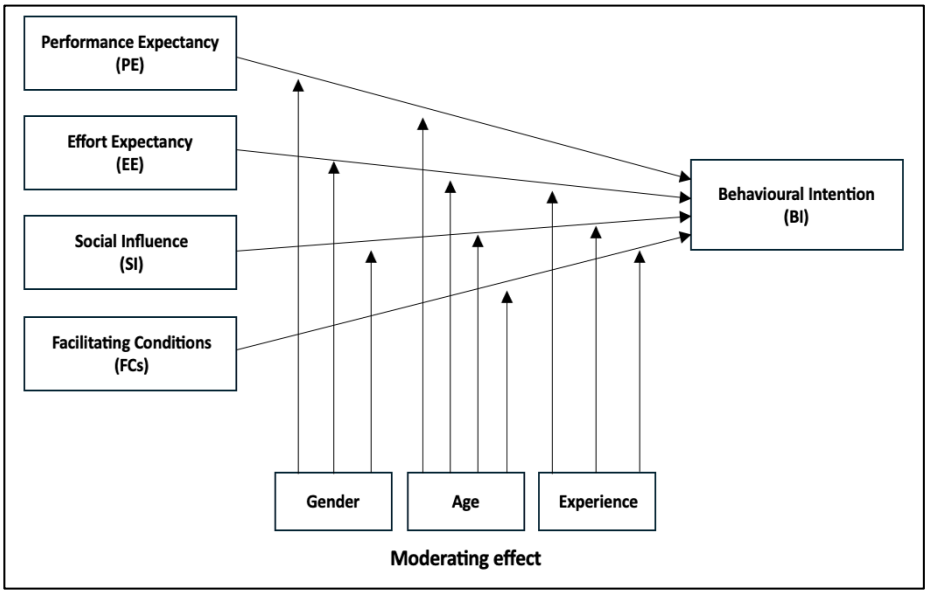


Figure 2.3: The conceptual model.

1. **Performance expectancy (PE)**

PE is the extent to which an individual believes that using a system will improve their job performance and advance goal realisation (Venkatesh et al., 2003). This belief considerably influences an individual's likelihood of accepting and using an innovation (Tian & Wu, 2022; Venkatesh et al., 2003). PE and the behavioural intention to adopt various technologies, including mHealth apps, have been demonstrated in numerous studies as strongly associated with each other (Abdel-Basset et al., 2021; Alam, Hoque, et al., 2020; Alam, Hu, et al., 2020; Wu et al., 2022). Considering the vital role of mHealth apps in enhancing healthcare provision, especially during the COVID-19 global outbreak, it is reasonable to anticipate Saudi physicians who see the advantages of these applications in their practice to be predisposed to adopting them. Furthermore, the relationship between

PE and behavioural intention is plausibly moderated by age and gender (Gu et al., 2021). For example, young physicians may be technologically adept and demand more from mHealth apps, while gender may affect perceptions of a technology's usefulness. On this basis, the following hypotheses were formulated:

H1: PE is positively associated with physicians' behavioural intention to adopt mHealth applications.

H1a: The impact of PE on behavioural intention is moderated by age and gender.

**2. Effort expectancy (EE)**

EE refers to the degree to which an individual considers the use of a system to be easy (Venkatesh et al., 2003), and its importance as a determinant of mHealth technology usage is supported by the literature (Alam, Hu, et al., 2020; Wu et al., 2022). In the context of mHealth, physicians are more likely to adopt user-friendly apps that integrate easily into their workflows. This usability, in turn, considerably facilitates adoption, whereas complexity reduces the intention to use technologies (Liu et al., 2022; Tian & Wu, 2022). Furthermore, the association between EE and behavioural intention may be moderated by factors such as age, gender and experience (Gu et al., 2021). To illustrate, using mHealth apps may be easier to use by young male physicians, who are accustomed to digital tools, and prior experience with similar technologies may also affect EE. Accordingly, the suppositions below were established:

H2: EE is positively associated with physicians' behavioural intention to adopt mHealth applications.

H2a: The impact of EE on behavioural intention is moderated by age, gender and experience.

3. **Social influence (SI)**

SI is defined as the degree to which an individual believes that other people or groups who have the same cultural or social beliefs as they do are key to their decision-making on the acceptance or usage of technology (Venkatesh et al., 2003). In a collectivist culture such as Saudi Arabia, individuals tend to prioritise the demands and expectations of the collective, such as their families, communities or tribes, over their own personal desires (Alotaibi & Campbell, 2022). As a result, physicians are more strongly inclined to implement mHealth apps in their practice if the community regards them as advantageous. Research has demonstrated that SI is strongly associated with a user's intention to use technology (Alam, Hoque, et al., 2020; Alam, Hu, et al., 2020; Wu et al., 2022). Furthermore, younger, male and more experienced physicians may be more susceptible to SI, which potentially moderates the aforementioned association (Gu et al., 2021). With consideration for this matter, we put forward the following assertions:

H3: SI is positively associated with physicians' behavioural intention to adopt mHealth applications.

H3a: The impact of SI on behavioural intention is moderated by age, gender and experience.

4. **Facilitating conditions (FC)**

FCs pertain to the extent to which an individual believes that an existing organisational and technical infrastructure supports the use of a new system (Venkatesh et al., 2003). In light of the nascency of mHealth app implementation in Saudi Arabia, the presence of FCs is critical in promoting adoption by physicians. Such practitioners tend to use mHealth apps if they are convinced that they have sufficient support for adoption in terms of organisational policy, technological resources and training opportunities (Wu et al., 2022).

As with the three other predictors, the relationship between FCs and behavioural intention may be moderated by age and experience, with younger physicians and those with less experience possibly relying more heavily on supportive infrastructure to promote their adoption of mHealth apps (Gu et al., 2021). This led us to establish Hypotheses 4 and 4a:

H4: FCs are positively linked to physicians' behavioural intention to adopt mHealth applications.

H4a: The impact of FCs on behavioural intention is moderated by age and experience.

The endogenous latent construct—**behavioural intention**—in the research model is described as follows: Behavioural intention refers to an individual's subjective probability of engaging in a specific behaviour (Venkatesh et al., 2003) (Table 1). Venkatesh et al. (2003) stated that the stronger an individual's behavioural intention to use technology, the greater the likelihood that they will actually use such an innovation. Previous studies have confirmed that the degree to which individuals intend to use a given technology is a crucial predictor of their actual usage of this technology (Abbad, 2021; Alam, Hoque, et al., 2020; Alam, Hu, et al., 2020; Venkatesh et al., 2003; Wu et al., 2022).

Table 1. Scale development and items for constructs

| Construct | Items | References |
|---|---|---|
| **Performance Expectancy (PE)** | PE 1: I would find mHealth apps useful in my job. | (Venkatesh et al., 2003) |
| | PE 2: Using mHealth apps enable me to accomplish tasks more quickly. | |
| | PE 3: Using mHealth apps increase my productivity. | |
| | PE 4: If I use mHealth apps, I will increase my chances of getting a raise. | |
| **Effort Expectancy (EE)** | EE 1: My interaction with mHealth apps would be clear and understandable. | (Venkatesh et al., 2003) |
| | EE 2: It would be easy for me to become skillful at using mHealth apps. | |
| | EE 3: I would find mHealth apps easy to use. | |
| | EE 4: Learning to operate mHealth apps would be easy for me. | |
| **Social Influence (SI)** | SI 1: People who influence my behaviour think that I should use mHealth apps. | (Venkatesh et al., 2003) |
| | SI 2: People who are important to me think that I should use mHealth apps. | |
| | SI 3: The senior management of my organisation has been helpful in the use of mHealth apps. | |
| | SI 4: In general, my organisation has supported the use of mHealth apps. | |
| **Facilitating Conditions (FCs)** | FCs 1: I have the resources necessary to use mHealth apps. | (Venkatesh et al., 2003) |
| | FCs 2: I have the knowledge necessary to use mHealth apps. | |
| | FCs 3: mHealth apps are not compatible with other systems I use. | |
| | FCs 4: A specific person (or group) is available for assistance with mHealth app difficulties. | |
| **Behavioural Intention to Use the System (BI)** | BI 1: I intend to use mHealth apps in the near future. | (Venkatesh et al., 2003) |
| | BI 2: I predict I would use mHealth apps in the near future. | |
| | BI 3: I plan to use mHealth apps in the near future. | |

### 2.7.4 Data collection strategies

A number of tools and methods are available for collecting quantitative data, including surveys, experiments and observations. Online surveys are a popular research tool for data collection because of their effectiveness in acquiring voluminous data from sizeable populations in an economical manner (Geldsetzer, 2020; Marija Topuzovska & Mirjana Borota, 2020; Safdar et al., 2016; Saunders et al., 2019). Such surveys are particularly suitable for gathering data from numerous respondents, which enables researchers to generalise findings and draw conclusions (Church & Waclawski, 2017). They also offer respondents privacy and anonymity, which can encourage accurate and honest responses, especially when dealing with sensitive or personal topics (Waller et al., 2020). Likewise, they are widely used in studies on health information technology to explain acceptance and adoption among healthcare professionals (Kong et al., 2020; Lim et al., 2021; Pan et al., 2019; Ramnund et al., 2023; Samadbeik et al., 2023; Tadayon et al., 2021; Wu et al., 2022). More importantly, online surveys are considered an effective tool for collecting information during the COVID-19 pandemic, at which time face-to-face surveys are impossible due to social distancing rules (Islam & Darzi, 2022; Yaprak et al., 2021).

These benefits motivated us to develop and administer an online survey via the Qualtrics platform. The suitability of the approach was reinforced by the complexity of collecting data on a national level in a massive territory such as Saudi Arabia. The survey link was distributed to prospective physicians by email through the Saudi Arabia Ministry of Health and Saudi medical societies, including the Saudi Society of Internal Medicine, Saudi General Surgery Society and the Saudi Paediatrics Association.

### 2.7.5 The survey

A cross-sectional survey design was implemented in the current study, and the survey questions were used to identify the key factors related to the behavioural intention of Saudi physicians to accept and adopt mHealth applications on the basis of the UTAUT model (Venkatesh et al., 2003). A pilot study is a preliminary research conducted on a smaller scale before a major investigation to test and refine methodologies and instruments (In, 2017). This step is crucial, as it confirms the feasibility of a research design, validates data collection instruments and initiates the implementation of essential modifications, thus improving the quality and efficiency of the research process (In, 2017). Before survey distribution, therefore, a pilot study was conducted involving 30 randomly chosen physicians, who were tasked with validating the survey instrument. Based on their feedback, adjustments were made, including adding a brief introduction to mHealth applications in Saudi Arabia, simplifying technical terms, and rewording unclear questions. After incorporating these changes, the final version of the survey was created for distribution.

The survey included an information sheet that described the research aim, contained the researchers' contact details, and consisted of a consent form. The initial section of the survey covered a definition and description of mHealth apps to clarify awareness of the technology of interest for the participants. The survey was divided into three main sections, among which the first revolved around demographic characteristics, including gender, age and specialisation. The second section was intended to derive additional details on the participants' awareness of mHealth implementation in Saudi Arabia. It comprised questions about the use of mHealth, years of experience and the type of mHealth services that the physicians have used. The third section consisted of items centred on the UTAUT factors that may influence the acceptance and adoption of mHealth apps. It also included statements related to the dependent variable (behavioural intention). Each variable was described in four statements, to which the

participants were asked to respond using a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

Data were collected from December 2022 to May 2023. To ensure the recruitment of appropriate participants, we set clear inclusion and exclusion criteria. Only Saudi physicians were eligible to participate in the study, ensuring the sample's relevance to the research goals. To guarantee the accuracy and integrity of the data, the survey platform was configured to permit only one submission per respondent and to include checks for inconsistent responses.

### 2.7.6 Data analysis

The Statistical Package for the Social Sciences (SPSS) was used for data screening purposes. Once the data were prepared, Structural Equation Modelling (SEM) was run in AMOS software. SEM was chosen, as it allows for the simultaneous testing of complex relationships among multiple independent and dependent variables. SEM is not limited to a single statistical methodology but encompasses a range of statistical methods designed for a comprehensive analysis of a multitude of variables and their interrelationships (Anderson & Gerbing, 1988; Collier, 2020; Dash & Paul, 2021; Musil et al., 1998).

At its core, SEM combines concepts from factor analysis, which identifies underlying factors from observed variables, and multiple regression analysis, which assesses how one set of variables predicts another (Dash & Paul, 2021; Musil et al., 1998). This combination makes SEM an ideal choice for examining the constructs of the UTAUT model and their influence on Saudi physicians' intentions to adopt mHealth applications. Using these constructs as latent variables, instead of measured variables, also has the advantage of minimizing measurement error, thereby enhancing the reliability and validity of the analysis. Moreover, SEM makes multigroup analysis possible, which is essential for exploring whether the relationships between constructs vary across subgroups, such as age and gender. This feature is particularly

valuable in this study, as it illuminates how the acceptance and adoption of mHealth applications differ among diverse groups in the Saudi physician population.

SEM was conducted using the two-step approach recommended by Anderson and Gerbing (1988), which involves measurement model assessment and structural model assessment. This approach underlines the importance of validating a measurement model before assessing a structural model, ensuring that constructs are measured accurately before their relationships are tested. SEM is often used in behavioural and social sciences to verify hypotheses about the associations between variables (Abbad, 2021; Alkhalifah, 2022; Rajak & Shaw, 2021; Shaheen et al., 2017; Wu et al., 2022).

#### 2.7.6.1 Data screening and descriptive statistics

Before SEM is conducted, it is necessary to perform data screening to ensure the validity and reliability of the model (Ahmed & Suliman, 2020). Accordingly, we initiated the analysis by screening the data using SPSS to prepare the raw data. The screening process involved checking for missing values, unengaged responses, outliers, normality and multicollinearity. Following the data screening, a descriptive analysis of the data obtained from the questionnaire survey was conducted. This involved summarising the basic features of the data as well as providing simple summaries of the sample and measures. Descriptive statistics, including means, standard deviations, frequencies and percentages, were calculated to provide an overview of the respondents' demographic attributes and their responses to the survey questions (Collier, 2020). This preliminary analysis helped shed light on the general trends and patterns in the data, setting the stage for more complex SEM analyses.

#### 2.7.6.2 Assessment of the measurement model

This step focuses on the relationships between observed variables (indicators) and their corresponding latent variables (factors or constructs) using a measurement model that tests both reliability and validity. Reliability refers to the consistency or stability of a measurement instrument, indicating how well a set of observed variables consistently measure a latent construct (Creswell & Creswell, 2018; Gellman, 2020). Validity refers to the extent to which a measurement instrument accurately measures what it is intended to ascertain (Gellman, 2020). In other words, the measurement model in SEM assesses the reliability (consistent measurement) and validity (accurate measurement) of constructs. Confirmatory Factor Analysis (CFA) was conducted to validate measurement models and examine relationships between latent constructs and their indicators.

In this work, reliability was assessed using Cronbach's alpha and composite reliability (CR). Cronbach's alpha measures the internal consistency of a construct, wherein values above 0.70 typically indicate acceptable consistency (Hair et al., 2018; Shah et al., 2021). Composite Reliability (CR) is another commonly used measure for assessing the internal consistency of a construct, with values of 0.70 or higher generally considered indicative of acceptability (Hair et al., 2018; Shah et al., 2021). These tools ensure that indicators yield stable and consistent results over repeated measurements (Table 2).

Table 2. Reliability of scales in previous studies

| Construct | Cronbach's alpha | |
|---|---|---|
| | Previous studies | The current study |
| **Performance Expectancy (PE)** | 0.790 (Wu et al., 2022) | 0.808 |
| | 0.798 (Al-Mamary, 2022) | |
| **Effort Expectancy (EE)** | 0.779 (Wu et al., 2022) | 0.799 |
| | 0.880 (Al-Mamary, 2022) | |
| **Social Influence (SI)** | 0.816 (Wu et al., 2022) | 0.801 |
| | 0.877 (Al-Mamary, 2022) | |
| **Facilitating Conditions (FCs)** | 0.752 (Wu et al., 2022) | 0.815 |
| | 0.928 (Al-Mamary, 2022) | |
| **Behavioural Intention to Use the System (BI)** | 0.811 (Wu et al., 2022) | 0.792 |
| | 0.956 (Al-Mamary, 2022) | |

The validity of our measurement models, including both convergent and discriminant validity, was assessed (Baharum et al., 2023; Collier, 2020; Hair et al., 2018). Convergent validity refers to the extent to which different measures that are designed to assess the same factor yield similar results (Collier, 2020). In this study, convergent validity was evaluated using the average variance extracted (AVE), which points to the level of variance captured by a construct in relation to the variance arising from measurement errors. An AVE value of 0.5 or higher generally indicates satisfactory convergent validity (Fornell & Larcker, 1981; Hair et al., 2018). Discriminant validity is a statistical concept that refers to the effectiveness of a collection of indicators that are assumed to measure a certain factor and that differ from other factors (Fornell & Larcker, 1981). In this study, discriminant validity was assessed by

comparing the square root of the AVE of each construct with its correlations with other constructs (Fornell & Larcker, 1981). Fornell and Larcker (1981) stated that to establish discriminant validity, the square root of the AVE should exceed its correlation with all other constructs.

In addition, goodness-of-fit indices, namely the comparative fit index (CFI), Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA) and standardised root mean square residual (SRMR), were assessed based on the most prominent tests in AMOS software (Collier, 2020). A reasonably good fit can be obtained with CFI values close to 1, IFI values of .90 or higher, TLI values above .90, RMSEA values of .08 or below and SRMR values of .08 or lower (Collier, 2020).

#### 2.7.6.3 Assessment of the structural model

After establishing the reliability and validity of the measurement model, the analysis proceeds to the evaluation of the structural model, which is intended to test the hypothesised relationships between latent variables. This is achieved by examining path coefficients that reveal the direction of these relationships. The significance of these coefficients is determined by *t*-values (with values greater than 1.96 indicating significance) and *p*-values (with values less than 0.05 considered statistically significant) (Hair et al., 2018). Additionally, moderation analysis is carried out to explore how the interaction between two variables is changed by the presence of a third variable (the moderator) (Collier, 2020). Thus, multigroup analysis is performed to determine whether the relationships within the structural model differ across various demographic groups, thereby enhancing the model's robustness and generalisability. Such rigorous methodologies are consistent with previous studies that have explored users' behavioural intention to adopt technology, including those using the UTAUT model to investigate variables influencing technology use, as demonstrated by researchers such as

Abbad (2021), Al-Mamary (2022), Salloum and Shaalan (2019), Wu et al. (2022), and Ustun et al. (2023).

## 2.8 Phase 3: Qualitative study

### 2.8.1 Overview

The aim of the qualitative study was to elicit rich information about the acceptance and adoption of mHealth and identify contextual aspects that were not captured in the quantitative examination. Qualitative research enables researchers to engage with participants on a personal level, providing opportunities for participants to express themselves in their own words and share their lived experiences rather than choosing from a fixed set of answers (Baran & Jones, 2016; Farrelly, 2013). Venkatesh et al. (2013) averred that implementing a qualitative study, along with a quantitative investigation, is essential when using the UTAUT model to address issues relevant to a developing country because this approach may illuminate factors that are not common to developed nations. In particular, the qualitative study intended to address physicians' intention to use mHealth applications during the COVID-19 pandemic—an aspect that was not explicitly captured in the quantitative phase. This element was critical in understanding the role of pandemic-specific pressures, such as the urgency for remote healthcare delivery and the heightened reliance on digital solutions during a public health crisis, in shaping physicians' behavioural intentions. By capturing these unique insights, the qualitative study provided a more comprehensive and contextually relevant understanding of mHealth adoption. Hence, to address the third research question, the qualitative study was designed to explore other factors that might influence physicians' behavioural intention to accept and adopt mHealth applications.

### 2.8.2 Sampling method and sample size

In the qualitative research component of this thesis, purposive nonprobability sampling was utilized to enable an in-depth exploration of specific topics, enabling researchers to gain extensive and detailed understandings that may not be possible in broader, more generalisable studies (Islam et al., 2022). One of the objectives of this thesis was to discover additional factors that influence physicians' behavioural intentions to accept and adopt mHealth applications but are disregarded in the UTAUT model. This model offers a robust framework for understanding technology adoption. Nevertheless, traditional quantitative methodologies or existing models may not effectively capture the impact of these factors on the uptake and usage of mHealth applications, such as context-specific determinants relevant to Saudi physicians (Bawack & Kala Kamdjoug, 2018; Swidi & Faaeq, 2019; Venkatesh et al., 2003). By utilising purposive nonprobability sampling, researchers can focus on physicians who are early adopters of mHealth technology or those who have unique perspectives on its implementation. This approach enables the collection of rich qualitative data that can reveal insights into the specific factors that these physicians encounter in their practice.

Predetermining sample size in qualitative research is intrinsically challenging, as this type of study explores phenomena without having the opportunity to identify core themes beforehand (Sim et al., 2018). The sample size in qualitative research is typically determined by data saturation instead of statistical considerations, as is the case with quantitative research (Hennink & Kaiser, 2022). Thus, researchers typically interview participants until they reach data saturation, that is, until they have collected sufficient data to gain a comprehensive understanding of a phenomenon under investigation and no new insights or themes emerge from the interviews (Charmaz, 2014; Kamei-Hannan et al., 2023). Empirical studies suggest that data saturation is typically achieved within a range of 9 to 17 interviews, particularly when working with narrowly defined research objectives (Hennink & Kaiser, 2022). In this study,

the interviews continued until data saturation was reached, ensuring no new insights or themes emerged from the interviews. Reaching this point was especially challenging due to the demanding schedules of the participating physicians, who are also often difficult to interview and who hesitate to participate because of their heavy workloads and patient care responsibilities.

### 2.8.3 Data collection strategies

Several data collection tools, including interviews, focus group discussions and observations, are commonly used in qualitative research (Creswell & Creswell, 2018; McNabb, 2021). Interviews, which are the most widely used tool for collecting qualitative data (Denny & Weckesser, 2022), were chosen for this work for a number of reasons. Interviews can be tailored to a given research context and participants, allowing for flexibility in questioning and probing techniques (Britten, 1995). Researchers can adapt their questioning and pursue further investigation into interesting or unforeseen responses, thus facilitating a more thorough comprehension of the topic being examined. Interviews also often involve face-to-face or one-on-one interaction between a researcher and participants, enabling the cultivation of a personal connection and trust (Seitz, 2016). They provide a private and individualised setting, allowing participants to feel comfortable sharing personal experiences and sensitive information (Corbin & Strauss, 2015). Participants may feel less pressure to conform to group dynamics or social expectations, leading to more individualised responses.

### 2.8.4 The interviews

Semi-structured interviews were conducted. The development of the interview guide was informed by a systematic review of the relevant literature on mHealth acceptance and adoption by physicians, conducted to thoroughly understand the factors influencing their

decision-making processes (Alsahli et al., 2023). This guide included an introduction that defined and described mHealth apps to ensure that the participants were aware of the technologies being studied. It was structured into two main sections: demographic information and interview questions. The demographic section included questions about the participants' genders, ages and specialisations. The interview questions were further divided into three subcategories: general open-ended, in-depth and closing questions. All the interviews were scheduled and conducted using the Zoom platform, with each session lasting 20 to 40 minutes.

### 2.8.5 Data analysis

Data analysis in qualitative research involves systematically interpreting and making sense of qualitative data, such as interview transcripts, focus group discussions, observations and textual documents (Creswell, 2013). Unlike quantitative research, which focuses on numerical data analysis, qualitative research seeks to understand the richness, depth and complexity of human experiences, perspectives and meanings (Creswell & Creswell, 2018). In this study, template analysis was used to analyse the interview data (King et al., 2018). This method of analysis is a systematic and flexible approach that has become increasingly popular for the management and examination of qualitative data (King et al., 2018). A crucial benefit of template analysis lies in its facilitation of both inductive and deductive methods, thereby allowing for an exhaustive and multifaceted approach to research (Glass et al., 2021). Template analysis entails many steps: data familiarisation, preliminary coding, clustering, initial template development, template modification, final template definition, and template use for data interpretation (King et al., 2018) (Figure 2.4).

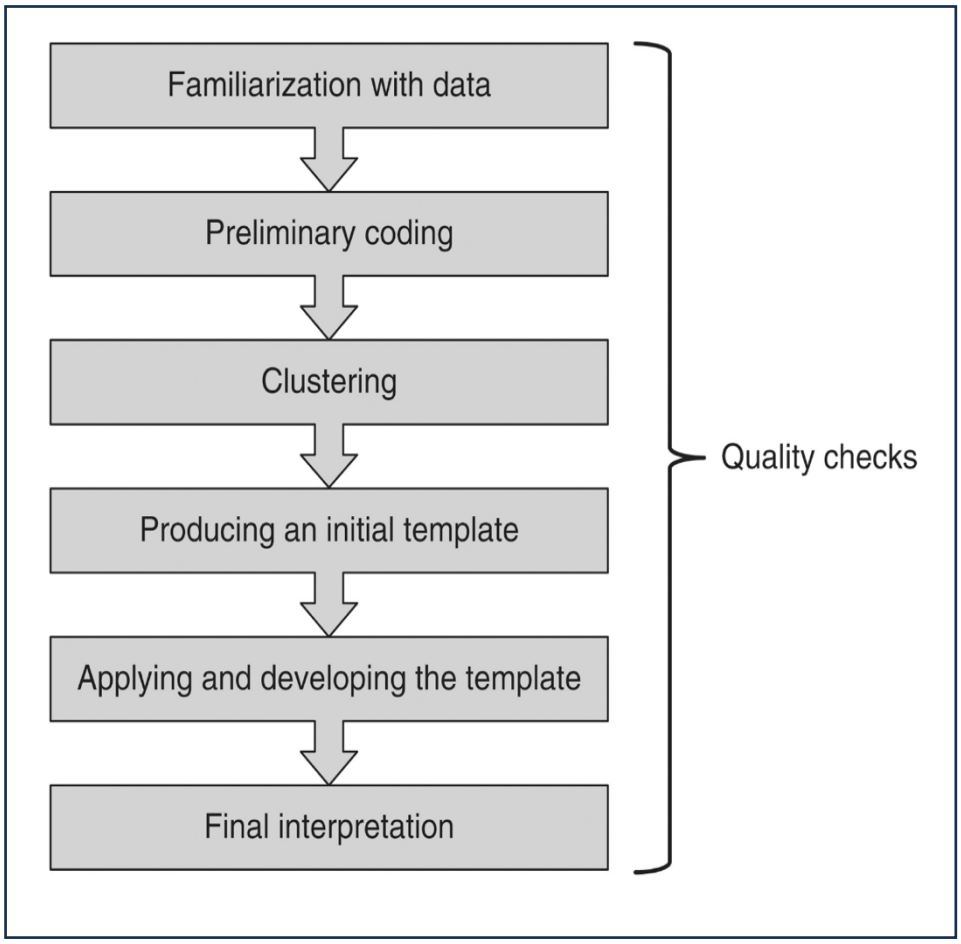


Figure 2.4: Steps in Template Analysis (King et al., 2018).

**Data Familiarisation**

The first step in template analysis is familiarising oneself with the data. This involves reading and re-reading the raw data to gain a thorough understanding of each participant's perspective. By immersing themselves in the data, researchers develop a sense of the overall content, tone, and context of the information provided. In this study, familiarisation was achieved by carefully reading through each interview transcript multiple times while taking notes on initial impressions and recurring ideas.

### Preliminary Coding

Preliminary coding is the process of marking and categorizing relevant text segments from the data. In this study, coding was guided by a priori themes derived from the Unified Theory of Acceptance and Use of Technology (UTAUT) model and additional factors identified in Phase 1, systematic review (Alsahli et al., 2023). These pre-established themes served as a starting point but remained flexible to accommodate new insights from the data. The coding process involved assigning labels to specific passages of text that aligned with these themes while remaining open to emergent codes that captured unexpected aspects of the participants' responses.

### Clustering

Clustering involves grouping the coded segments into meaningful categories or themes. In this step, related codes were examined and combined into broader clusters that represented key patterns in the data. This process of clustering not only refined the initial themes but also allowed for the identification of subthemes that provided deeper insights into specific factors influencing mHealth adoption.

### Initial Template Development

The initial template was developed by synthesising the clustered themes into a structured framework for further analysis. This template included both the a priori themes and emergent themes. The initial template provided a comprehensive framework for organizing the data and guided subsequent analysis by ensuring that all relevant aspects of the data were captured systematically.

### Template Modification

During the analysis process, the initial template was continuously refined to reflect the nuances and complexities of the data. Themes were adjusted, combined, or subdivided to ensure they accurately represented the participants' perspectives. This iterative process ensured that the template was flexible and adaptable, allowing the analysis to remain grounded in the data while addressing the research objectives comprehensively.

### Final Template Definition

Once the modifications were complete, a final version of the template was established. This final template provided a clear and organized framework for interpreting the data, ensuring that all identified themes and subthemes were systematically addressed. The finalized structure not only streamlined the analysis but also enhanced the transparency and rigor of the research process. The final template incorporated both the theoretical constructs from the UTAUT model and the unique factors that emerged from the Saudi context.

### Template Use for Data Interpretation

The final step involved applying the refined template to the entire dataset. This process allowed for a detailed exploration of the identified themes and generated meaningful insights aligned with the research objectives. Quotations were selected based on their ability to represent key themes and illustrate the diversity of responses among the physicians. These included quotations that highlighted common experiences, as well as those that provided contrasting or divergent viewpoints, to ensure a balanced and comprehensive analysis. Each quotation was contextualized by including relevant background information about the participant, such as their role, years of experience, or specific challenges they faced with

mHealth adoption. By incorporating quotations that represented both shared and unique perspectives, this analysis provided a nuanced understanding of the factors influencing physicians' adoption of mHealth applications during the COVID-19 pandemic. The presentation of findings was designed to reflect the richness of the data, with themes and subthemes supported by illustrative examples that brought the participants' voices to the forefront. This approach ensured that the analysis was not only systematic but also transparent and faithful to the participants' experiences.

## 2.9 Ethical considerations

This study was granted ethical approval by the Ethics Committee of the University of Technology Sydney (UTS HREC REF NO. ETH21-6751). The research complied with the Australian Code for the Responsible Conduct of Research and the National Statement on Ethical Conduct in Human Research. The survey included an information sheet that described the research aim, contained the researchers' contact details and consisted of a consent form. The information sheet provided participants with a comprehensive overview of the study, outlining the purpose, objectives and potential benefits of the research. It also included details about the voluntary nature of participation, ensuring that the respondents understood their right to withdraw from the study at any time without consequences.

Interview participants were provided with an information sheet and consent form, assuring them that the collected data would not be shared with unauthorised persons, including their employers, and that confidentiality would be maintained throughout the data collection process. The information sheet and consent form explained the nature and purpose of the interviews, the type of information that would be collected and how this information would be used. The participants were informed that their identities would be protected, as their names would be

replaced by codes and that all data would be stored securely. Participants were also given the opportunity to ask questions and express any concerns before consenting to participate.

# CHAPTER 3

## CHAPTER 3: PHASE 1:

## FACTORS INFLUENCING THE ACCEPTANCE AND ADOPTION OF MOBILE HEALTH APPS BY PHYSICIANS DURING THE COVID-19 PANDEMIC: SYSTEMATIC REVIEW

## 3.1 Chapter preface

Building upon the objectives outlined in Chapter 1, this chapter systematically reviews and synthesizes the scientific literature on factors influencing the acceptance and adoption of mHealth among physicians. It delves into the adoption of mobile health applications by physicians during the COVID-19 pandemic. The findings from this review seek to answer the first research question:

*What are the key factors influencing the acceptance and adoption of mobile health applications among physicians, as identified in existing literature?*

During the COVID-19 pandemic, health care systems faced unprecedented challenges in delivering essential services while minimizing face-to-face interactions, particularly during lockdowns and in managing COVID-19 cases. This placed immense pressure on already overburdened systems, making it more critical than ever to ensure the accessibility of health care services. Mobile health (mHealth) apps emerged as a promising solution, offering the potential to improve health care outcomes and address systemic challenges worldwide. Despite their numerous advantages, the acceptance and adoption of mHealth technologies by physicians remain limited, highlighting the need for health care organizations to understand and address physicians' perspectives for successful implementation. This systematic review aimed to explore the factors influencing the acceptance and adoption of mHealth by physicians during the COVID-19 pandemic by synthesizing studies published between March 2020 and December 2022. Using the PRISMA guidelines, a comprehensive search of the MEDLINE, Scopus, Embase, and ProQuest databases identified 455 potential publications, of which nine met the inclusion criteria. The findings categorized influencing factors into technological, individual, and organizational barriers and facilitators. Key technological barriers included accessibility, technical issues, and data management, while individual barriers encompassed

workload pressures, technical literacy, and peer support, and organizational barriers involved financial constraints, management support, and data security concerns. Conversely, facilitators included clinical usefulness, intrinsic motivation, collaboration, and organizational readiness, with patient-centered care and evidence-based guidelines playing a pivotal role in fostering adoption. The review concluded that addressing organizational readiness, shifting focus from purely technological factors to patient-centered care, and ensuring seamless integration of mHealth into routine practice are essential to overcoming barriers and realizing the full potential of mHealth technologies during and beyond the pandemic.

**Publication details**

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Review

# Factors Influencing the Acceptance and Adoption of Mobile Health Apps by Physicians During the COVID-19 Pandemic: Systematic Review

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## Abstract

**Background:** During the COVID-19 pandemic, the provision of and access to health care have been uniquely challenging, particularly during lockdowns or when dealing with COVID-19 cases. Health care professionals have had to provide patients with the necessary health care. However, delivering health care services while reducing face-to-face interaction puts an immense strain on health systems that are already overburdened. Against this backdrop, it is now more critical than ever to ensure the accessibility of health care services. Such access has been made increasingly available through mobile health (mHealth) apps. These apps have the potential to significantly improve health care outcomes and expectations and address some of the challenges confronting health care systems worldwide. Despite the advantages of mHealth, its acceptance and adoption remain low. Hence, health care organizations must consider the perceptions and opinions of physicians if the technology is to be successfully implemented.

**Objective:** The objective of this systematic review was to explore and synthesize the scientific literature on the factors influencing the acceptance and adoption of mHealth among physicians during the COVID-19 pandemic.

**Methods:** A systematic review of the studies published between March 2020 and December 2022 was conducted using the MEDLINE, Scopus, Embase, and ProQuest databases. The database search yielded an initial sample of 455 potential publications for analysis, of which 9 (2%) met the inclusion criteria. The methodology of this review was based on PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses).

**Results:** The factors influencing mHealth acceptance and adoption by physicians were divided into perceived barriers and perceived facilitators, which were further grouped into the following 3 major thematic categories: technological, individual, and organizational barriers and facilitators, respectively. The technological barriers were accessibility, technical issues, usefulness, and data management; individual barriers were perceived patient barriers, time and workload pressure, technical literacy, knowledge of mHealth, and peer support; and organizational barriers were financial factors, management support and engagement, data security, telemonitoring policy, and collaboration. The technological facilitators of uptake were technical factors, clinical usefulness, and data management; individual facilitators were patient-related care, intrinsic motivation, collaboration, and data sharing (individual); and organizational facilitators were workflow-related determinants, organizational financial support, recommendation of mHealth services, and evidence-based guidelines.

**Conclusions:** This review summarized the evidence on the factors influencing mHealth acceptance and adoption by physicians during the COVID-19 pandemic. The main findings highlighted the importance of addressing organizational readiness to support



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physicians with adequate resources, shifting the focus from technological to patient-centered factors, and the seamless integration of mHealth into routine practice during and beyond the pandemic.

**Trial Registration:** PROSPERO CRD42022356125; https://tinyurl.com/2mmhn5yu

***(JMIR Mhealth Uhealth 2023;11:e50419)*** doi: 10.2196/50419

**KEYWORDS**

mobile health; mHealth; mobile app; adoption; acceptance; barrier; attitude; physician; doctor; practitioner; mobile phone

## Introduction

### Background

On March 11, 2020, the World Health Organization (WHO) declared the outbreak of the COVID-19 pandemic [1], a crisis that has put pressure on health care systems around the world [2,3], with multiple waves of infections and deaths [4,5]. A recent report by the WHO stated that there have been 757,264,511 confirmed cases of COVID-19, of which 6,850,594 (0.9%) have been fatalities [6].

During this period, the provision of and access to health care have been uniquely challenging [3,7,8], particularly during lockdowns or when dealing with COVID-19 cases. Health care professionals have had to provide patients with the necessary health care. However, delivering health care services while reducing face-to-face interaction puts an immense strain on health systems that are already overburdened [9]. Against this backdrop, it is now more critical than ever to ensure the accessibility of health care services. Such access has been made increasingly available through mobile health (mHealth) apps, given the advancements in information and communication technology. These apps have the potential to significantly improve health care outcomes and expectations and address some of the challenges confronting health care systems worldwide [10-14].

mHealth falls under the broader umbrella of eHealth, which encompasses the use of electronic technologies and digital communication to enhance health care delivery [15-17]. However, mHealth technologies differ from conventional eHealth technologies in that they are specifically designed for use on mobile devices, and as such, mHealth apps do not rely solely on computers and wired internet connections, which makes them more accessible [18]. In addition, mHealth extends beyond medical consultations (more commonly known as telemedicine), offering features such as symptom tracking, mental health support, fitness tracking, medication reminders, personalized support, and access to health-related information [18-21]. Using mHealth is a popular strategy because it is user driven, readily available, and often reasonably priced [22].

The WHO [23] acknowledged that there is no widely accepted definition of mHealth, but it could be understood as the practice of using mobile devices for health care. More specifically, it refers to the capability to use mobile devices to collect health care–relevant data from patients in real time and use such information to monitor, diagnose, and treat patients [24]. It has the potential to benefit both health care professionals and patients during the COVID-19 pandemic [14,25,26]. For instance, it can improve the delivery of health care services, reduce health care professional and patient exposure to infectious diseases, and minimize patient demand for facilities [27,28]. In addition, mHealth apps use location data and proximity alerts to notify users if they were in close contact with someone who later tested positive for COVID-19 [29,30]. These timely alerts empower people to self-isolate, get tested, and inform their health care providers, helping break the chain of transmission [29,31]. It also offers opportunities for health care professionals to remotely consult and share data with their colleagues [32,33]. Furthermore, mHealth not only enables patients to receive remote consultation but also improves their adherence to medication and delivers disease education [20,25,33,34].

Despite the above-mentioned advantages, the acceptance and adoption of mHealth remain low [35-38]. The factors that influence technology acceptance and adoption are likely to vary across target users [39,40]. Physicians, for example, can stimulate changes in the health care sector and play a critical role in mHealth acceptance and adoption, depending on whether they themselves embrace this new technology. As explained by Cajita et al [41], patients are willing to accept and adopt mHealth when their physicians recommend it. Hence, health care organizations must consider the perceptions and opinions of physicians if the technology is to be successfully implemented [42].

### Objectives

Before the COVID-19 pandemic, the acceptance and adoption of technology for work duties were a matter of personal or organizational preference [43]. This orientation was changed by the crisis, which compelled technology use in work environments, thereby accelerating the process of digitization in all sectors, including health care. As previously stated, physicians have been forced to provide health care services remotely [44], and they have accepted and adopted mHealth because of physical distancing restrictions. This situation may affect their continued use of the technology, which is one of the success factors for acceptance and adoption [38]. However, Keuper et al [44] found in their study that only a few physicians intend to continue offering remote health care services in the future. A possibility is that the COVID-19 pandemic has changed the behavioral intentions and perceptions of people regarding digital transformation [45,46]. Thus, the factors influencing technology acceptance and adoption have also likely changed [47], or new factors might have emerged. Shedding light on these factors can facilitate the acceptance and adoption of mHealth and help health care professionals provide services during the COVID-19 pandemic and other similar crises in the future.



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Although previous reviews have analyzed mHealth acceptance and adoption by physicians [42,48,49], to the best of our knowledge, none of these reviews have focused on this topic in the context of the COVID-19 pandemic. This systematic review intended to fill this void. This review can benefit policy makers and mHealth providers by presenting an updated and thorough assessment of important issues that affect mHealth acceptance and adoption among physicians. This review can also help them design a strategy for promoting mHealth acceptance and adoption and derive potential benefits from this technology. Finally, this review provides opportunities for follow-up research by identifying potential gaps in mHealth acceptance and adoption.

## Methods

### Overview

The methodology of this review was based on the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) [50], which provides guidelines for a reliable and rigorous literature review (Multimedia Appendix 1). The review protocol was registered and published in advance with PROSPERO (CRD42022356125). The review focused on quantitative, qualitative, and mixed method studies to identify the factors that influenced the acceptance and adoption of mHealth among physicians during the COVID-19 pandemic.

### Search Strategy

MEDLINE (Ovid), Scopus (Elsevier), Embase (Ovid), and ProQuest databases were searched for studies published in the English language. As the aim of this review was to explore mHealth acceptance and adoption factors during the pandemic, the time frame selected was from 2020 to 2022. The search strategy was established based on the population, intervention, comparator, and outcome (PICO) framework [51]. Specifically, we searched for studies revolving around physicians (population); the use of mHealth apps, including smartphones, portable digital devices, and tablets (intervention); and mHealth acceptance and adoption (outcome). Comparators were not relevant to this review.

Initially, combinations of Medical Subject Headings (MeSH) terms, keywords, and terminologies were used with reference to the following 3 categories: “mHealth,” “acceptance or adoption,” and “physician” (Multimedia Appendix 2). The more specific search terms used were as follows: “mobile health,” “mHealth,” “mHealth,” or “mobile app”; “adoption,” “acceptance,” “barrier,” or “attitude”; and “physician,” “doctor,” or “practitioner.”

### Study Selection

We used Covidence (Veritas Health Innovation, Ltd), a web-based collaboration software platform, to support the screening of the identified studies, all of which were uploaded onto the platform. A 2-step screening procedure was conducted to evaluate the relevance of the studies. In the first step, the titles and abstracts of the studies were screened independently by 2 reviewers (SA and SH). Any disagreements between the reviewers at the first step were discussed until a consensus was reached, or a third reviewer assisted in resolving the disagreement. In the second step, the studies that met the inclusion criteria were subjected to full-text screening carried out independently by 2 reviewers (SA and ML). Any disagreements at this point were resolved through discussion, or a third reviewer (SH) aided in the resolution.

### Inclusion and Exclusion Criteria

The inclusion criteria were studies that (1) focused on the acceptance and adoption of mHealth primarily by physicians, (2) addressed factors influencing acceptance and adoption, (3) were peer reviewed, and (4) were published in English. The exclusion criteria were studies that (1) examined other health care technologies, such as electronic health records and electronic medical records; (2) focused solely on participants other than physicians (ie, patients, nurses, and midwives); and (3) collected data before the COVID-19 pandemic.

### Quality Assessment

The studies included in the final data synthesis were assessed for methodological quality using the Quality Assessment with Diverse Studies (QuADS) criteria [52]. The QuADS is a 13-criteria tool developed to evaluate the quality of different designs, including quantitative, qualitative, and mixed methods research. For each criterion, a study can derive a score ranging from 0 (no mention at all) to 3 (full details), with the maximum possible score being 39. A QuADS score was calculated for each study, after which the item scores were summed and divided by the maximum possible score to obtain an overall quality assessment for each study. Studies with scores lower than 50%, ranging from 50% to 70%, and greater than 70% were classified as being of low, moderate, and high methodological quality, respectively [53]. Two authors (SA and SH) independently assessed the studies, and disagreements were resolved through discussion (Multimedia Appendix 3 [28,54-61]).

### Data Extraction and Synthesis

Given the heterogeneous factors identified in the included studies, conducting a meta-analysis synthesis was not possible. Instead, the results on factors influencing the acceptance and adoption of mHealth among physicians were narratively synthesized. The selected studies were subjected to data extraction, with their titles, abstracts, and full texts screened, after which the required information was obtained using a predefined data extraction form. This form included the following details: authors, year of publication, location, study design, sample size, targeted population, theoretical framework, and influencing factors. To ensure the validity of these details, 2 reviewers (SA and ML) independently recorded them. Differences or disagreements were resolved through discussion.

## Results

### Overview

The database search yielded an initial sample of 455 potential publications for analysis. Of these 455 publications, 117 (25.7%) duplicates were eliminated. The titles and abstracts of the remaining 338 (85.3%) publications were reviewed, resulting in 314 (92.9%) publications being discarded at this stage for



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failing to meet the inclusion criteria. This remaining 24 (7.1%) publications underwent full-text review, of which 15 (62%) were eliminated because they did not meet the inclusion criteria (Figure 1). The final sample consisted of 9 published papers, whose key features are highlighted in Table 1.

**Figure 1.** PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses). mHealth: mobile health.

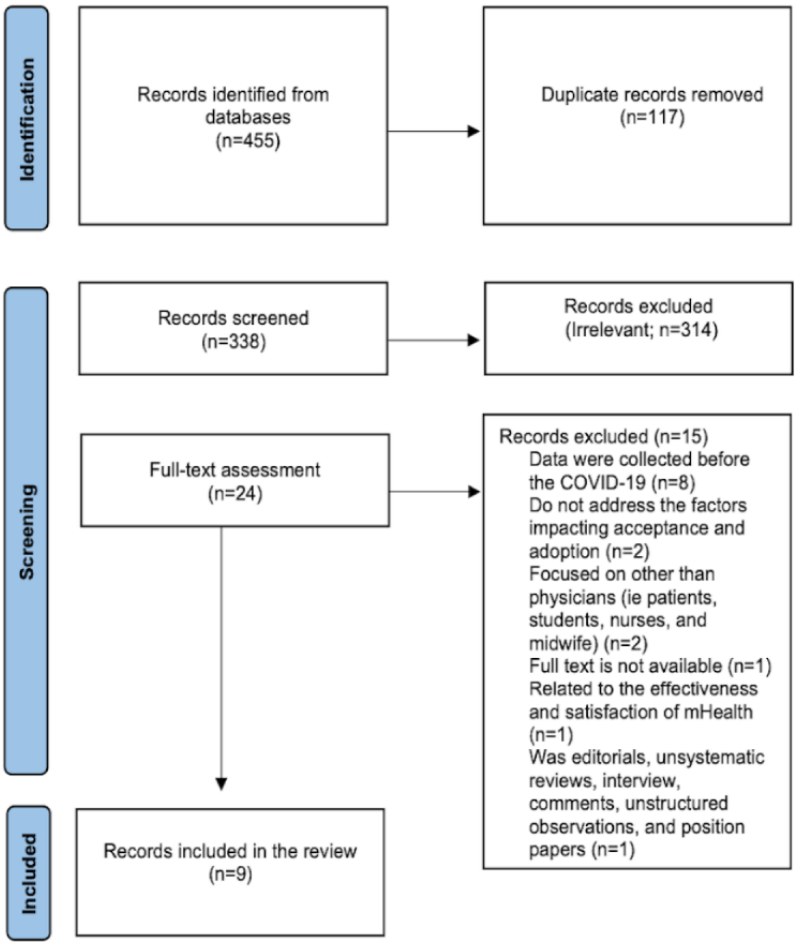




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**Table 1.** Characteristics of the included studies (N=9).

| Study | Country | Study Design | Participants (physicians), n | Targeted population | Specialty | Theoretical framework | Assessment tool | QuADS[a] score (%) |
|---|---|---|---|---|---|---|---|---|
| Aquino et al [54] | Canada | Qualitative | 5 | Clinicians and patients | Obstetricians | NR[b] | Interviews | 59 |
| Artanian et al [28] | Canada | Qualitatibe | 5 | Clinicians and patients | Cardiologists | Chaudoir multilevel framework | Interviews | 87 |
| Bhatt and Chakraborty [55] | India | Quantitative | 316 | Physicians | Multiple specialties | UTAUT[c] | Questionnaire | 51 |
| Dahlhausen et al [56] | Germany | Mixed methods | 1295 | Physicians | Multiple specialties | NR | Interviews and questionnaire | 79 |
| Fleddermann et al [57] | United States | Qualitative | 13 | Physicians | Multiple specialties | NR | Interviews | 69 |
| Jackson et al [58] | United States | Qualitative | 29 | Clinicians (physicians, nurses, diabetes educators, and dietitians) | Obstetricians | Stakeholder co-design framework | Focus groups and interviews | 77 |
| Li et al [59] | Australia | Qualitative | 13 | Clinicians and patients | Obstetricians | NR | Interviews | 59 |
| Mansour [60] | Egypt | Quantitative | 203 | Physicians | Multiple specialties | NR | Questionnaire | 51 |
| Wu et al [61] | China | Quantitative | 393 | Physicians | Multiple specialties | UTAUT | Questionnaire | 72 |

[a]QuADS: Quality Assessment with Diverse Studies.

[b]NR: not reported.

[c]UTAUT: Unified Theory of Acceptance and Use of Technology.

## Characteristics of the Included Studies

As shown in Table 1, of the 9 included studies, 2 (22%) each were conducted in the United States [57,58] and Canada [28,54], whereas 1 (11%) each was conducted in India [55], Australia [59], China [61], Egypt [60], and Germany [56]. A total of 5 (56%) studies focused on physicians [55-57,60,61], and 2 (22%) studies included patients as well [28,59]. Moreover, 1 (11%) study included practicing nurses in addition to physicians and patients [54], whereas another (11%) involved physicians, nurses, diabetes educators, dietitians, and lactation counselors [58]. From the perspective of specialization, most studies (5/9, 56%) involved physicians with multiple specialties [55-57,60,61], whereas other studies (4/9, 44%) involved cardiologists and obstetricians [28,54,58,59]. More than half (5/9, 56%) of the studies did not mention the use of a theoretical framework. A total of 2 (22%) studies used the Unified Theory of Acceptance and Use of Technology [55,61], 1 (11%) adopted a stakeholder co-design framework [58], and another used the Chaudoir multilevel framework [28]. Most studies (5/9, 56%) followed a qualitative approach that entailed conducting semistructured interviews and focus group discussions [28,54,57-59]. Overall, 3 (33%) studies adopted a quantitative approach entailing questionnaire administration [55,60,61], and only 1 (11%) used a mixed methods approach, in which questionnaires were administered and semistructured interviews were conducted [56].

## Quality Assessment

As mentioned earlier, the studies were assessed using the QuADS tool to evaluate quality and risk of bias [52]. The methodological quality of the examined studies ranged from 51% to 87%. Overall, 4 (44%) studies had high-quality methodologies (scores of 72% to 87%), 5 (56%) studies had moderate-quality methodologies (scores ranging from 51% to 69%), and no study had low scores.

## Factors Affecting Physicians' Acceptance and Adoption of mHealth Technologies

### *Perceived Barriers*

#### Overview

All but 1 (11%) [61] of the 9 reviewed papers reported on perceived barriers to the acceptance and adoption of mHealth technologies by physicians. These barriers are summarized in Table 2. The literature is characterized by inconsistency in the use of theoretical frameworks to categorize barriers, and no single framework captures all relevant factors without some form of extension. Therefore, in this review, perceived barriers were grouped based on common themes and mapped into the following 3 major thematic categories: technological, individual, and organizational barriers (Figure 2).



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**Table 2.** Barriers to the acceptance and adoption of mobile health (mHealth) technologies among physicians.

| Study | Technological barriers | Individual barriers | Organizational barriers |
|---|---|---|---|
| Aquino et al [54] | • Lack of availability of telemonitoring systems for patients at a high risk for preeclampsia<br>• Clinical utility: additional value in care management | • Increased clinician workload | • Lack of health system policies: limited guidelines for the telemonitoring of patients at a high risk for preeclampsia<br>• Lack of access to appropriate resources (eg, validated BP[a] cuffs)<br>• Financial cost (eg, cost of home BP monitor for patients) |
| Artanian et al [28] | • Lack of preparedness to implement telemonitoring: uncertainty regarding the functionality, operationalization, and integration of technology | • Patient preference for face-to-face contact<br>• Patient acceptance of long-term technology use | • Lack of resources for supporting telemonitoring intervention: in the absence of a dedicated coordinator, time consuming for clinicians<br>• Financial and economic factors: costs associated with resources for sustaining telemonitoring (eg, additional staff)<br>• Physician remuneration: lack of compensation for services |
| Bhatt and Chakraborty [55] | • NR[b] | • Limited confidence (technology anxiety)<br>• Lack of skill set for using mHealth services | • NR |
| Dahlhausen et al [56] | • Technical concerns: training needs, technical integration issues, and lack of technical support<br>• Clinical utility: uncertainties about benefits and insufficient medical evidence<br>• Low availability of technology | • Increased workload<br>• Lack of awareness<br>• Perceived low competence due to insufficient knowledge about differentiating mHealth platforms<br>• Medicolegal concerns about potential liabilities for mistreatment | • Data protection and security<br>• Financial factor: lack of reimbursement for mHealth-related medical services<br>• Limitations of infrastructures: workflow-related issues (eg, workflow adjustments and training needs) |
| Fleddermann et al [57] | • Lack of adequate access to technology (among patients)<br>• Challenges in navigating the technology<br>• Competition from other similar apps<br>• Lack of relatable content | • Lack of time<br>• Competing priorities<br>• Perceived lack of patient motivation (resistance to change)<br>• Lack of peer support during internet-based treatment<br>• Lack of in-person interaction for guiding patient use of mHealth | • Uncertainty regarding privacy and confidentiality<br>• Limited organizational support and engagement<br>• Limitations of infrastructures and workflows<br>• Pandemic impact: disruption to the provision of services and challenges in shifting to hybrid care delivery and retaining patients |
| Jackson et al [58] | • Lack of evidence-based mHealth resources<br>• Reliability of internet resources<br>• Concern over ease of use and operationalization<br>• Lack of credibility | • Limited familiarity, awareness, and knowledge of mHealth availability and utility<br>• Low patient engagement in the long term | • Formal organizational structure: reliance on provider knowledge networks |
| Li et al [59] | • Accuracy of devices and uncertainty about technology reliability<br>• Challenges related to integration with other health record systems<br>• Clinical utility or usefulness: lack of evidence on the effectiveness of mHealth monitoring in pregnancy | • Pregnant women needing training to measure BP correctly<br>• Difficulty with the sustainability of and compliance with the collection of data on pregnant women, especially due to cultural and linguistic barriers<br>• Extra workload due to the review of monitoring data<br>• Skill set required to accurately analyze the data | • Limited communication among clinicians from multiple disciplines: multidisciplinary approach or communication needed to consider pregnancy symptoms, risk factors, test findings, and data about babies<br>• Concerns about patient data privacy<br>• Limitation of resources for supporting mHealth<br>• Financial cost of technology (especially among patients from low socioeconomic backgrounds) |



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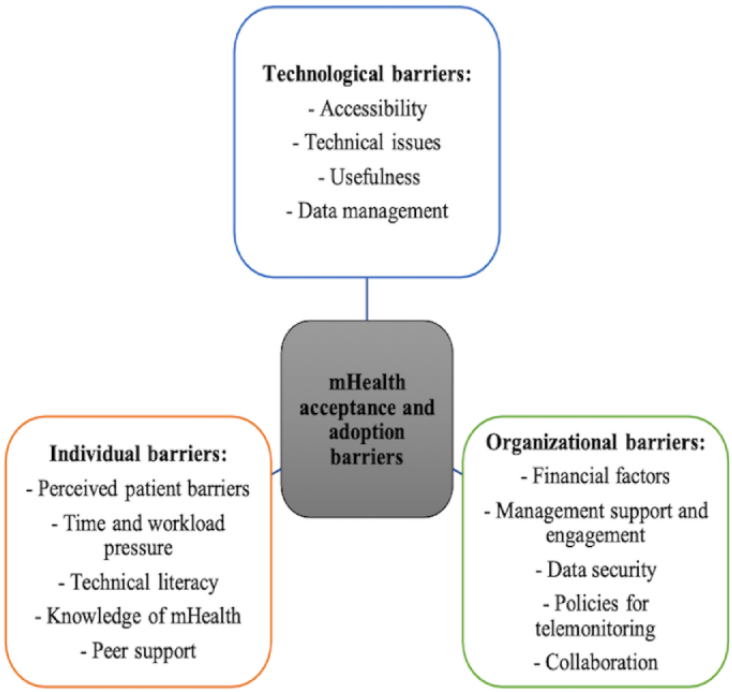
| Study | Technological barriers | Individual barriers | Organizational barriers |
|---|---|---|---|
| Mansour [60] | • Lack of training on using mHealth technologies<br>• Lack of appropriate and relevant content<br>• Failure of mobile network connection<br>• Potential for the misuse of collected information | • Lack of time for using technology<br>• Lack of technical skills<br>• Lack of interest in, knowledge about, or awareness of the benefits of mHealth technologies<br>• Lack of language skills<br>• Communication barriers: demographic characteristics of patients (age, education, and gender) | • Financial cost of technology implementation<br>• Concerns about personal data privacy and security |
| Wu et al [61] | • NR | • NR | • NR |

[a]BP: blood pressure.

[b]NR: not reported.

**Figure 2.** Themes of barriers to mobile health (mHealth) acceptance and adoption by physicians.




### Technological Barriers

The technological barriers to acceptance and adoption were further classified into the following 4 key subthemes identified from 8 (89%) of the 9 examined studies: accessibility, technical issues, usefulness, and data management. Technical issues were the most frequently reported barriers, including functionality (eg, concern over ease of use and operationalization) [28,57,58] and technical support (eg, technical issues in daily operations) [56]. Features related to usefulness, such as the clinical utility, added value, and evidence-based effectiveness of mHealth in care management (eg, lack of or insufficient evidence of benefit for patients), were other significant impediments to the use of mHealth technologies [54,56,58,59]. Concerns related to data management, including integration issues (eg, challenges with integration into clinical health records and poor integration or compatibility with existing practice software and tools) [28,56,59], were also raised. Lack of access [54,56,57], reliability [58,59], and limited connectivity (eg, concern about weak or failure of mobile network connectivity) [60] were cited by the rest of the studies.

### Individual Barriers

Individual intrinsic (eg, confidence) and extrinsic (eg, technical competence) barriers emerged from the 8 (89%) of the 9 explored studies and were categorized into the following 5 key subthemes: perceived patient barriers, time and workload pressure, technical literacy, knowledge of mHealth, and peer support. Patient-related factors were the most prominently cited individual barriers, with patient acceptance or motivation (eg, perceived lack of patient motivation due to resistance to change) and sustained compliance with long-term technology use (eg, difficulty with the sustainability of and compliance with the collection of data on patients, especially due to cultural and linguistic barriers) being central concerns [28,57-60]. Time pressure and extra workload (eg, the additional work required for physicians to monitor patient data) [54,56,57,59,60] were reported as impediments to mHealth use by health care professionals. Other barriers mentioned were limited technical



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skills and confidence (eg, lack of language skills and technology anxiety) [55,57-60], the lack of knowledge about differentiating between mHealth platforms and awareness of mHealth benefits [56,58,60], and the lack of peer support [57].

#### Organizational Barriers

Organizational barriers were divided into 5 central subthemes: financial factors, management support and engagement, data security, technology policy, and collaboration. The most commonly reported barrier at the organizational level was financial factors, including the cost of mHealth apps and reimbursement issues. These issues involved costs associated with mHealth implementation (eg, the cost of devices) for both physicians [60] and patients [54,59], especially for those with low socioeconomic status [59], and the lack of or insufficient reimbursement for mHealth-related medical services (eg, responding to follow-up questions from patients) [56]. Other central barriers included the need for organizational engagement, lack of human resource support (eg, hiring a dedicated mHealth coordinator to reduce the workload of clinicians), lack of infrastructure [28,54,56-59], and lack of training [60]. The rest of the hindrances to mHealth uptake were the lack of policies related to data security (eg, uncertainty about the privacy and security of personal health data) [56,57,59,60], lack of evidence-based telemonitoring guidelines [54], and lack of communication among health care providers [59].

### *Perceived Facilitators*

#### Overview

All the included studies discussed the perceived facilitators of mHealth acceptance and adoption by health care providers (Table 3). Similar to the barriers, the facilitators were categorized into technological, individual, and organizational facilitators (Figure 3).



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**Table 3.** Facilitators of the acceptance and adoption of mobile health (mHealth) technologies among physicians.

| Study | Technological facilitators | Individual facilitators | Organizational facilitators |
|---|---|---|---|
| Aquino et al [54] | • Evidence-based action prompts generated from patient data based on guidelines for patients at a high risk for preeclampsia<br>• Functionality: automatic data entry into telemonitoring systems | • Perceived benefits: self-management tool for patients<br>• Effective display of patient data to facilitate trend detection and the visualization of patient health status | • Facilitation of decision-making for clinicians by integrating evidence-based protocols and standards for patients at a high risk for preeclampsia |
| Artanian et al [28] | • Functionality: ease of use of telemonitoring systems and their seamless integration into clinical practice and patient's daily routine<br>• Clinical utility: access to daily data for providing accurate information about patient well-being | • Engagement of eligible patients in telemonitoring | • Availability of organizational resources: dedicated staff<br>• Advantageous over standard care owing to overcoming limitations in clinic space and the optimization of clinical resources<br>• Establishment of reimbursement models<br>• Adequate information on how to implement telemonitoring |
| Bhatt and Chakraborty [55] | • Streamlined data handling for patient care management | • Self-confidence or self-efficacy of physicians in handling technology requirements<br>• Performance expectancy<br>• Personal innovativeness | • NR[a] |
| Dahlhausen et al [56] | • Clinical utility: data and more accessible medical evidence<br>• Functionality: opportunities to navigate or test mHealth apps<br>• Additional information about mHealth platforms<br>• Compatibility of mHealth with existing infrastructures and workflows | • Patient motivation or patient request to use mHealth tools | • Recommendations by peers or medical associations<br>• Provision of provider reimbursement for mHealth-related medical services<br>• Extensive training with incentives (eg, certification for continuing medical education) |
| Fleddermann et al [57] | • Integration of technology use into routine workflows<br>• Technological support for facilitating engagement | • Significant levels of clinician engagement for supporting patient use of mHealth platforms, especially for supporting the management of challenges encountered by patients unable to access typical in-person treatment during isolation<br>• Collaboration with other staff using mHealth technologies | • Recommendation by physicians for potential mHealth benefits<br>• Ongoing training |
| Jackson et al [58] | • Functionality: patient-centered participatory design of customized functions and educational features, including data-tracking, motivational feedback, and bidirectional communication capabilities<br>• Clinical utility: potential to streamline clinical activities and resources<br>• Clinical integration (into routine prenatal care) | • Provision for continued practical patient education to promote self-care management<br>• Clinician engagement with patient education | • Integration of activities related to behavioral health changes into the patient's daily routine |



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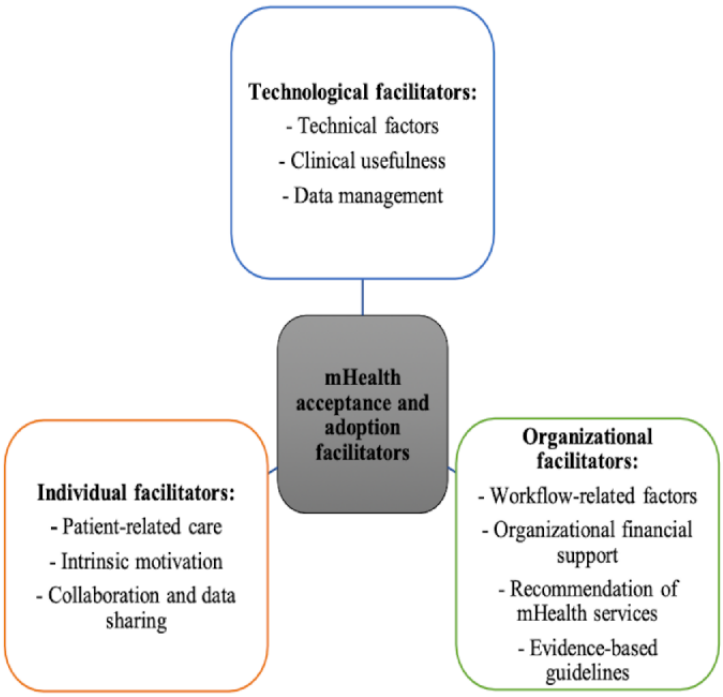
| Study | Technological facilitators | Individual facilitators | Organizational facilitators |
|---|---|---|---|
| Li et al [59] | • Functionality alert: function for the early detection of issues and timely interventions<br>• User-friendly and comes with an automatic data capture feature<br>• Access to data from multiple sources and integration of data with health records<br>• Demonstration of impact and evidence-based evaluation studies before implementation<br>• Compatibility with current practices of risk assessment and care for pregnant women with potential for multidisciplinary approach | • Integrated tailored educational content and feedback for pregnant women based on conditions and risks<br>• Additional education and monitoring for pregnant women at high risk to improve data collection compliance and engagement | • Recommendations by clinicians with indications for potential benefits<br>• Provision of ongoing education and training on using mHealth technologies |
| Mansour [60] | • Simplicity, user-friendliness, and convenience of mHealth apps (eg, detection of COVID-19 symptoms, pulse oximeter, and COVID-19 health-monitoring apps)<br>• Access to COVID-19–related services and updated information<br>• Clinical utility: support for frequent health monitoring and preventive health care | • Self-confidence in using technology<br>• Increased patient knowledge, improved patient engagement and medication adherence, and faster access to providers<br>• Communication and consultation with peers or colleagues and data sharing with other providers | • Recommendation of mHealth use by physician |
| Wu et al [61] | • Effort expectancy (ease and simplicity of mHealth) | • Behavioral intention of physicians to use mHealth was significantly affected by intrinsic motivations (altruism and cognitive trust)<br>• High internet-based ratings affect sense of self-worth and contribute to positive participation in web-based health services | • Integration of mHealth into the national health system<br>• Facilitating conditions, such as technical and human resource support, have a positive effect on mHealth adoption |

[a]NR: not reported.

**Figure 3.** Themes of facilitators of mobile health (mHealth) acceptance and adoption by physicians.



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### Technological Facilitators

The 3 main subthemes related to technological facilitators were technical factors, clinical usefulness, and data management. Technical factors were subdivided into access, functionality, and technical support domains, which were discussed in most of the reviewed studies (8/9, 89%) [28,54,56-61]. Specifically, of the 9 reviewed studies, 7 (78%) highlighted functionality and ease of use as important features for engaging providers [28,54,56,58-61]. For instance, the clinicians participating in these studies applauded the ease with which patients with diabetes can use mHealth systems to track blood sugar levels in real time and the advantage of direct feeds to providers [54]. Technological support was a critical facilitator of mHealth use [57]. Of the 9 studies, 2 (22%) identified access to mHealth services, such as data collection from multiple sources [59] and updated information [60], as facilitators of successful uptake by health care providers.

Among the 9 included studies, 5 (56%) discussed clinical utility and usefulness as factors that favor adoption [28,56,58-60]. Providers are more likely to use mHealth services when they perceive mHealth technologies as potentially streamlining patient management care and clinical resources; some examples are technologies that allow the monitoring of prescription changes and updating of medical charts or clinical notes [58]. Usefulness pertained primarily to the availability of accurate real-time information about patient well-being [28], additional support for current prenatal care practices [59], and frequent health monitoring [60]. Evidence-based evaluation studies and accessible evidence of the usefulness of mHealth platforms also potentially facilitate the adoption of mHealth technologies by health care providers [56,59]. Finally, facilitators that support adoption and sustained use were data management, including the integration of mHealth technologies into routine clinical practice and health records [28,56-59] and streamlined data handling for patient management [55].

### Individual Facilitators

Individual facilitators were divided into the following 3 central subthemes: patient-related care, intrinsic motivation, and collaboration and data sharing. Facilitators related to patients were central in most of the reviewed studies (7/9, 78%). These included the perceptions (of physicians) that mHealth technologies have the potential to support self-managed care and provide real-time feedback [54,58], allow faster access to health care providers [60], integrate mHealth into patient routines with tailored content [59], improve patient engagement [58-60], and provide support to patients who are unable to access typical in-person clinical treatment given the isolation prompted by the COVID-19 pandemic [57]. In particular, physicians are predisposed to use mHealth services when their integration increases the efficiency of daily patient flow, data management, patient diagnosis, and other clinical activities [55,58]. During the pandemic, especially when clinic access was largely restricted, the promotion of mHealth as a patient self-care management tool was one of the key factors in physicians' decision to adopt this innovation as a critical supportive tool in clinical care [54,57,58]. This decision is further supported by the effectiveness of mHealth in advancing multidisciplinary communication, as is the case, for example, with pregnancy care, for which access to data from multiple disciplines or sources is needed [59]. In addition, health care professionals with self-confidence, self-efficacy [55,60], altruism, and cognitive trust [61] in the reliability of technology are inclined to engage with and use mHealth platforms. These factors were rounded up through collaboration with peers or other users to share experiences and knowledge as well as data sharing with other providers [56,57,60].

### Organizational Facilitators

Organizational facilitators were divided into the following 4 key subthemes: workflow-related factors, organizational financial support, recommendation of mHealth services, and evidence-based guidelines. Among the 9 included studies, 3 (33%) pinpointed workflow-related factors, such as the availability of support for streamlining clinical resources and activities and improvement of infrastructure for seamless workflow, as key facilitators [28,58,61]. In particular, organizational human resource support, such as the hiring of a dedicated coordinator to reduce physician workload [28] and address training needs [56,57,59,61], was highly advocated as a facilitator of mHealth uptake by physicians. Moreover, widespread adoption was found to be motivated by organizational financial support deployed via the establishment of reimbursement models [28] and the provision of financial incentives or reimbursement for mHealth services [56]. Effective implementation was also regarded as facilitated by the recommendation of mHealth services by trusted leaders, such as medical associations [56] or other physicians [57,59]. Other important facilitators of successful uptake included the integration of evidence-based standards and guidelines for telemonitoring into practice to facilitate clinical decision-making [54] and the integration of mHealth into the national health system [61]. None of the included studies reported specific facilitators regarding legal issues related to the security and privacy of patient data.

## Discussion

### Summary of the Main Findings

The COVID-19 pandemic has clearly been a catalyst of the wider acceptance and adoption of mHealth interventions worldwide, with studies frequently reporting benefits such as minimized risk of transmission, increased patient involvement, and reduced burden on hospitals and health care expenditure [9,62,63]. Nevertheless, the move toward mHealth apps as a model of care delivery during the pandemic has revealed several shortcomings in stimulating physicians' uptake of such technologies. This review explored the factors influencing mHealth acceptance and adoption by physicians as the COVID-19 pandemic evolves. Factors related to the technological, individual, and organizational domains were identified.

### Critical Barriers to mHealth Acceptance and Adoption

Evidence suggests that a number of barriers have persisted since the prepandemic period [42,48,49]. This finding corresponds to the work of Zakerabasali et al [42], who reviewed evidence from 18 articles and identified 18 technical, individual, and



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health care system barriers. Similar to the findings in this review, the authors identified the lack of technical infrastructure, concerns about privacy issues, and the lack of workflow compatibility as barriers to mHealth adoption. Other principal barriers were limited technical literacy, preference for face-to-face interaction, financial factors, and health system policies [42]. Another prepandemic systematic review conducted in 2020 identified 55 barriers, including the lack of clinical training, the lack of technical support, the lack of compatibility with the existing workflow, and patient-related factors [48]. Consistent with the aforementioned studies, a systematic review conducted in 2016 identified 81 barriers, with emphasis placed on cost and time issues as well as difficulties in patient-professional interaction [49].

Although some of the perceived barriers that we found were similar to those identified in explorations carried out before the pandemic, we were able to identify other factors that are specific to acceptance and adoption during the pandemic. Examples include challenges accompanying the shift to hybrid care delivery to retain patients affected by the implementation of mHealth tools by physicians. The transition to internet-based treatment during the COVID-19 pandemic has disrupted services by dramatically reducing clinical caseloads, an issue that highlights patients' preference for face-to-face appointments. Clinicians also lamented the considerable difficulty involved in assisting and guiding patients in downloading and signing up to an mHealth app [57]. As can be seen, the pandemic has highlighted the need to improve organizational readiness by making workflow adjustments to allow time for the introduction of mHealth tools to patients and the effective implementation of such innovations in practice. Another novel finding of this systematic review is that physicians perceive low competence in dealing with mHealth technologies as a result of insufficient knowledge and information regarding differentiating between mHealth platforms [56]. Collectively, these findings point to the importance of organizational support during *business as usual* periods to provide physicians with adequate education and training on the use of emerging mHealth tools.

Systematic reviews conducted before the pandemic differently emphasized barriers to mHealth adoption. Whereas cost issues and patient-professional interaction were reported as the most common barriers in an early systematic review [49], technical difficulties, particularly the lack of technical support, the lack of compatibility with the existing workflow, and patient-related challenges, were underscored as principal impediments in a more recent analysis [48]. In addition to technical and cost factors, privacy concerns were one of the most cited barriers in the examined studies [42]. To these lists, our study added limited financial support and technical and privacy issues as common barriers to uptake. However, in contrast to prepandemic reviews, this review identified patient-related factors, such as patient preference, engagement, and compliance, as the most frequently reported determinants of uptake during the pandemic. On these bases, we can conclude that the pandemic has shifted the focus from a technological perspective to a more patient-centered perspective in recognizing the main challenges to mHealth adoption and integration into practice.

## Leading Facilitators of mHealth Acceptance and Adoption

Some of the common facilitators of mHealth uptake evaluated in this study were consistent with those reported before the pandemic. These include perceived usefulness and ease of use, perceived patient-related benefits (eg, improved patient care, interprofessional collaborations, and data sharing), ongoing technical support and training, and financial support for technology implementation and integration with practice systems [48,49]. However, this review is distinct from prior research in terms of facilitators that are specific to the context of the pandemic.

The most prominent facilitators before the pandemic were those related to organizational workflow, such as infrastructure, training, resource allocation, perceived efficiency, improved reimbursement, and compatibility with workflow [48,49]. Against the backdrop of the pandemic, the central facilitators were the individual factors associated with the intrinsic motivation of physicians and patient-related matters. For instance, the behavioral intention of physicians to use mHealth apps was significantly influenced by self-efficacy [55], and intrinsic motivation was potentially strengthened by altruism and cognitive trust (perceived reliability) linked to competence in using mHealth platforms [61]. Recent studies confirmed that cognitive trust strongly influences the use of digital technologies, suggesting that it is essential to cultivate physicians' trust in mHealth adoption through their sense of altruism [64] while their self-efficacy in the sustained intention to use mHealth platforms is elevated [65].

In our review, individual factors related to patient acceptance for greater engagement in and long-term commitment to using mHealth services were demonstrated to be critical to sustained uptake by physicians. High levels of physician engagement in promoting the benefits of mHealth apps for treatment [57] and clinician involvement with patient education [58] were also regarded as necessary for supporting patient access and the use of mHealth tools. This was especially important during periods of enforced isolation, as mHealth use fostered connections and supported the management of patients unable to access face-to-face treatment [57].

Furthermore, although addressing legal issues was one of the organizational factors that facilitated mHealth adoption before the pandemic [48], none of the reviewed studies discussed security and data protection. This deficiency can be attributed to the changes to regulations made by some countries during the global outbreak to provide further security guidance and support the more extensive use of telehealth [66]. In this situation, the attention of physicians could have been diverted from legal issues to concerns about their patients. Altogether, the available evidence highlights the importance of physicians' intrinsic self-motivation in supporting a patient-centered approach. The focus should be directed to patient benefits as critical facilitators of successful acceptance and adoption in the context of the COVID-19 pandemic.

It is worth noting that there are varying factors influencing the acceptance and adoption of mHealth across limited-resource and high-resource countries. For instance, in limited-resource



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countries, Mansour [60] and Bhatt and Chakraborty [55] highlighted barriers, including the lack of language, technical skills, and training. By contrast, some studies in high-resource countries emphasized that mHealth apps were easy to use and integrated well into clinicians' routines [28,58]. This variation can be attributed to the fact that health care systems in high-resource countries commonly have well-established training programs that integrate the latest medical advancements for health care professionals. By contrast, limited-resource countries may face challenges in providing sufficient training and education programs for health care professionals because of limited resources and funding [67-70]. Consequently, health care professionals in limited-resource countries may have limited opportunities for training and may not have the same skills and knowledge as their peers in high-resource countries.

Although our findings indicate that health care professionals have a generally positive attitude toward mHealth, there are variations in attitudes across various medical specialties [56,60]. For example, Dahlhausen et al [56] highlighted that neurologists have a mostly favorable perspective toward mHealth apps, whereas orthopedists and trauma surgeons hold somewhat less positive attitudes toward these apps. In line with our findings, a survey conducted by Zaslavsky et al [39] revealed differences in attitudes toward implementing mHealth apps across different medical specializations. Understanding these differences is crucial for customizing strategies to promote the adoption of mHealth among various medical specialties.

### Limitations and Recommendations for Future Research

Although this review contributes to the understanding of the factors influencing the acceptance and adoption of mHealth technologies among physicians, some limitations must be acknowledged. Most studies (6/9, 67%) were conducted in developed countries (eg, the United States, Canada, and Germany) [28,54,56,57], which means that our understanding of the factors influencing the acceptance and adoption of mHealth among physicians in developing countries is limited. Moreover, more than half (5/9, 56%) of the studies [28,54,57-59] used qualitative methods, such as semistructured interviews and focus group discussions, to gather data. Therefore, generalizing the results of this review may be challenging. In addition, this review might not have incorporated relevant papers that were not listed in the databases that were searched and that were published in a language other than English, which would have helped identify more factors that influence the acceptance and adoption of mHealth among physicians.

We provide several recommendations for future research. Identifying the factors that affect the acceptance and adoption of technologies such as mHealth is an ongoing process [57]. Hence, there is a need for more extensive research on these behaviors of physicians, especially in limited-resource countries. Research in limited-resource countries is necessary to understand whether there are different opportunities and constraints. In addition, robust methodologies, such as mixed methods approaches, are required to uncover the factors influencing acceptance and adoption. Mixed methods research can overcome the disadvantages associated with quantitative or qualitative approaches, thereby enriching the findings. For example, some researchers claim that quantitative exploration insufficiently advances the understanding of contexts or areas in which people live, as the voices of participants are not directly heard [71]. Qualitative studies might be considered deficient because of a researcher's subjective interpretations, the bias that results from these, and the difficulty in generalizing findings [71]. Finally, the identified factors could help policy makers make decisions aimed at implementing mHealth successfully. These factors may facilitate physicians' acceptance and adoption of mHealth technologies.

### Conclusions

The pandemic has highlighted and expanded the avenues in which mHealth can aid clinical decision-making and improve the quality of care. This review summarized the evidence on the factors influencing mHealth acceptance and adoption by physicians during the COVID-19 pandemic. The main findings of this review highlighted the importance of addressing organizational readiness to support physicians with adequate resources, shifting the focus from technological to patient-centered factors, and the seamless integration of mHealth into routine practice during and beyond the pandemic.

### Authors' Contributions

SA, the first author, wrote the manuscript, and ML and SH provided insightful feedback on the manuscript. All the authors were involved in screening the studies, extracting data, and synthesizing the findings. SA was funded by a Doctor of Philosophy (PhD) scholarship from the Saudi Arabian Cultural Mission in Australia. All the authors approved the final manuscript.

### Conflicts of Interest

None declared.

### Multimedia Appendix 1

PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) 2020 checklist.
[DOCX File , 21 KB-Multimedia Appendix 1]

### Multimedia Appendix 2

Search strategy.
[DOCX File , 16 KB-Multimedia Appendix 2]



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## Multimedia Appendix 3

Risk-of-bias assessment of the included studies.
[DOCX File , 17 KB-Multimedia Appendix 3]

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## Abbreviations

**MeSH:** Medical Subject Headings
**mHealth:** mobile health
**PICO:** population, intervention, comparator, and outcome
**PRISMA:** Preferred Reporting Items for Systematic Reviews and Meta-Analyses
**QuADS:** Quality Assessment with Diverse Studies
**WHO:** World Health Organization


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## 3.9 Synthesis of related literature

Despite the availability and considerable potential of mHealth apps, their acceptance and adoption remain relatively low, especially in developing countries (Alsahli et al., 2023; Kong et al., 2020; Rajak & Shaw, 2021; Said, 2022; Wu et al., 2022), prompting researchers to address potential deterrents to the use of such technologies. However, the majority of studies have focused on perceptions regarding patients' behavioural intention toward using these technologies (Alam et al., 2021; Alam, Hoque, et al., 2020; Esber et al., 2023; Petersen et al., 2020). These explorations identified performance expectancy, effort expectancy, and social influence as significant positive predictors of mHealth app adoption. Moreover, they indicated technology anxiety, resistance to change and a lack of trust as negatively associated with adoption (Petersen et al., 2020). These studies provide valuable insights into patient attitudes toward mHealth adoption, but less attention has been paid to the perspectives of physicians (Addotey-Delove et al., 2022; Kong et al., 2020; Yoon et al., 2022), despite these professionals being a vital link in treatment pathways for patients (Della Vecchia et al., 2022). Physicians are often key to driving change in healthcare, substantially influencing the acceptance and adoption of mHealth technologies on the basis of their own usage decisions (Yoon et al., 2022). For instance, physician advocacy for mHealth apps can influence patients' decision to use them, with the latter being more likely to accept and adopt these innovations upon recommendation by healthcare providers (Cajita et al., 2018; Chahal et al., 2021).

Additionally, studies such as Dahlhausen et al. (2021); Li et al. (2021) highlighted a general consensus among physicians on the integration of mHealth apps into standard care and identified barriers to adoption, such as the lack of information and medical evidence, legal concerns, challenges related to patient engagement, and financial implications. However, these researchers focused on developed countries, deriving findings that might not fully be applicable to the context of developing countries. Correspondingly, this translates to a gap in

understanding physicians' attitudes toward mHealth adoption on a global scale. This gap was underscored in a recent systematic review conducted by Alsahli et al. (2023), who noted that the majority of research on mHealth acceptance among physicians during the COVID-19 pandemic has been conducted in developed nations. This one-sided concentration is concerning because the dynamics underlying the sociocultural, economic, and healthcare systems in developing countries vary markedly from those in their developed counterparts (Ayukekbong et al., 2017; Bojanic & Tan, 2021). Cultural and contextual factors play a crucial role in the acceptance and adoption of mHealth apps (Deng et al., 2018; Hamidi & Chavoshi, 2018). Studying the factors that influence mHealth acceptance and adoption in these specific contexts helps researchers and practitioners understand the dynamics and nuances that shape technology acceptance and adoption. This knowledge can inform the design, development, and implementation of mHealth interventions that are culturally sensitive, contextually appropriate, and aligned with the needs and preferences of the target population. A case in point is Saudi Arabia, which is a religiously and socially conservative country with a high degree of cultural homogeneity stemming from Islamic and tribal affiliations—features that contribute not only to the cultural uniqueness but also to the complexity of the country (Alghamdi & Ernest, 2019; Binsahl et al., 2020).

Furthermore, the majority of the current studies were quantitative or qualitative in nature (Aquino et al., 2022; Artanian et al., 2021; Kong et al., 2020; Li et al., 2021; Lim et al., 2021; Wu et al., 2022). While quantitative and qualitative approaches offer valuable insights, each approach has its limitations (Creswell & Creswell, 2018; McNabb, 2021). Quantitative research relies on pre-defined measurement tools and variables, which may not capture the full range of relevant dimensions or perspectives. Qualitative research, however, typically involves a smaller sample size and a focus on in-depth exploration, which limits the generalizability of findings to larger populations. Hence, there are instances where a mixed methods approach

becomes necessary and advantageous, such as mHealth acceptance and adoption (Aljohani & Chandran, 2021a). If research is intended to use models, such as the UTAUT, in determining factors for information system acceptance and adoption in a developing country, a mixed methods design might uncover factors that typically do not arise in developed nations in the West (Venkatesh et al., 2013).

Finally, identifying the factors that affect the acceptance and adoption of technologies such as mHealth is indeed an ongoing process (Fleddermann et al., 2021). User needs, preferences, and expectations are not static but can evolve over time. As technology becomes more integrated into various aspects of daily life, user expectations regarding usability, functionality, privacy, security, and user experience may change. For example, the COVID-19 era has brought unique challenges, opportunities, and changes in user behaviour regarding the acceptance and adoption of mHealth technologies (Alanzi, 2022). Ongoing research in this context is essential to understand the evolving factors that influence acceptance and adoption, address specific challenges, leverage lessons learned from the pandemic, and adapt healthcare systems to meet the changing needs of patients and providers.

To the best of the researcher's knowledge, the Saudi Arabian healthcare context is characterised by a notable lack of studies on the acceptance and adoption of mHealth applications among physicians. This thesis aims to address this gap through a comprehensive mixed-methods design. To achieve this, the researcher has adapted a survey to examine the associations between the factors of the Unified Theory of Acceptance and Use of Technology (UTAUT) model and the acceptance and use of mHealth applications by physicians in Saudi Arabia. Additionally, semi-structured interviews with Saudi physicians were conducted to explore other influential factors that might not be covered by the UTAUT model.

# CHAPTER 4

## CHAPTER 4: PHASE 2:

## THE ADOPTION OF MOBILE HEALTH APPLICATIONS BY PHYSICIANS DURING THE COVID-19 PANDEMIC IN DEVELOPING COUNTRIES: THE CASE OF SAUDI ARABIA

## 4.1 Chapter preface

As discussed in Chapter 3, the systematic review identified gaps in understanding the factors influencing the acceptance and adoption of mHealth among physicians in developing countries, including Saudi Arabia. Consequently, this chapter examines the key factors that influence the acceptance and adoption of mHealth by physicians in Saudi Arabia. It aims to address the second research question:

*What are the associations between the UTAUT model factors and Saudi physicians' intentions towards the use of mHealth applications in Saudi Arabia?*

The rapid evolution of mobile health applications (mHealth apps) has become increasingly important in enhancing healthcare delivery, especially during the COVID-19 pandemic. Despite the critical role of such technologies, however, acceptance and adoption rates among physicians in developing countries, particularly Saudi Arabia, have been relatively low. This highlights the need to explore the determinants of acceptance. In response to this call, this study aimed to identify the factors that influence Saudi physicians' acceptance and adoption of mHealth apps during the COVID-19 pandemic using the unified theory of acceptance and use of technology. Data were collected using an online survey, after which the responses were analysed via structural equation modeling. The analysis assessed the influence of four primary constructs, namely, performance expectancy, effort expectancy, social influence, and facilitating conditions, on the physicians' behavioural intention to adopt these technologies. The results indicated that while all factors significantly affected the intention to adopt the apps, facilitating conditions were the most influential. These findings punctuate the necessity of investing in infrastructure and implementing training programs focused on integrating mHealth technology into medical practice. By drawing attention to influencing factors, this research provides critical insights for policymakers and healthcare managers to

enhance the adoption of mHealth apps. This enhancement, in turn, can help improve healthcare delivery and patient outcomes during and beyond health crises. Finally, this study not only sheds light on the adoption dynamics prevalent in a developing context but also serves as a valuable guide for implementing similar technologies in other global regions.

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# The adoption of mobile health applications by physicians during the COVID-19 pandemic in developing countries: The case of Saudi Arabia

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ABSTRACT

The rapid evolution of mobile health applications (mHealth apps) has become increasingly important in enhancing healthcare delivery, especially during the COVID-19 pandemic. Despite the critical role of such technologies, however, acceptance and adoption rates among physicians in developing countries, particularly Saudi Arabia, have been relatively low. This highlights the need to explore the determinants of acceptance. In response to this call, this study aimed to identify the factors that influence Saudi physicians' acceptance and adoption of mHealth apps during the COVID-19 pandemic using the unified theory of acceptance and use of technology. Data were collected using an online survey, after which the responses were analyzed via structural equation modeling. The analysis assessed the influence of four primary constructs, namely, performance expectancy, effort expectancy, social influence, and facilitating conditions, on the physicians' behavioral intention to adopt these technologies. The results indicated that while all factors significantly affected the intention to adopt the apps, facilitating conditions were the most influential. These findings punctuate the necessity of investing in infrastructure and implementing training programs focused on integrating mHealth technology into medical practice. By drawing attention to influencing factors, this research provides critical insights for policymakers and healthcare managers to enhance the adoption of mHealth apps. This enhancement, in turn, can help improve healthcare delivery and patient outcomes during and beyond health crises. Finally, this study not only sheds light on the adoption dynamics prevalent in a developing context but also serves as a valuable guide for implementing similar technologies in other global regions.

## 1. Introduction

The healthcare sector is a critical domain that affects the global population and is fundamentally linked to the development of any nation. The importance of healthcare in daily life demands the provision of high-quality services that encompass treatment, care, and operational aspects, which are crucial across various facets of society (Jonkisz et al., 2021). Such services are delivered to individuals by healthcare facilities equipped with the resources necessary for this purpose (Jamil et al., 2020), but this task is an extremely complicated process involving the diagnosis, treatment, and prevention of diseases, injuries, and other physical and mental impairments (Khatoon, 2020; Pereira Detro et al., 2020). Healthcare systems worldwide face several challenges, with developing countries particularly struggling to deliver consistent and adequate services (Ahmed et al., 2020; Chakraborty et al., 2021). For example, accessing healthcare services is difficult, especially for populations in remote areas, where disparities between urban and rural healthcare provision are pronounced (Bristow et al., 2021; Sasaki et al., 2021). These inequalities in access often confront rural populations with serious health issues, including higher rates of disability, cognitive impairment, and mortality (Harrison et al., 2020). In addition to the delivery and accessibility of healthcare services, the increasing prevalence of chronic diseases presents a considerable hurdle to healthcare systems worldwide (Al Asmri et al., 2020; Chudasama et al., 2020; Jarrar et al., 2023; Kendzerska et al., 2021). The incidence of chronic conditions has increased dramatically, making these diseases major contributors to morbidity and mortality (Al-Hanawi, 2021; Okoroiwu et al., 2020).

Beyond the existing problems of healthcare systems, the COVID-19 pandemic has substantially exacerbated pressures on health services

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globally. In March 2020, the World Health Organization officially declared the pandemic to be caused primarily by the COVID-19 virus (Mansour, 2021), which has presented a challenge to humanity given its considerable effects on several sectors, especially healthcare (Alhasan et al., 2022; Alzahrani et al., 2022). The pandemic has affected millions globally, causing multiple waves of infections and leading to a considerable increase in mortality rates (Woods et al., 2020). The sudden global outbreak caught the healthcare sector unawares (Filip et al., 2022), challenging the ability of healthcare professionals to provide standard care and severely affecting their own safety and protection (Abdel-Basset et al., 2021). This situation was made worse by lockdown periods and issues arising from the management of COVID-19 cases (Mitra & Basu, 2020; Roy et al., 2021). Health systems, which are already overburdened, are put under tremendous strain by their obligation to provide healthcare while eliminating face-to-face communication to minimize virus transmission (Echelard et al., 2020; Houlding et al., 2021).

In Saudi Arabia, the context of interest in this study, the government guarantees free healthcare services for all citizens, ensuring that everyone has access to essential medical care without financial burdens (Al-Hanawi et al., 2020). However, the Saudi healthcare system has also faced serious challenges that have impacted its overall efficiency and effectiveness. These challenges include the considerable shortage of qualified healthcare professionals, such as physicians, nurses, and allied health workers (Al Asmri et al., 2020; Al Saffer et al., 2021). This shortage has driven a heavy reliance on expatriate professionals, which creates workforce instability, as these practitioners are unlikely to remain in the country in the long term. High turnover rates among expatriate healthcare professionals diminish productivity, necessitating the continual recruitment and training of new staff (Mohammed & Waleed, 2022). Furthermore, the number of individuals with chronic diseases in Saudi Arabia has remarkably increased in the past decades (Al Asmri et al., 2020; Jarrar et al., 2023). Among these health conditions, diabetes is particularly critical, with its prevalence ranking the country among the top 10 worldwide (Jarrar et al., 2023). These figures are a primary public health concern because diabetes is related to increased mortality, morbidity, and vascular complications accompanied by public health and quality of life issues (Al-Hanawi, 2021; Okoroiwu et al., 2020). Ensuring the provision of healthcare services is a challenge in Saudi Arabia also because it is a vast country spanning more than 2,150,000 square kilometers of territory (Alanazi & Alanazi, 2023). It is beset with inequalities that have left rural regions with fewer and under-resourced facilities compared with urban regions, rendering access to such facilities one of the main barriers to healthcare for rural patients (Al Asmri et al., 2020; Amin et al., 2020).

The abovementioned challenges drove the rapid use of digital innovations, especially during the pandemic, as a means of providing immediate and effective solutions to healthcare-related crises (Crawford & Serhal, 2020). This situation created a valuable opportunity for developers specializing in mobile health applications (mHealth apps) to provide easily accessible platforms that enable the general public to access healthcare services (Ming et al., 2020). These apps have advanced the remote provision of healthcare services, reduced the need for face-to-face consultations, and contributed to the effective surveillance and control of diseases (Alzahrani et al., 2022; Asadzadeh & Kalankesh, 2021).

Despite their potential advantages, however, their acceptance and adoption have been limited, particularly in Saudi Arabia (Aljohani & Chandran, 2021a; Alsswey et al., 2021; Rajak & Shaw, 2021; Wu et al., 2022). This peculiarity has encouraged researchers to investigate potential barriers to using such technologies. The problem is that the literature predominantly focuses on developed nations or the perceptions of patients (Alam et al., 2020a; Aljohani & Chandran, 2021a; Dahlhausen et al., 2021; Deng et al., 2018; Edo et al., 2023; Li et al., 2021). This focus creates a considerable gap because developed and developing countries differ in the factors that affect technology adoption, such as healthcare infrastructure, technological availability, socioeconomic situations, and cultural attitudes (Alsahli et al., 2023; Getachew et al., 2022). Furthermore, patients' perspectives are important, but acceptance by healthcare professionals and the integration of technologies into their practices are critical to the adoption of mHealth applications (Alsahli et al., 2023). Studies have frequently failed to consider specific factors from the perspectives of physicians, who are the primary users of these technologies (Kong et al., 2020; Wu et al., 2022).

In consideration of these issues, the current study aimed to identify the factors influencing physicians' acceptance and adoption of mHealth apps during the COVID-19 pandemic in Saudi Arabia. The findings provide meaningful insights for policymakers, healthcare managers, and mHealth developers by helping them understand the barriers to and facilitators of mHealth usage in healthcare settings. This comprehension is crucial in efforts to encourage the use of mHealth technology, which can improve healthcare delivery, patient outcomes, and medical efficiency during and beyond the pandemic.

## 2. Literature review

### 2.1. Impact of COVID-19 on healthcare systems and the role of mHealth apps in the pandemic

The healthcare sector has faced urgent and critical issues in the COVID-19 pandemic. For example, there was an extreme shortage of beds, personal protective equipment, and medical equipment in multiple hospitals due to the tremendous increase in patients needing treatment (Clay-Wililams et al., 2020; Sen-Crowe et al., 2021). This situation drove a high demand not only for unique treatments for COVID-19 patients but also for protective measures for healthcare professionals who were in direct contact with these patients (Monaghesh & Hajizadeh, 2020). In this respect, technological solutions have the potential to enhance and optimize the response of communities and healthcare systems to outbreaks of infectious illnesses (Alam et al., 2021; Asadzadeh & Kalankesh, 2021). Among these technologies, mHealth apps, have elicited tremendous global attention as preventive measures against the COVID-19 pandemic (Alam et al., 2021; Casalino et al., 2023; Kondylakis et al., 2020).

The term "mHealth" is defined as the use of mobile technologies, including smartphones, wearable devices, and tablets, to support the delivery of healthcare services by healthcare professionals to patients (Said, 2022; Yang et al., 2021). It presents a promising opportunity to generate advantages for healthcare professionals and patients during the pandemic (Mansour, 2021). For instance, mHealth technologies can maximize service delivery even under reduced face-to-face health consultations (Asadzadeh & Kalankesh, 2021; Kondylakis et al., 2020), thus enhancing the safety of healthcare professionals and patients (Asadzadeh & Kalankesh, 2021). Furthermore, the geographical information made available through mHealth innovations aids the identification of COVID-19 infections by tracing cases, thereby advancing control over further spreading (Altmann et al., 2020; Alzahrani et al., 2022). These technologies can also improve the management of chronic diseases (Said, 2022; Salas-Groves et al., 2023), provide access to reliable information (Kondylakis et al., 2020; Said, 2022), and reduce the costs of healthcare services (Abbaspur-Behbahani et al., 2022; Alhasan et al., 2022).

With the advent of the global outbreak, multiple mHealth apps were introduced or upgraded according to the needs and demands of the time. Some of these apps were Apple's COVID-19 app, COVID Symptom Tracker, Patient Sphere for COVID-19, and CoronaFACTS (Ming et al., 2020). In Saudi Arabia, the Ministry of Health launched and upgraded several mHealth apps to deal with healthcare-related crises (Alassaf et al., 2021; Hassounah et al., 2020). For example, the Sehhaty "My Health" app enables users to have audiovisual consultations with healthcare professionals, book COVID-19 testing and vaccination, and acquire immediate guidance on treating possible side effects (Alassaf

et al., 2021). Tawakkalna is another app equipped with GPS technology that monitors and regulates individuals' mobility within curfew hours and generates permits for exceptional circumstances (Hassounah et al., 2020).

### 2.2. Acceptance and adoption of mHealth apps

Despite the availability and considerable potential of mHealth apps, their acceptance and adoption remain relatively low (Kong et al., 2020; Rajak & Shaw, 2021; Said, 2022; Wu et al., 2022), prompting researchers to address potential deterrents to the use of such technologies. The majority of studies have focused on perceptions regarding patients' behavioral intention toward using these technologies (Alam et al., 2020a; Alwashmi et al., 2020; Deng et al., 2018). These explorations identified perceived usefulness, ease of use (Alwashmi et al., 2020; Deng et al., 2018), performance expectancy, and social influence (Alam et al., 2020a) as significant positive predictors of mHealth app adoption. They indicated privacy concerns, performance risks (Deng et al., 2018), technical matters, and financial issues (Alwashmi et al., 2020) as negatively associated with adoption. These studies provide valuable insights into patient attitudes toward mHealth adoption, but less attention has been paid to the perspectives of physicians (Addotey-Delove et al., 2022; Kong et al., 2020; Yoon et al., 2022), despite these professionals being a vital link in treatment pathways for patients (Della Vecchia et al., 2022). Their limited involvement can hinder the success of mHealth apps (Addotey-Delove et al., 2022; Wu et al., 2022). Physicians are often key to driving change in healthcare, substantially influencing the acceptance and adoption of mHealth technologies on the basis of their own usage decisions (Yoon et al., 2022). For instance, physician advocacy for mHealth apps can influence patients' decision to use them, with the latter being more likely to accept and adopt these innovations upon recommendation by healthcare providers (Cajita et al., 2018; Chahal et al., 2021).

Additionally, Dahlhausen et al. (2021) and Li et al. (2021) highlighted a general consensus among physicians on the integration of mHealth apps into standard care and identified barriers to adoption, such as the lack of information and medical evidence, legal concerns, challenges related to patient engagement, and financial implications. However, these researchers focused on developed countries, deriving findings that might not fully be applicable to the context of developing countries. Correspondingly, this translates to a gap in understanding physicians' attitudes toward mHealth adoption on a global scale. This gap was underscored in a recent systematic review conducted by Alsahli et al. (2023), who noted that the majority of research on mHealth acceptance among physicians during the COVID-19 pandemic has been conducted in developed nations. This one-sided concentration is concerning because the dynamics underlying the sociocultural, economic, and healthcare systems in developing countries vary markedly from those in their developed counterparts (Ayukekbong et al., 2017; Bojanic & Tan, 2021). Cultural and contextual factors play a crucial role in the acceptance and adoption of mHealth apps (Deng et al., 2018; Hamidi & Chavoshi, 2018). For example, Saudi Arabia is a religiously and socially conservative country with a high degree of cultural homogeneity stemming from Islamic and tribal affiliations—features that contribute not only to the cultural uniqueness but also to the complexity of the country (Alghamdi & Ernest, 2019; Binsahl et al., 2020). Additionally, given that the majority of the global population resides in developing countries (Arceneaux et al., 2017), investigating mHealth acceptance and adoption factors in these regions improves the applicability and relevance of research findings in the international arena.

## 3. Theoretical background and hypotheses

### 3.1. Technology acceptance models and theories

Exploring the determinants that influence technology acceptance is a vital research topic in the field of information technology (Yadegari et al., 2022). Technology acceptance can be defined as constituted by attitudes toward technologies, which are influenced by several factors (Momani, 2020; Yadegari et al., 2022). Such acceptance by users must be evaluated to minimize the chances of failure in the implementation of new technology (Hanaysha, 2022). This evaluation is typically carried out with the help of technology acceptance theories and models, which are instrumental in comprehending the dynamics that underlie adoption or rejection (Yadegari et al., 2022). Over the years, researchers have proposed various theories and models, each offering unique perspectives on technology acceptance. For example, the theory of reasoned action (TRA) emphasizes the importance of individual attitudes and subjective norms in forecasting behavioral intentions (Ajzen & Fishbein, 1980), underscoring the societal and individual motivational factors that influence behavior. The TRA was expanded into the theory of planned behavior (TPB), which includes an additional construct—perceived behavioral control (Ajzen, 1985). This factor refers to an individual's perception of their capability to successfully execute behavior (Ajzen, 1985). It acknowledges that even if individuals have positive attitudes and experience social pressure to adopt a behavior, they may still be constrained by their perceived control over such conduct. Transitioning into the information systems field, the technology acceptance model (TAM) focuses particularly on technology adoption (Davis, 1985). This model is an adaptation of the TRA and TPB, streamlining influencing factors into two primary predictors: perceived usefulness and perceived ease of use (Davis, 1985; Marangunic & Granic, 2015). According to the TAM, a positive attitude toward both usefulness and ease of use leads to an increased intention to use a technology.

In comparison studies of previously proposed theories and models, Venkatesh et al. (2003) identified major limitations, such as the considerable focus of these frameworks on individuals and simple information technologies that do not have the complexity and sophistication of organizational innovations. These theories/models are also substantiated mostly in empirical studies conducted in academic settings, involving students and therefore failing to sufficiently reflect the experiences of practical users (e.g., employees). Finally, these theories and models commonly evaluate technology acceptance in a retroactive manner, rather than during the initial stage of adoption. Addressing these limitations, Venkatesh et al. (2003) refined and integrated disparate technology acceptance models to propose the unified theory of acceptance and use of technology (UTAUT), which is considered the most comprehensive framework for elucidating acceptance and adoption in the field of information systems (Al-Mamary, 2022; Deryl et al., 2023; Hanaysha, 2022; Momani, 2020; Tamilmani et al., 2022). The UTAUT stands out for its robust explanatory power, accounting for up to 70 % of the variances in users' intention to adopt technology, considerably outperforming other models, which explain only 17 % to 53 % of such variances (Alfalah, 2023; Momani, 2020; Sultana, 2020; Venkatesh et al., 2003). The UTAUT emphasizes the influence of performance expectancy (PE), effort expectancy (EE), social influence (SI), and facilitating conditions (FCs) on a user's behavioral intention to accept and use technologies (Venkatesh et al., 2003). It further explains that such acceptance and usage are also affected by individual differences in age, gender, experience, and voluntariness of use. These four measured variables serve as moderators of the relationship between the four basic predictors (PE, EE, SI, and FCs) and the aforementioned intention (Fig. 1).

### 3.2. The conceptual model

The conceptual model for this study is an adaptation of the unified theory of acceptance and use of technology (UTAUT). The UTAUT is widely recognized for its effectiveness in predicting user acceptance- and usage-related intentions and behaviors toward technology in various contexts (Al-Mamary, 2022; Deryl et al., 2023; Momani, 2020). Given the unique setting of Saudi Arabia, the model was adapted to

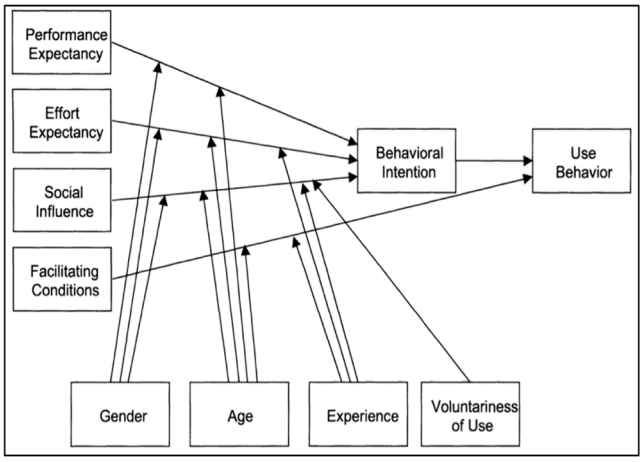


**Fig. 1.** The unified theory of acceptance and use of technology (Venkatesh et al., 2003).

focus on the core constructs of the UTAUT while considering the sociocultural and technological factors that influence the acceptance and adoption of mHealth apps by physicians. This adaptation involved a targeted examination of how the UTAUT constructs operate in the Saudi healthcare sector, as well as an acknowledgment of the rapid evolution of healthcare technologies and the increasing importance of digital health solutions.

Although there is extensive research on technology adoption models across several industries and global contexts, there is a notable lack of understanding regarding these dynamics, specifically within the healthcare context of developing nations, such as Saudi Arabia. These dynamics include the unique sociocultural influences, technological infrastructure challenges, and the specific behaviors and attitudes of healthcare professionals toward technology adoption. As previously stated, the majority of such studies have concentrated on developed countries or the wider perspectives of patients, frequently neglecting the crucial involvement of healthcare professionals in the process of adoption (Aljohani & Chandran, 2021a; Alsahli et al., 2023; Alsswey et al., 2021). This oversight is critical because these professionals not only serve as primary users but also play a major role in influencing and promoting the adoption of technology in healthcare environments. This deficiency was addressed in the current work by investigating how the adapted UTAUT constructs of PE, EE, SI, and FCs influence Saudi physicians' intention to adopt mHealth technologies and by exploring the moderating effects of demographic variables, such as age, gender, and experience, on these relationships.

The adaptation of the UTAUT model involved retaining behavioral intention but excluding use behavior, which pertains to continuous and routine usage post-acceptance (Wu et al., 2022). According to Venkatesh et al. (2003) a strong behavioral intention toward technology use significantly predicts actual technology usage. However, considering the early stage of mHealth app implementation in Saudi Arabia (Alharbi et al., 2021), the present study focused on examining physicians' behavioral intention instead of their actual usage. Another modification made to the model was the elimination of voluntariness of use as a moderator seeing as this concept determines whether the use of technology is voluntary or mandatory. The use of mHealth apps among the participants of this study was neither strictly required nor purely optional. The constructs used in this research and the adapted hypotheses are discussed in the following sections (Fig. 2).

### 3.2.1. Performance expectancy (PE)

PE is the extent to which an individual believes that using a system will improve their job performance and advance goal realization (Venkatesh et al., 2003). This belief considerably influences an individual's likelihood of accepting and using an innovation (Alfalah, 2023; Tian & Wu, 2022; Venkatesh et al., 2003). PE and the behavioral intention to adopt various technologies, including mHealth apps, have been demonstrated in numerous studies as strongly associated with each other (Alam et al., 2020a, 2020b; Octavius & Antonio, 2021; Wu et al., 2022). Considering the vital role of mHealth apps in enhancing healthcare provision, especially during the COVID-19 global outbreak, it is reasonable to anticipate Saudi physicians who see the advantages of these applications in their practice to be predisposed to adopting them. Furthermore, the relationship between PE and behavioral intention is plausibly moderated by age and gender (Gu et al., 2021). For example, young physicians may be technologically adept and demand more from mHealth apps, while gender may affect perceptions of a technology's usefulness. On this basis, the following hypotheses were formulated:

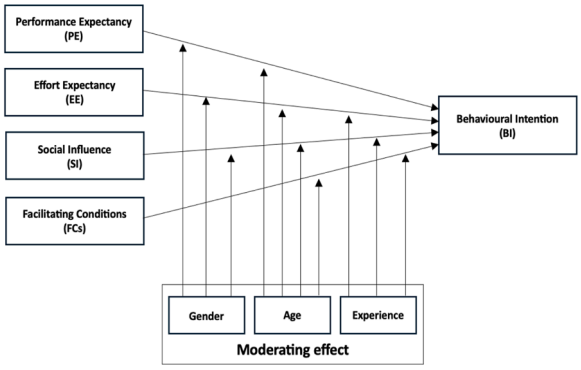


**Fig. 2.** The conceptual model.

**H1**. PE is positively associated with physicians' behavioral intention to adopt mHealth applications.

**H1a**. The impact of PE on behavioral intention is moderated by age and gender.

### 3.2.2. Effort expectancy (EE)

EE refers to the degree to which an individual considers the use of a system to be easy (Venkatesh et al., 2003), and its importance as a determinant of mHealth technology usage is supported by the literature (Alam et al., 2020b; Wu et al., 2022). In the context of mHealth, physicians are more likely to adopt user-friendly apps that integrate easily into their workflow. This usability, in turn, considerably facilitates adoption, whereas complexity reduces the intention to use technologies (Liu et al., 2022; Tian & Wu, 2022). Furthermore, the association between EE and behavioral intention may be moderated by factors such as age, gender, and experience (Gu et al., 2021). To illustrate, using mHealth apps may be easier for younger male physicians, who are more used to digital tools, and prior experience with similar technologies may also affect EE. Accordingly, the suppositions below were established:

**H2**. EE is positively associated with physicians' behavioral intention to adopt mHealth applications.

**H2a**. The impact of EE on behavioral intention is moderated by age, gender, and experience.

### 3.2.3. Social influence (SI)

SI is defined as the degree to which an individual believes that other people or groups who have the same cultural or social beliefs as they do are key to their decision-making on the acceptance or usage of technology (Venkatesh et al., 2003). In a collectivist culture such as Saudi Arabia, individuals tend to prioritize the demands and expectations of the collective, such as their families, communities, or tribes, over their own personal desires (Alotaibi & Campbell, 2022). As a result, physicians are more inclined to implement mHealth apps in their practice if the community regards them as advantageous. Research has

demonstrated that SI is strongly associated with a user's intention to use technology (Alam et al., 2020a, 2020b; Wu et al., 2022). Furthermore, younger, male, and more experienced physicians may be more susceptible to SI, which potentially moderates the aforementioned association (Gu et al., 2021). With consideration for this matter, we put forward the following:

**H3**. SI is positively associated with physicians' behavioral intention to adopt mHealth applications.

**H3a**. The impact of SI on behavioral intention is moderated by age, gender, and experience.

#### 3.2.4. Facilitating conditions (FCs)

FCs pertain to the extent to which an individual believes that an existing organizational and technical infrastructure supports the use of a new system (Venkatesh et al., 2003). In light of the nascency of mHealth app implementation in Saudi Arabia, the presence of FCs is critical in promoting adoption by physicians. Such practitioners tend to use mHealth apps if they are convinced that they have sufficient support for adoption in terms of organizational policy, technological resources, and training opportunities (Wu et al., 2022). As with the three other predictors, the relationship between FCs and behavioral intention may be moderated by age and experience, with younger physicians and those with less experience possibly relying more heavily on supportive infrastructure to promote their adoption of mHealth apps (Gu et al., 2021). This led us to establish Hypotheses 4 and 4a:

**H4**. FCs are positively linked to physicians' behavioral intention to adopt mHealth applications.

**H4a**. The impact of FCs on behavioral intention is moderated by age and experience.

## 4. Methodology

### 4.1. Research approach and design

This study administered a cross-sectional survey to Saudi physicians to capture their intentions regarding the acceptance and adoption of mHealth apps. This method was chosen because it involves the use of statistical analysis techniques that enable the derivation of conclusions and generalizations about a population (Baran & Jones, 2016; Creswell & Creswell, 2018). This research was granted approval by the ethics committee of the University of Technology Sydney (UTS HREC REF NO. ETH21-6751).

### 4.2. Sampling and data collection

Online surveys are considered an effective way of reaching respondents amid the COVID-19 pandemic, during which face-to-face surveys would have contravened social distancing rules (Yaprak et al., 2021). Accordingly, online administration was selected as the method of data collection in this work. Before survey distribution during the research proper, a pilot study was conducted involving 30 randomly chosen physicians, who were tasked with validating the survey instrument. The feedback obtained thus was used to make adjustments to the survey. For the main study, simple random sampling was carried out to ensure that each Saudi physician had an equal opportunity to participate, to minimize selection bias, and to enhance the generalizability of the findings (Baran & Jones, 2016). The inclusion criterion was Saudi physicians practicing in Saudi Arabia, while the exclusion criterion was non-Saudi physicians. The appropriate sample size was determined following Kline's recommendation of a minimum of 200 respondents for structural equation modeling (SEM) to ensure the statistical robustness and reliability of model estimates (Kline, 2015). The online survey was then made available over the Qualtrics platform via a link distributed to the eligible physicians by email with assistance from the Saudi Arabia Ministry of Health and Saudi medical societies. Reminder emails were sent every three weeks to maximize response rates and encourage participation. Data were collected from December 2022 to May 2023. To ensure the accuracy and integrity of the data, the survey platform was configured to permit only one submission per respondent and to include checks for inconsistent responses. The data were encrypted and securely stored to ensure confidentiality and adherence to ethical standards.

### 4.3. Measurement

The survey instrument was grounded in the UTAUT, which is a well-established standardized tool for assessing the factors that influence the acceptance and adoption of technology (Alam et al., 2020a; Aljohani & Chandran, 2021b). The survey included an information sheet that describes the research aim, contains the researchers' contacts detail, and a consent form. The start of the survey included a definition and description of mHealth apps to clarify awareness of the technology of interest for participants. The survey is divided into three main sections, among which the first revolves around demographic characteristics, including gender, age, and specialization. The second section is intended to derive additional details on the participants' awareness of mHealth implementation in Saudi Arabia. It includes questions about the use of mHealth, years of experience, and the type of mHealth services that the physicians have used. The third section consists of items centered on UTAUT factors that may influence the acceptance and adoption of mHealth apps. It also includes statements related to the dependent variable (behavioral intention). Each variable is described in four statements, to which the participants were asked to respond using a five-point Likert scale (1 = *strongly disagree*, 5 = *strongly agree*).

### 4.4. Data analysis

The data were analyzed using the Statistical Package for the Social Sciences (SPSS) 28, along with its supplementary software AMOS 28. Structural equation modeling (SEM) was conducted using the two-step approach recommended by Anderson and Gerbing (1988). This approach underlines the importance of validating the measurement model before assessing the structural model, ensuring that the constructs are measured accurately before testing the relationships among them.

## 5. Results

### 5.1. Demographic characteristics

The demographic information on the respondents is shown in Table 1. The study involved a diverse group of participants, who were mainly males (59.8 %) and general practitioners (71 %). The largest age group was between 31 and 40 years (48.8 %). The majority were familiar with mHealth apps (84.1 %), with 77.1 % having used them primarily for personal use (60.3 %) and online consultations (18.9 %).

### 5.2. Assessment of the measurement model

The reliability and convergent validity of the research constructs were evaluated using Cronbach's alpha values, composite reliability (CR), average variance extracted (AVE), and factor loadings in accordance with established quality standards. Recommendations are for Cronbach's alpha and CR to be 0.70 or higher, while factor loadings and the AVE value should be 0.5 or above (Creswell & Creswell, 2018; Fornell & Larcker, 1981; Hair et al., 2018; Siri et al., 2020). As illustrated in Table 2, the values derived in this study exceed the acceptable levels.

The study also assessed discriminant validity using the criterion of Fornell and Larcker (1981), which suggests that discriminant validity is established if the square root of the AVE is greater than the correlation between a given construct and any other construct. Table 3 confirms that

**Table 1**
Demographic profile of the participants.

| Items | Frequency ($N = 428$) | (%) |
|---|---|---|
| *Gender* | | |
| Male | 256 | 59.8 |
| Female | 172 | 40.2 |
| *Age (years)* | | |
| 25–30 | 73 | 17.1 |
| 31–40 | 209 | 48.8 |
| 41–50 | 85 | 19.9 |
| 51–60 | 61 | 14.2 |
| *What is your specialization?* | | |
| General practitioner (G.P.) | 304 | 71 |
| Internal medicine | 43 | 10 |
| Surgery | 17 | 4 |
| Pediatrics | 34 | 8 |
| Other | 30 | 7 |
| *Have you heard about the implementation of mobile health applications (mHealth apps) in Saudi Arabia?* | | |
| Yes | 360 | 84.1 |
| No | 68 | 15.9 |
| Have you used mHealth apps before? | | |
| Yes | 330 | 77.1 |
| No | 98 | 22.9 |
| *How many years have you been using it?* | | |
| Never use | 68 | 15.9 |
| 1–2 years | 214 | 50 |
| 3–4 years | 146 | 34.1 |
| *What type of mHealth services have you used?* | | |
| Providing online consultations | 81 | 18.9 |
| Creating e-prescriptions | 21 | 4.9 |
| Personal use | 258 | 60.3 |
| Never use | 68 | 15.9 |

**Table 2**
Measurement model.

| Constructs | Items | Factor loadings | Cronbach's alpha | CR | AVE |
|---|---|---|---|---|---|
| PE | PE1 | 0.682 | 0.808 | 0.809 | 0.514 |
| | PE2 | 0.714 | | | |
| | PE3 | 0.764 | | | |
| | PE4 | 0.706 | | | |
| EE | EE1 | 0.653 | 0.799 | 0.800 | 0.501 |
| | EE2 | 0.723 | | | |
| | EE3 | 0.722 | | | |
| | EE4 | 0.731 | | | |
| SI | SI1 | 0.639 | 0.801 | 0.802 | 0.504 |
| | SI2 | 0.720 | | | |
| | SI3 | 0.764 | | | |
| | SI4 | 0.712 | | | |
| FC | FC1 | 0.669 | 0.815 | 0.818 | 0.530 |
| | FC2 | 0.731 | | | |
| | FC3 | 0.718 | | | |
| | FC4 | 0.789 | | | |
| BI | BI1 | 0.737 | 0.792 | 0.792 | 0.560 |
| | BI2 | 0.758 | | | |
| | BI3 | 0.749 | | | |

**Table 3**
Discriminant validity.

| Latent variables | PE | EE | SI | FC | BI |
|---|---|---|---|---|---|
| 1. PE | **0.717** | | | | |
| 2. EE | 0.646 | **0.708** | | | |
| 3. SI | 0.666 | 0.628 | **0.710** | | |
| 4. FC | 0.614 | 0.560 | 0.595 | **0.728** | |
| 5. BI | 0.575 | 0.574 | 0.588 | 0.567 | **0.748** |

all diagonal values (square root of AVE) exceed the correlations among the constructs, affirming their discriminant validity.

Subsequent to these assessments, the model's goodness-of-fit indices were scrutinized using AMOS (Collier, 2020). Table 4 summarizes the outcomes for the primary fit measures, including the recommended and observed values for each measure. The results indicated that all observed values fall within the recommended ranges, suggesting an adequate fit of the structural model (Fig. 3).

**Table 4**
Model fit (goodness-of-fit indicators).

| Fit index | Recommended value | Observed value | Fit (yes/no) |
|---|---|---|---|
| X2/DF | 1–5 | 1.637 | Yes |
| CFI | >0.90 | 0.972 | Yes |
| IFI | >0.90 | 0.972 | Yes |
| TLI | >0.90 | 0.966 | Yes |
| RMSEA | <0.08 | 0.039 | Yes |
| SRMR | <0.08 | 0.035 | Yes |

### 5.3. Assessment of the structural model

The structural model was used to test the research hypotheses. As presented in Table 5, all paths hypothesized in the study are statistically significant. The results demonstrated that performance expectancy is positively impact on physicians' behavioral intention to adopt mHealth apps ($b = 0.147$, $t = 2.579$, $p = 0.004$), thereby supporting H1. A significant positive association was found between effort expectancy and the physicians' behavioral intention to adopt mHealth apps ($b = 0.232$, $t = 4.936$, $p = <0.0001$), thus supporting H2. A statistically significant relationship between social influence and the physicians' behavioral intention to adopt mHealth apps was found ($b = 0.240$, $t = 4.615$, $p = <0.0001$), confirming H3. Also, the impact of facilitating conditions on physicians' behavioral intention was positive and significant ($b = 0.242$, $t = 5.628$, $p = <0.0001$), translating to support for H4. Notably, facilitating conditions exert the most substantial influence on the physicians' behavioral intention to accept mHealth apps. The combination of the four factors (PE, EE, SI, FCs) explains 58 % of the variance in behavioral intention ($R^2 = 0.58$) as shown in Fig. 4.

### 5.4. Moderating effects

We carried out a moderation analysis to delve into the effects of gender, age, and experience using the multigroup analytical function in AMOS. The comparison of unconstrained and fully constrained models revealed no statistically significant variations in the chi-square values, indicating that these factors do not moderate the studied relationships (Table 6). All significant and non-significant paths are depicted in Fig. 5.

## 6. Discussion

To the best of our knowledge, this study is the first to examine physicians' acceptance and adoption of mHealth apps in Saudi Arabia during the COVID-19 pandemic on the basis of the UTAUT. This distinction is vital, as it not only addresses a gap in the literature but also offers a foundational understanding of the factors influencing mHealth adoption during a critical period—a global health crisis—in a developing country. By leveraging the UTAUT, our research delivers insights into the behavioral intention of physicians to use mHealth apps, with consideration for the unique sociocultural and technological environment of Saudi Arabia.

The first hypothesis suggests that performance expectancy is positively associated with the behavioral intention of physicians to adopt mHealth apps. This supposition was supported by the findings, demonstrating that Saudi physicians who have a strong belief in the effectiveness of mHealth apps in enhancing their professional performance are motivated to use them. The importance of efficient and effective healthcare delivery was magnified in the Saudi Arabian context during the COVID-19 pandemic, during which the country's healthcare system faced considerable pressure. It highlights the critical role of performance expectancy in the adoption of mHealth apps. The findings

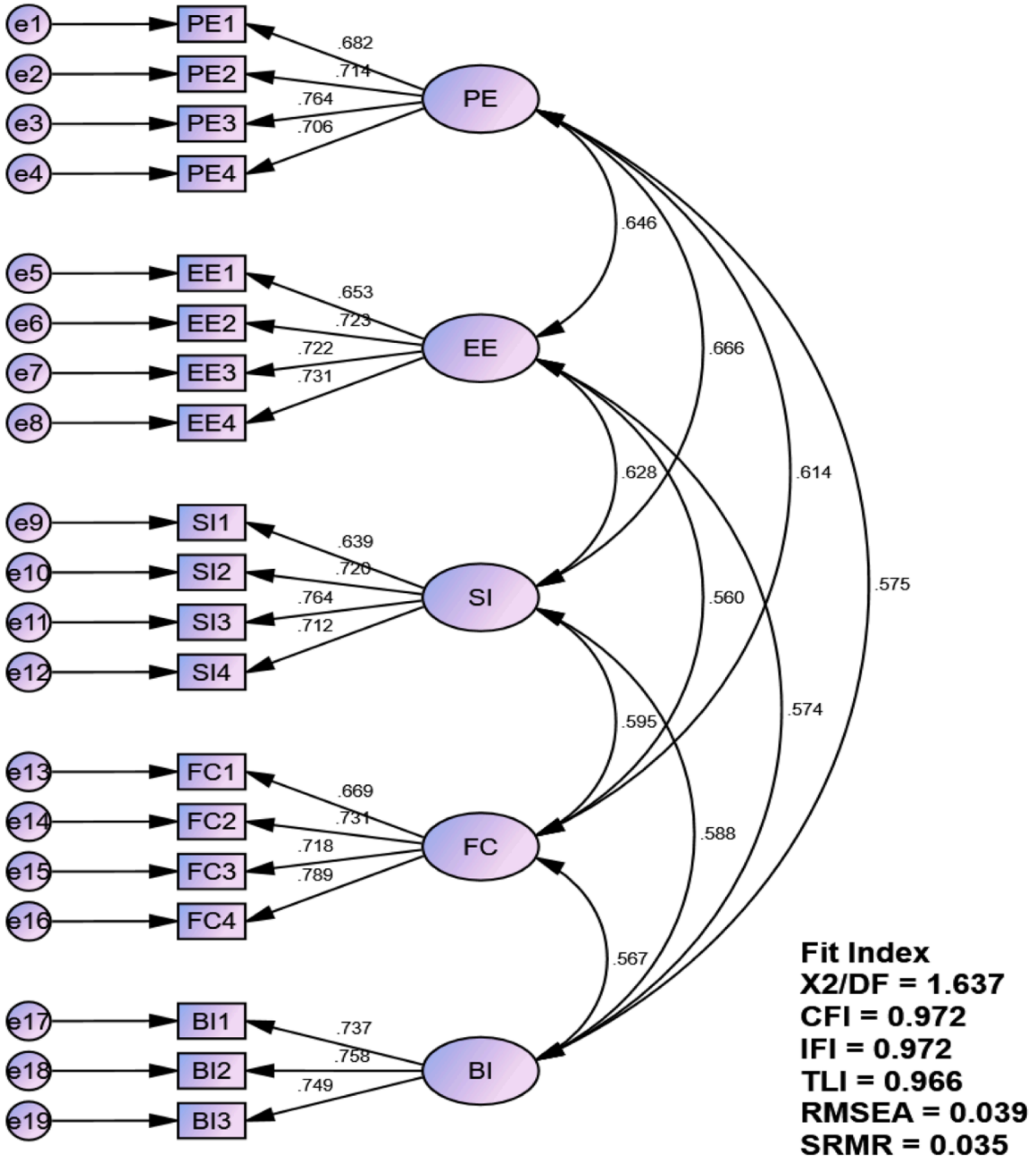


**Fig. 3.** The Measurement model.

**Table 5**
Summary of results on structural relationships.

| Hypothesis | Structural path | SRW | Std. error | *t*-value | *p*-value | Result |
|---|---|---|---|---|---|---|
| H1 | PE -> BI | 0.147 | 0.057 | 2.579 | 0.004 | Accepted |
| H1 | EE -> BI | 0.232 | 0.047 | 4.936 | <0.0001 | Accepted |
| H3 | SI -> BI | 0.240 | 0.052 | 4.615 | <0.0001 | Accepted |
| H4 | FC -> BI | 0.242 | 0.043 | 5.628 | <0.0001 | Accepted |

are also consistent with the results of prior studies (Alfalah, 2023; Edo et al., 2023; Octavius & Antonio, 2021; Venkatesh et al., 2003; Wu et al., 2022). More specifically, Wu et al. (2022) showed that physicians believe mHealth extensively improves their jobs by helping them save time and effort as they deliver healthcare services to patients.

Our second hypothesis posits that effort expectancy favorably influences physicians' behavioral intention to use mHealth apps. This hypothesis was supported, indicating that ease of use is a critical factor for technology acceptance. In the context of Saudi Arabia, physicians are tremendously more likely to use mHealth apps when they believe that their integration into their routine practices and existing workflows is a smooth undertaking, that is, involving slight changes to the status quo. This finding aligns with those of previous studies, which suggested that users are motivated to adopt user-friendly mHealth apps (Al-Mamary, 2022; Deng et al., 2018; Wu et al., 2022).

The third hypothesis maintains that social influence positively impacts physicians' behavioral intentions. This hypothesis was also confirmed, demonstrating that the opinions of colleagues and cultural contexts remarkably affect mHealth app adoption among physicians in Saudi Arabia. This result highlights the essentiality of social norms and collective beliefs in the healthcare community of Saudi Arabia, where individual decision-making is heavily influenced by consensus in one's social and professional networks. In contrast to the findings of Edo et al. (2023), who found that social influence has no significant impact on digital health technology adoption among healthcare workers, our results demonstrated the meaningful role of social dynamics in Saudi Arabia. This difference can be explained by the collectivist culture prevalent in Saudi Arabia, where the expectations of the collective (e.g.,

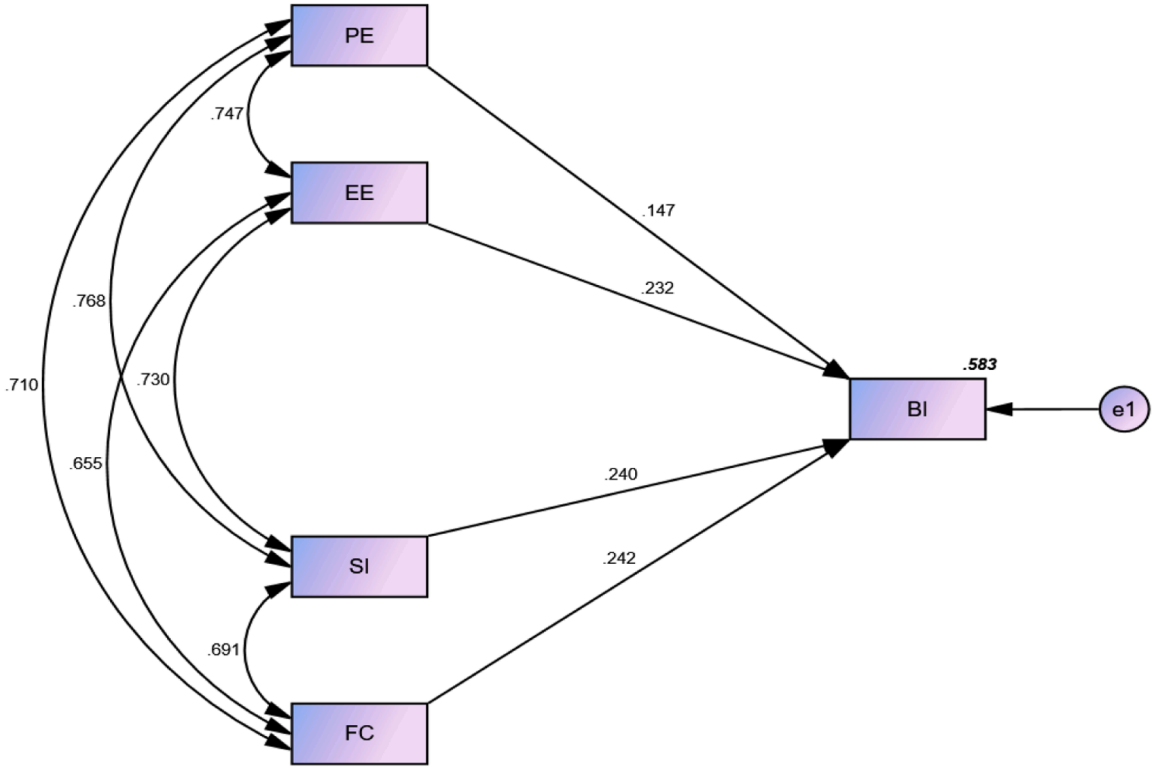


**Fig. 4.** The structural model.

**Table 6**
Overall analysis of moderators.

| Moderators | Models | $X^2$ | df | CFI | $\chi^2$/df | $\chi^2$ Difference | *p*-value |
|---|---|---|---|---|---|---|---|
| Gender | Unconstrained | 351.531 | 284 | 0.979 | 1.238 | 34.258 | 0.598 |
| | Fully constrained | 385.789 | 321 | 0.979 | 1.202 | | |
| Age | Unconstrained | 859.601 | 702 | 0.955 | 1.225 | 37.000 | 0.140 |
| | Fully constrained | 905.928 | 739 | 0.952 | 1.226 | | |
| Experience | Unconstrained | 625.305 | 493 | 0.959 | 1.268 | 45.110 | 0.169 |
| | Fully constrained | 670.415 | 530 | 0.957 | 1.265 | | |

families, communities, colleagues, or tribes) often come before individual desires (Alotaibi & Campbell, 2022). Our findings parallel those of previous research on mHealth acceptance (Alam et al., 2020a; Wu et al., 2022), which implied that recommendations from colleagues, the views of peers, and the general social context surrounding a medical community exert an essential influence on the behavioral intention to use mHealth innovations.

The final hypothesis, which proposes that facilitating conditions are positively linked to the adoption of mHealth apps, was supported, implying that having a supportive technological and organizational infrastructure is instrumental in the acceptance and implementation of mHealth apps among Saudi physicians. This finding is in line with the research conducted by Wu et al. (2022), who demonstrated that these technologies cannot be used in mainstream medical practice until a comprehensive system that encompasses infrastructure and training programs is established. Healthcare organizations that support the use of technological components and the provision of educational programs are vital facilitators of the use of these innovations.

In addition, the current study examined the potential moderating effects of gender, age, and experience on the associations between the four primary constructs (performance expectancy, effort expectancy, social influence, and facilitating conditions) and the behavioral intention of physicians to use mHealth apps. The results led us to conclude that gender, age group, and experience exert nonsignificant moderation effects on the physicians' behavioral intention to use mHealth apps. Our findings contradict those reported by Gu et al. (2021), who found that demographic factors significantly moderate the associations between the UTAUT factors and user adoption of e-health technologies. This difference may be ascribed to the uniformity of the healthcare system and education standards in Saudi Arabia, which perhaps leads to comparable familiarity with mHealth apps among physicians. It is also possible that rapid advancements in technology and the government efforts implemented during the COVID-19 pandemic have reduced typical demographic barriers, as these situations compelled physicians of all backgrounds to embrace new technologies.

The results of this research likewise pinpointed notable differences in the determinants of mHealth app implementation between physicians in Saudi Arabia and their peers in other countries (Edo et al., 2023; Gu et al., 2021). For instance, the importance of social influence in our study contrasts with the results derived in cultures that prioritize individualism, where personal independence may be more important than collective opinions when making decisions about adopting technology (Edo et al., 2023). This difference highlights the import of cultural norms in influencing attitudes toward technology adoption. It also implies that successful implementation is not universal and that applicability in other regions requires adjustment to local contexts. Furthermore, the lack of moderation by age, gender, and experience in our study indicates remarkable homogeneity in the acceptance of technology among Saudi physicians. This may be attributed to national policies and educational standards that differ from those in other countries. These contrasts offer crucial insights for global health technology strategists, emphasizing the need for tailored mHealth

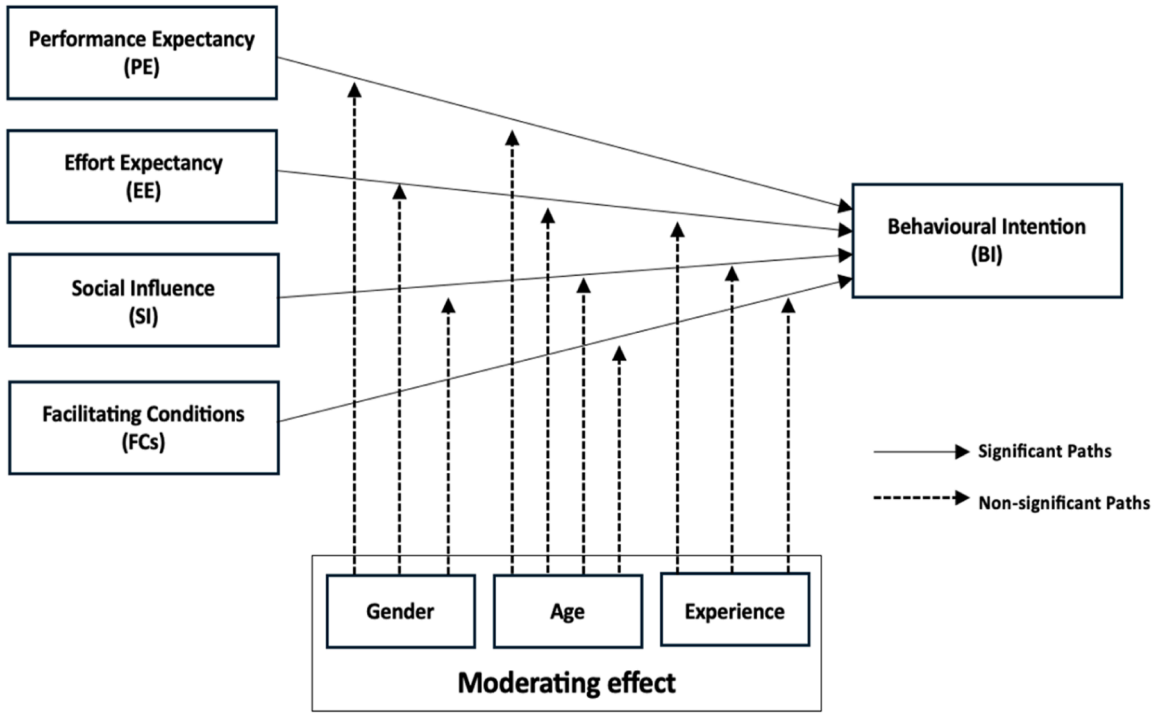


**Fig. 5.** Results of path analysis.

implementation policies to suit the particular cultural, infrastructural, and policy circumstances of each region to maximize acceptance and effectiveness. Our comparative analysis strengthens the importance of context in the development and deployment of technological innovations in healthcare and enhances our comprehension of global technology adoption patterns.

### *6.1. Theoretical implications*

This study offers important contributions to the theories underlying technology acceptance models, particularly focusing on healthcare sector in developing countries. The UTAUT was used to examine the acceptance and adoption of mHealth apps by Saudi physicians during the COVID-19 pandemic, thus extending the traditional boundaries to which the theory has hitherto been applied. The UTAUT has been previously associated mainly with developed nations and the broader technological environment, but its deployment in the specific, emergent context of Saudi Arabia not only validated the model's robustness and adaptability but also highlighted its relevance and efficacy in dynamic and crisis-driven settings. Furthermore, it illustrated the UTAUT's considerable effectiveness in predicting behavioral intentions amid rapid technological development and challenges to healthcare services beyond the settings for which it was originally developed. This predictive effectiveness extensively broadens the scope of the UTAUT, emphasizing its potential applicability across a diverse range of situations beyond those previously considered. This expansion is particularly pertinent, as it illustrates the model's utility in understanding and predicting technology acceptance in less-studied, rapidly evolving environments.

The adaptation of the UTAUT model also enabled a more accurate reflection of contexts in which cultural elements could considerably influence technology acceptance. The adjustments carried out in this research rendered the model more sensitive to the features of local culture and the limitations imposed by existing infrastructure. Therefore, the adaptation more effectively advanced a nuanced understanding of the dynamics underlying technology acceptance in a specific context. This tailored approach reflects the importance of considering local realities that shape the use and acceptance of technology, thus adding to the depth of the theoretical understanding of technology adoption. Furthermore, since Saudi Arabia is essentially a collectivist society, as opposed to the individualist Western context, this study expands the academic discussion of the societal values and social dynamics that influence technology acceptance. From this point of view, this research encourages the further expansion of the UTAUT by adding variables that specifically target cultural dimensions. In this way, the model could be refined to more accurately reflect a variety of cultural contexts and improve its prediction of technology acceptance behaviors in these settings. Such broadening of the model's theoretical and practical relevance could lead to more effective and culturally tailored strategies for technology implementation, ultimately enhancing the adoption and integration of technology globally.

### *6.2. Practical implications*

The results also offer valuable insights to stakeholders in healthcare sectors, especially in countries similar to Saudi Arabia, where technology adoption is considerably influenced by cultural factors and infrastructural conditions. This study highlights the critical need for healthcare policymakers and managers to address infrastructural needs and take complex sociocultural dynamics into account when planning and implementing strategies for the effective integration and acceptance of mHealth applications. In particular, this research emphasizes the essential role of facilitating conditions, such as organizational support and training assistance, in technology acceptance and adoption. Thus, it is important for policymakers to strategize significant investments in IT that support healthcare services. Comprehensive training programs designed to meet the specialized demands of healthcare professionals should also be established. These programs should exemplify the practical benefits of mHealth apps alongside the development of the skills necessary for physicians to effectively utilize the technologies involved. These initiatives would not only drive the awareness of healthcare providers regarding the full potential of mHealth solutions but also develop the proficiency that they need to realize this potential. Both infrastructural resources and user training are prerequisites for the optimal effectiveness of mHealth technologies.

Additionally, the importance of social influence dynamics,

particularly in a collectivist culture such as Saudi Arabia, cannot be overstated. To take advantage of these dynamics, promotional strategies for mHealth app usage should, for example, include endorsements by respected professionals and influencers within medical communities. Successful case studies and peer testimonials can be leveraged in dedicated promotional programs to effectively harness social influence, leading to considerably enhanced adoption rates. This strategic approach underscores the practical benefits of mHealth apps and highlights their acceptance and effectiveness in the healthcare community so that they become more broadly integrated into everyday healthcare practices. This holistic strategy likewise ensures the successful introduction of mHealth technologies and their continued integration and effective use. The findings are equally beneficial for developers of mHealth applications, enabling them to design user-friendly applications that also align with the professional expectations and accepted practices of healthcare providers. It is crucial for developers to focus on seamless integration into existing workflows while adding features that enhance job performance so as to encourage adoption by practitioners. Such an approach will not only guarantee the creation of fully functional apps but also ultimately make them indispensable tools for healthcare professionals.

### 6.3. Limitations and directions for future research

This research used the UTAUT to elucidate the acceptance of mHealth apps by physicians in Saudi Arabia during the COVID-19 pandemic. As with any other research, ours was encumbered by certain limitations that also translate to opportunities for future research. First, although the UTAUT is a comprehensive framework, it might not completely capture all the unique factors influencing mHealth app acceptability during the COVID-19 pandemic. For example, physicians may have faced unique stresses and rapidly changing healthcare regulations, which could have affected their adoption behaviors in ways not fully accounted for by the theory. Second, the selection of Saudi Arabia as the sole context for investigation potentially hinders the generalizability of the results to other countries. This specific setting offers unique perspectives, but cultural, infrastructural, and regulatory disparities restrict generalizability. Moreover, while our data analysis confirmed our hypotheses, the use of the survey method constrained our ability to delve into the complexities and nuanced perspectives of physicians. The survey format inherently limits the extent of responses and may fail to consider subtle yet crucial elements of user experience and personal decision-making processes. Finally, this study employed a multigroup analysis to examine the moderating effects of gender, age, and experience on mHealth adoption among Saudi physicians, revealing evidence of moderation effects. Moderation effects typically require a large sample size to detect, with our study we are likely detect only very large, e.g. cross-over moderation effects where the association in one group is large and opposite to the other group. It is not considered that the results from this study can be interpreted as definitive evidence that such effects do not exist.

Future research can benefit from integrating qualitative approaches, such as interviews or case studies, as this would advance a more exhaustive understanding of the individual and contextual factors that influence the acceptance of or resistance to mHealth technologies. Longitudinal studies can also cast light on the evolution of physicians' usage and attitudes toward mHealth applications as they adjust to ongoing transformations in their professional and regulatory environments. By expanding the scope of the research to involve other countries, future studies can uncover region-specific challenges and opportunities, thus enhancing the practical application of mHealth technologies in a wide range of healthcare settings. Finally, future research investigating the potential moderating effects of gender, age, and experience should consider a larger sample size and collecting data with more diversity in cultural or healthcare contexts. Conducting such research would not only confirm or challenge our findings but also enhance our understanding of the factors that impact the uptake of mHealth technologies.

## 7. Conclusion

This study employed the UTAUT to analyze the factors that drive the acceptance and use of mHealth apps by Saudi physicians amid the COVID-19 pandemic. The study uncovered that all the four major constructs of the model—performance expectancy, effort expectancy, social influence, and facilitating conditions—exerted a significant influence on Saudi Arabian physicians' behavioral intention to use mHealth technologies. In particular, facilitating conditions, such as organizational support and training assistance, emerged as the strongest predictors of Saudi physicians' intention to adopt mHealth apps. This finding punctuates the necessity of investing in infrastructure and implementing training programs focused on integrating mHealth technology into medical practice. Compared with existing studies, which mainly focus on developed countries, the current work unraveled the dynamics of mHealth acceptance and adoption in developing nations. The observations derived point to the fact that although personal perceptions about the usefulness and simplicity of technology are crucial factors, the collective influence of social influence and organizational support is paramount in a collectivist culture such as Saudi Arabia's. By addressing these specific factors, healthcare stakeholders can better plan the implementation of digital health solutions to enhance service delivery and patient outcomes during health crises and beyond.

## CRediT authorship contribution statement

**Sultan Alsahli:** Writing – review & editing, Methodology, Investigation, Conceptualization. **Su-yin Hor:** Writing – review & editing, Supervision.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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# CHAPTER 5

## CHAPTER 5: PHASE 3:

## PHYSICIANS' ACCEPTANCE AND ADOPTION OF MOBILE HEALTH APPLICATIONS DURING THE COVID-19 PANDEMIC IN SAUDI ARABIA: EXTENDING THE UNIFIED THEORY OF ACCEPTANCE AND USE OF TECHNOLOGY MODEL

## 5.1 Chapter preface

As highlighted in Chapter 4, while the UTAUT model provides a robust framework for understanding mHealth acceptance and adoption, it does not cover all variables that might influence behaviour in developing countries. This chapter explored additional factors that may impact the acceptance and adoption of mHealth applications among Saudi physicians during the COVID-19 pandemic. It aims to address the third research question:

*From the perspectives of Saudi physicians, what factors other than those covered by the UTAUT might influence Saudi physicians' intention towards the use of mHealth applications in Saudi Arabia?*

The COVID-19 pandemic has highlighted the critical role of mobile health applications (mHealth apps) in the management of health crises, particularly in developing countries. Despite the promising outcomes of these technologies, however, their acceptance and use among physicians in the developing world are notably low. Against this backdrop, this qualitative study explored the factors influencing the acceptance and adoption of mHealth apps by physicians in Saudi Arabia during the pandemic. The exploration, grounded in the unified theory of acceptance and use of technology (UTAUT), involved semi-structured interviews with 19 physicians to delve into the determinants of their readiness to adopt mHealth technologies. In line with the UTAUT, we identified performance expectancy, effort expectancy, social influence, and facilitating conditions as significant influencing factors of mHealth adoption. We also inquired into context-specific determinants, such as data privacy concerns, patient engagement, organizational support, and compatibility with religious and cultural norms, which are especially relevant in Saudi Arabia and similar developing countries. These factors, alongside the exigencies arising from the COVID-19 pandemic, have defined the landscape of mHealth utilization in the aforementioned nations. This study enriches the

literature by expanding the UTAUT model to include context-specific drivers of acceptance and adoption. It highlights the need for policy and practice that enhance the user-friendly features of mHealth apps, take into account cultural and religious norms, and ensure robust data security to foster a broader adoption of mHealth solutions among healthcare professionals in Saudi Arabia and similar regions.

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# Physicians' acceptance and adoption of mobile health applications during the COVID-19 pandemic in Saudi Arabia: Extending the unified theory of acceptance and use of technology model

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**Abstract**

**Background:** The COVID-19 pandemic has highlighted the critical role of mobile health applications in the management of health crises. Despite the promising outcomes of these technologies, however, their acceptance and use among physicians in the developing world such as Saudi Arabia are notably low. **Objective:** The study aimed to explore the factors influencing the acceptance and adoption of mobile health applications by physicians in Saudi Arabia during the COVID-19 pandemic. **Method:** The study employed a qualitative research method, guided by the Unified Theory of Acceptance and Use of Technology (UTAUT). The study collected data through semi-structured interviews with 16 physicians to delve into the determinants of their readiness to adopt m-health technologies. Data were analysed using template analysis to identify key themes and patterns. **Results:** In line with the UTAUT, the study identified performance expectancy, effort expectancy, social influence and facilitating conditions as significant influencing factors of the acceptance and adoption of mobile health applications by physicians in Saudi Arabia during the pandemic. This study also inquired into context-specific determinants, such as data privacy concerns, patient engagement, organisational support and compatibility with religious and cultural norms, which are especially relevant in Saudi Arabia and similar developing countries, where these factors, alongside the exigencies arising from the COVID-19 pandemic, have shaped the landscape of mobile health applications utilisation. **Conclusions:** This study enriches the literature by expanding the UTAUT model to include context-specific drivers of acceptance and adoption. It highlights the need for tailored adoption frameworks to fit local contexts for successful m-health integration. **Implications:** This research broadens the UTAUT model by including cultural compatibility and data privacy concerns, offering deeper insights into mHealth adoption during crises. It highlights the need for policies and practices that support culturally sensitive app design, strengthen data privacy measures and provide improved training and patient engagement to enhance mHealth adoption.

**Keywords (MeSH)**
mHealth; m-health; mobile health; eHealth; telehealth; telemedicine; health information management; health informatics

**Supplementary keywords**
COVID-19; UTAUT model; Saudi Arabia

## Introduction

The COVID-19 pandemic was a major global health crisis, significantly affecting healthcare sectors worldwide, with those in developing countries facing particularly acute challenges (Levin et al., 2022; Yang et al., 2021). These regions were especially susceptible to the effects of the pandemic because of their limited healthcare resources. This scarcity was most evident in the shortfall in healthcare professionals, including physicians, nurses and allied health workers, which led to detrimental outcomes, such as high staff turnover (Addotey-Delove et al., 2023; Bolan et al., 2021). Turnover not only affected the quality of patient care but also increased training costs and placed additional burdens on the remaining workforce (Lim, 2021). There were also inequalities in healthcare provision and access, as

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rural areas often had fewer and poorly equipped facilities compared with urban areas (Bolan et al., 2021; Wang et al., 2020).

These long-standing issues were exacerbated by the pandemic, which highlighted the vulnerabilities inherent in the healthcare systems of developing nations. In these countries, hospitals struggled to provide health care to both COVID-19 patients and people afflicted with other medical conditions (Mahendradhata et al., 2021). The strain on resources underlined critical gaps in infrastructure and the urgent need to foster the systemic resilience necessary to withstand global health emergencies. In this research study, the term "developing countries" is used, with the understanding that no globally standardised alternative currently exists (Khokhar and Serajuddin, 2015).

In response to the COVID-19 pandemic, many countries, including Saudi Arabia, implemented a range of strategies for combatting the virus, such as enforcing lockdowns, suspending flights and promoting social distancing protocols (Li et al., 2021). These measures, mainly intended to minimise physical contact, transformed daily life and posed significant challenges to the continuity of essential services, including health care. Amid this landscape, the integration of mobile health applications (m-health apps) into healthcare provision emerged as a crucial intervention.

Mobile health applications refer to smartphone-based software programmes designed to deliver, support and enhance healthcare services (Jin et al., 2023; Yang et al., 2021). The m-health apps used in developing countries played a fundamental role in the management of the COVID-19 crisis, making it possible for practitioners to adeptly address the unique challenges that these regions were facing (Adetunji et al., 2022). These applications enabled the remote provision of healthcare services, allowing for ongoing patient care and monitoring while following social distancing protocols (Adetunji et al., 2022; Asadzadeh and Kalankesh, 2021). M-health applications also contributed to the identification of COVID-19 cases by providing geographical information on infected individuals who were tracked by the applications, which helped mitigate the further spread of infections (Adetunji et al., 2022; Alzahrani et al., 2022). With these advantages, m-health technologies had the potential to significantly improve access to healthcare resources and services, decrease healthcare costs and reduce health inequalities (Azam et al., 2023). During the COVID-19 period, various m-health apps were developed globally to meet the needs and demands of the period. Notable examples include the COVID Symptom Tracker, Corona Checker, Relief Central and Test Yourself Goa (Ming et al., 2020).

In the Saudi Arabian setting, which is the focus of the study, the government provides free healthcare services to all citizens (Al-Hanawi, 2021). Saudi Arabia launched "Saudi Vision 2030," with the Health Sector Transformation Programme as a key element aimed at reforming the healthcare system into a comprehensive, value-based model focused on public health, prevention and financial sustainability (Saudi Vision, 2020). A central enabler of this transformation, mobile health applications, is expected to enhance healthcare productivity, integrate services, and improve patient experiences. For example, applications such as Sehhaty, Tawakkalna and Tabaud were launched and updated to enhance healthcare accessibility across the country during the pandemic (Hassounah et al., 2020). Sehhaty provides services ranging from online consultations to e-prescriptions and booking COVID-19 tests (Alanzi, 2021). Tawakkalna uses global positioning system to manage movement during curfew hours and issues special permits (Alanzi, 2021; Hassounah et al., 2020). Tabaud aids in COVID-19 contact tracing by transmitting anonymous data to those near confirmed cases (Alanzi, 2021; Hassounah et al., 2020).

## *Acceptance and adoption of m-health applications*

Despite the significant benefits that m-health apps have offered, their acceptance and use among physicians in developing countries, such as Saudi Arabia, have been notably low (Addotey-Delove et al., 2023; Wu et al., 2022). This limitation has prompted researchers to examine the potential deterrents to the adoption of such technologies. For example, several studies have explored the factors influencing physicians' usage of mobile health services (Azam et al., 2023; Bhatt and Chakraborty, 2022; Diel et al., 2023; Wu et al., 2022). One such factor is performance expectancy, which has been found to be critical in encouraging physicians to use m-health technologies (Azam et al., 2023; Bhatt and Chakraborty, 2022; Diel et al., 2023; Wu et al., 2022). Other factors that have been highlighted as significant in successful m-health adoption by physicians are effort expectancy, social influence (Diel et al., 2023; Wu et al., 2022) and facilitating conditions (Della Vecchia et al., 2022; Wu et al., 2022). Furthermore, Bhatt and Chakraborty (2022) and Shiferaw et al. (2021) highlighted self-efficacy as a crucial factor in physicians' adoption of m-health technologies, while Bhatt and Chakraborty (2022) pinpointed personal innovativeness as an important determinant. Researchers have also identified a number of major barriers to widespread m-health adoption, including technology anxiety (Bhatt and Chakraborty, 2022; Diel et al., 2023), and concerns about data security, financial incentives and patient engagement (Della Vecchia et al., 2022).

While existing research has provided considerable insights into the factors affecting physicians' behavioural intention to use m-health apps, important gaps have remained unaddressed. For example, most previous studies have predominantly employed quantitative methodologies to examine physicians' perceptions about and acceptance of m-health apps (Azam et al., 2023; Bhatt and Chakraborty, 2022; Wu et al., 2022). Although quantitative research is valuable for probing into predefined variables and their relationships, it may not delve deeply into the nuanced factors that influence adoption, potentially overlooking unforeseen variables or emerging phenomena (Busetto et al., 2020; Creswell and Creswell, 2023). A quantitative approach might also fail to fully capture the complexities

underlying the individual attitudes, beliefs and social contexts that are critical for comprehensively understanding m-health acceptance (Lee et al., 2021). Therefore, there is a compelling case for incorporating qualitative research into investigations. Such a methodology is aimed at deriving deeper insights as well as uncovering the underlying motives, patterns and broader social and cultural dynamics at play, thereby offering a richer, more nuanced perspective on the factors influencing m-health app adoption among physicians (Busetto et al., 2020; Creswell and Creswell, 2023). Moreover, understanding is lacking as to how the demands emerging due to global health emergencies, such as the COVID-19 pandemic, influence healthcare professionals' attitudes and usage of digital health technologies in these settings (Jin et al., 2023). The current crisis has highlighted opportunities and obstacles related to the use of m-health applications in emergency situations, emphasising the importance of understanding professionals' motivations and barriers with respect to using these technologies. Illuminating these issues is crucial, as it can offer invaluable guidance on improving m-health adoption and thereby better prepare healthcare systems for future health crises.

In the Saudi Arabian setting, which is the focus of the current research, most existing studies have explored patients' behavioural intention to adopt m-health technologies (Aljohani and Chandran, 2021; Alsswey et al., 2021). For example, Aljohani and Chandran (2021) investigated the factors influencing patients' adoption of mobile health applications. The authors found that key determinants, such as effort expectancy, social influence and healthcare authority enforcement, significantly affect patients' intention to use these technologies. However, limited attention has been paid to the perspectives of physicians, despite these professionals being a vital link in treatment pathways for patients (Della Vecchia et al., 2022). Physicians considerably influence m-health adoption, with patients more likely to use apps recommended by their healthcare providers (Chahal et al., 2021).

## *Technology acceptance frameworks*

Theories and models of technology acceptance are conceptual frameworks developed to understand and predict the adoption and use of new technologies by individuals and organisations (Momani, 2020). In the rapidly evolving world of technology, it is crucial to comprehend why some innovations are embraced enthusiastically, while others are met with resistance or indifference (Sohn and Kwon, 2020). Using theories and models for this purpose enables stakeholders to design more user-centric technologies, tailor implementation strategies, and address barriers to adoption, ultimately increasing acceptance and successful technology integration (Venkatesh et al., 2003).

One of the most comprehensive and widely recognised models in the field is the Unified Theory of Acceptance and Use of Technology (UTAUT), proposed by Venkatesh et al. (2003). The UTAUT integrates elements from various technology acceptance theories, aiming to offer a unified framework for understanding the factors influencing individuals' acceptance and use of technology in organisational settings (Venkatesh et al., 2003). This model identifies four key determinants of technology acceptance: performance expectancy, effort expectancy, social influence and facilitating conditions. Additionally, it considers moderating factors such as gender, age, experience and voluntariness of use.

In contrast to previous theories and models that primarily focus on individual attitudes and perceptions, the UTAUT model considers wider organisational and sociocultural determinants of decisions regarding technology adoption, making it highly relevant for studies involving employees, such as physicians (Sharifian et al., 2014; Venkatesh et al., 2003; Wu et al., 2022). Though there are other acceptance models such as Theory of Reasoned Action, Technology Acceptance Model (TAM), Theory of Planned Behaviour (TPB), Combined model of TAM and TPB (C-TAM-TPB), Motivational Model, model of Personal Computer Utilisation, Social Cognitive Theory and Innovation Diffusion Theory, but Venkatesh et al. (2003) established that UTAUT outperformed these models by explaining as much as 70% of the variance in behavioural intention and 50% in technology use. This makes the UTAUT model standout justifying its robust explanatory power.

The study aimed to extend the original UTAUT by exploring additional factors specific to the Saudi Arabia context. By incorporating qualitative methods alongside the main determinants of UTAUT, the research seeks to identify context-specific influences on physicians' acceptance and use of m-health technologies, offering a more comprehensive framework for understanding technology adoption in health care (Figure 1).

Prevalent technology acceptance theories and models, including the UTAUT, are predominantly created and validated in developed countries (Venkatesh et al., 2003). However, Venkatesh et al. (2013) emphasised that it is necessary to incorporate qualitative methodologies into UTAUT-based quantitative studies on developing regions. Prior research has highlighted the comprehensiveness of the UTAUT model in predicting the behavioural intentions of users toward information technology in developing nations (Alsahli and Hor, 2024; Bawack and Kala Kamdjoug, 2018; Swidi and Faaeq, 2019). Similar to Venkatesh et al. (2013), these studies suggest including qualitative methods in explorations to uncover additional acceptance-related factors that the model may not capture on its own or factors that might not be as pronounced in Western settings. The insights derived can significantly enhance the applicability and effectiveness of the UTAUT model in diverse geographical and cultural contexts.

## *Aims*

The current study aimed to explore the factors that influenced the acceptance and adoption of m-health apps by physicians in Saudi Arabia during the COVID-19 pandemic, across both public and private hospitals. This research seeks to identify the key facilitators and barriers of

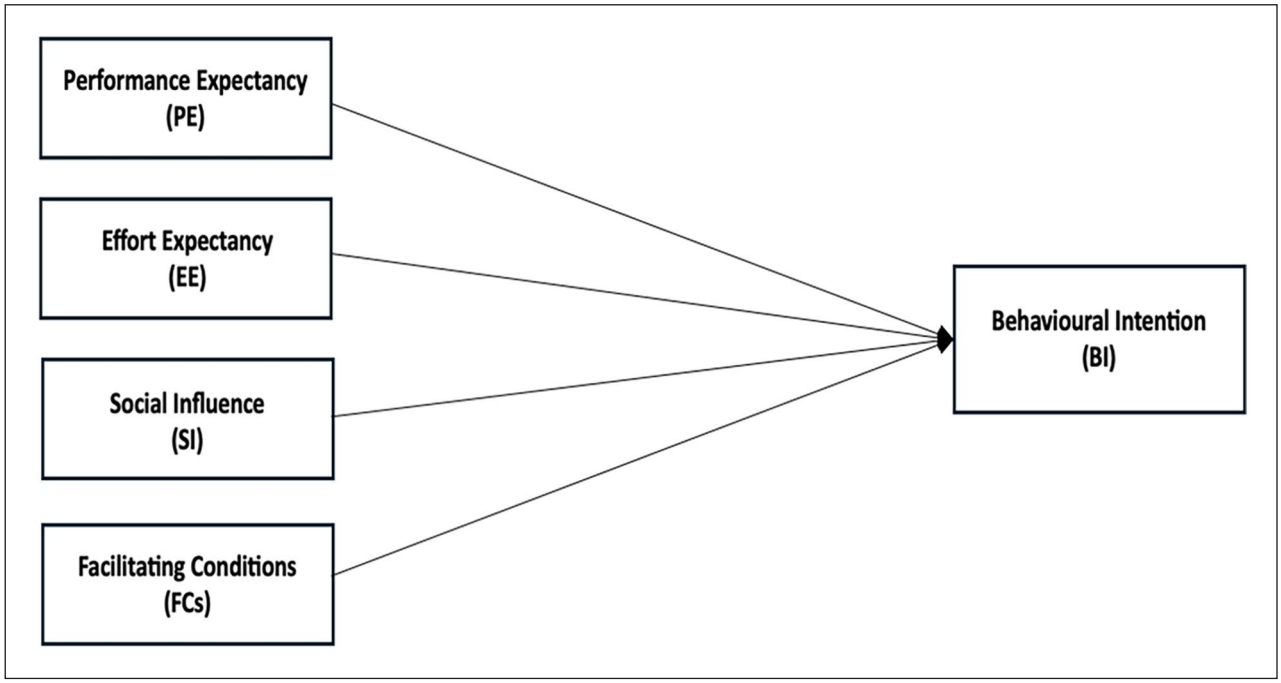


**Figure 1.** The conceptual model, adapted from the UTAUT (Venkatesh et al., 2003).
UTAUT: Unified Theory of Acceptance and Use of Technology.

m-health adoption in Saudi Arabia, with the goal of informing strategies to enhance the use of these technologies in healthcare settings within the country.

## Method

### *Research approach and design*

The study employed a qualitative research method. It was guided by the UTAUT. The study collected data through semi-structured interviews with physicians to delve into the determinants of their readiness to adopt m-health technologies.

### *Sampling and data collection*

As the study aimed to uncover additional factors influencing physicians' behavioural intentions to accept and adopt m-health applications – factors not addressed by the UTAUT model – purposive sampling was employed. This approach specifically targeted physicians who were early adopters of m-health technology or have unique perspectives on its implementation. By focusing on these key participants, the study gathered rich, qualitative data, offering insights into the specific factors these physicians encounter in their practice. The inclusion criteria required participants to be licensed physicians practising in Saudi Arabia during the COVID-19 pandemic. The job description criteria for the physicians selected in this study were based on their active involvement in patient care, clinical decision-making and use of m-health applications. Their roles in prescribing treatments and managing patient health made them key stakeholders in m-health adoption. Focusing on licensed physicians in Saudi Arabia during the COVID-19 pandemic ensured that participants had practical experience with these technologies, making their insights critical to the aim of this study. On the other hand, non-Saudi physicians were excluded to focus on those fully integrated into Saudi Arabia's healthcare system, culture and regulations. This ensures the data reflect local physicians' experiences, making the findings more applicable to Saudi healthcare policies and decision-making.

In qualitative research, sample size is determined predominantly on the basis of data saturation, which means that data collection continues until no additional themes that affect the understanding of the pursued research question emerge (Hennink and Kaiser, 2022). Empirical studies suggest that data saturation is typically achieved within a range of 9–17 interviews, particularly when working with narrowly defined research objectives (Hennink and Kaiser, 2022). In this study, Saudi physicians were interviewed until data saturation was reached, with a total of 16 physicians participating. These physicians were drawn from various public and private healthcare institutions across Saudi Arabia, ensuring a diverse representation from different sectors of the healthcare delivery system. The reason for focusing solely on physicians is that the study aimed to explore the perspectives of medical practitioners who directly prescribe and manage patient care using m-health technologies, making their insights particularly relevant to m-health adoption. Informed consent was obtained electronically from all participating Saudi physicians before their interviews.

The development of the interview guide was informed by a literature review on m-health acceptance and adoption by physicians (Alsahli et al., 2023). The interview guide was piloted with four physicians prior to the main data collection phase. Feedback from this pilot phase was used to adjust the questions for clarity and relevance, ensuring the final interview guide aligned with the research aim. This

guide included an introduction that defined and described m-health apps to ensure that the participants were aware of the technologies being studied. The interview guide was initially developed in English and subsequently translated into Arabic, the official language of Saudi Arabia, to ensure full comprehension by all participants. The questions were divided into two main categories: those on demographic information (i.e. gender, age, specialisation), and those to be presented during the interview proper. The latter were subdivided into three questions, namely, general open-ended, in-depth and closing questions. In the general open-ended questions, participants were asked about their overall awareness of m-health, whether such applications had been used by them, and any barriers or facilitators encountered in using m-health technologies. Based on their responses, follow-up prompts were used to further explore these areas. The in-depth questions were focused on specific aspects, including data privacy and security concerns, financial incentives, patient involvement and the influence of organisational culture on the adoption of m-health apps. Finally, the closing questions allowed participants to mention any additional factors or concerns they felt were relevant but had not been discussed during the interview. This structure ensured that both general and context-specific factors influencing participants' perspectives on m-health were comprehensively explored, with prompts used to facilitate deeper inquiry into key themes, thereby enhancing the richness of the qualitative data. All the interviews were scheduled and conducted using Zoom, and each lasted for 20–40 minutes. All interviews were conducted by the first author.

### *Data analysis*

The interviews were audio-recorded and then transcribed prior to data analysis. The transcription was conducted using NVivo software Version 14, which facilitated the organisation and coding of the data. The transcribed data were then examined using template analysis, a systematic and flexible approach that has become increasingly popular for the management and examination of qualitative data (King et al., 2018). A significant benefit of template analysis lies in its facilitation of both inductive and deductive methods, thereby allowing for an exhaustive and multifaceted approach to research (Glass et al., 2021). This framework entails many steps: data familiarisation, preliminary coding, clustering, initial template development, template modification, final template definition and template use for data interpretation (King et al., 2018). Researchers familiarise themselves with the data of interest by poring over raw data before beginning the coding process, ensuring a thorough grasp of each participant's experience. Preliminary coding involves marking relevant text segments and using a priori themes based on theoretical constructs or previous studies. In this stage, the study employed the UTAUT model, along with the findings from the literature review, to define a priori themes (Alsahli et al., 2023). These themes provided a structured basis for identifying relevant data segments but were subject to adjustment as the analysis progressed, reflecting the dynamic nature of qualitative template analysis. Clustering follows, which involves grouping coded segments to identify and refine the a priori themes into meaningful categories. The initial template is then developed by synthesising the defined clusters and their themes into an organised template, providing a clear framework for analysing the data. The template may be adjusted during the analysis by refining, combining or subdividing themes to accurately represent the nuances of the data. Finalising the template establishes a structure for interpreting the complete dataset, ensuring an in-depth analysis. The final step is applying the refined template to the dataset, facilitating a thorough and systematic exploration of the themes identified and thereby generating meaningful insights relevant to the research objectives.

### *Ethics approval*

Ethical approval for the research was granted by the ethics committee of the University of Technology Sydney (UTS HREC REF NO. ETH21-6751).

## Results

### *Participant characteristics*

The participant group comprised 10 men and 6 women physicians. The physicians' age distribution was as follows: One physician belonged to the age group of 25–30 years, the majority (11 physicians) belonged to the age group of 31–40 years, and four physicians belonged to the age group of 41–50 years. In terms of specialisation, most of the physicians (12) were general practitioners, three were in family medicine, and one was an urologist. With regard to work settings, four physicians were employed in the primary healthcare sector under the Ministry of Health, the majority (10 physicians) worked in hospitals also overseen by the Ministry of Health, and two were from the military sector.

### *Results of the template analysis*

The final template included four themes: technological, individual, organisational and external contexts (Table 1). These themes and subthemes are described in detail in the following sections.

*Theme 1: Technological context.* Technological context was related to the technical aspects of m-health apps and encompassed two subthemes: performance expectancy and effort expectancy (see Table 2).

### *Performance expectancy*

Performance expectancy refers to the degree to which physicians believe that using m-health apps will improve their job performance. The participating physicians acknowledged that m-health apps have significantly enhanced healthcare delivery in various respects. Specifically, they have transformed patient access to healthcare services by

simplifying procedures such as booking appointments, prescribing medications and facilitating remote clinical consultations: "The applications have made booking appointments, communicating with patients remotely, and prescribing medications much easier" (P3). These apps have also considerably reduced the need for physical visits among patients who do not require face-to-face consultations: "They don't need to come to the clinic, and we provide services using the apps" (P7). Finally, they have improved the physicians' access to up-to-date information, thus supporting clinical decision-making: "They have given me quick access to up-to-date medical information" (P12).

### *Effort expectancy*

Effort expectancy pertains to the ease with which m-health apps are used. The physicians found these applications user-friendly and effective, particularly in facilitating remote consultations: "The apps are easy tools to use" (P9) and "Just access the phone camera, and you will see the symptoms. You can then try to describe the treatments" (P14).

*Theme 2: Individual context.* This theme focused on the individual-level factors influencing physicians' decision-making regarding using m-health apps. It was divided into four subthemes: data privacy and security concerns, patient engagement, perceived incentives and social influence (see Table 3).

**Table 1.** Themes and subthemes in the template analysis.

| Themes | Subthemes |
|---|---|
| Technological context | Performance expectancy |
| | Effort expectancy |
| Individual context | Data privacy and security concerns |
| | Patient engagement |
| | Perceived incentives |
| | Social influence |
| Organisational context | Facilitating conditions |
| | Organisational culture |
| | Compatibility with religious and cultural norms |
| External context | Impact of COVID-19 |

### *Data privacy and security concerns*

The physicians expressed varied perceptions regarding data privacy and security in m-health apps. On the one hand, some felt confident about the security measures provided in the apps, emphasising the robustness of current cybersecurity systems against major breaches or complaints: "Mobile health apps are in compliance with rigorous data protection laws. . . . I'm pretty sure about patient data confidentiality" (P2). On the other hand, others shared prevalent concerns about hacking, unauthorised access to patient information, and the management of data by third parties: "The most important problem is data hacking and access to patient information. . . . how these applications store and deal with data, especially when sharing this information with third parties" (P10).

### *Patient engagement*

The level of patient involvement with m-health apps affected participants' adoption of these technologies. They were motivated to incorporate the apps into their practice when their patients actively used these tools: "When patients are passionate about mobile health applications, it really motivates me" (P2). Positive patient feedback also encouraged the physicians to use the technologies more broadly: "One of my patients has been using this app . . . this discipline in the use of the app has helped us both monitor her condition better" (P11). However, challenges in patient engagement existed, particularly among elderly patients. The lack of comfort and familiarity with these technologies drove a preference for face-to-face consultations: "Patients, especially older people, are less comfortable with these apps and prefer to come to the hospital" (P13).

### *Perceived incentives*

Financial incentives emerged as a crucial factor for adoption. The physicians recognised that such rewards can increase efficiency and motivation, especially when associated with improvements in patient care: "Financial rewards play a big role, especially when they're associated with significant improvements in patient care . . . the doctor becomes more productive because of financial compensation, but it also helps improve patient outcomes" (P3). Some of them expressed the belief that offering financial incentives may effectively motivate older physicians, who

**Table 2.** Theme 1: Technological context.

| Subtheme | Facilitators | Barriers |
|---|---|---|
| Performance expectancy | "The applications have made booking appointments, communicating with patients remotely, and prescribing medications much easier" (P3)<br>"They don't need to come to the clinic, and we provide services using the apps" (P7)<br>"They have given me quick access to up-to-date medical information" (P12) | No barrier statements provided |
| Effort expectancy | "The apps are easy tools to use" (P9)<br>"Just access the phone camera, and you will see the symptoms. You can then try to describe the treatments" (P14) | No barrier statements provided |

**Table 3.** Theme 2: Individual context.

| Subtheme | Facilitators | Barriers |
|---|---|---|
| Data privacy and security concerns | "Mobile health apps are in compliance with rigorous data protection laws. . . . I'm pretty sure about patient data confidentiality" (P2) | "The most important problem is data hacking and access to patient information. . . . how these applications store and deal with data, especially when sharing this information with third parties" (P10) |
| Patient engagement | "When patients are passionate about mobile health applications, it really motivates me" (P2)<br>"One of my patients has been using this app . . . this discipline in the use of the app has helped us both monitor her condition better" (P11) | "Patients, especially older people, are less comfortable with these apps and prefer to come to the hospital" (P13) |
| Perceived incentives | "Financial rewards play a big role, especially when they're associated with significant improvements in patient care . . . the doctor becomes more productive because of financial compensation, but it also helps improve patient outcomes" (P3)<br>: "If there is a financial incentive, the use of apps will increase, especially among older colleagues" (P1) | No barrier statements provided |
| Social influence | "When I see other doctors using mHealth apps successfully, it motivates me to use them too" (P5)<br>"I began using this app after a colleague suggested it at a conference" (P16) | No barrier statements provided |

tend to be hesitant about adopting new technologies: "If there is a financial incentive, the use of apps will increase, especially among older colleagues" (P1).

### *Social influence*

The impact of colleagues and professional networks was key to the physicians' decision to adopt m-health apps. They were more likely to use these solutions when they saw their peers using them successfully, which was a powerful motivational factor: "When I see other doctors using m-health apps successfully, it motivates me to use them too" (P5) and "I began using this app after a colleague suggested it at a conference" (P16).

*Theme 3: Organisational context.* Organisational context was related to the role of healthcare organisations in promoting m-health apps. This theme was divided into three subthemes: facilitating conditions, organisational culture and compatibility with religious and cultural norms (see Table 4).

### *Facilitating conditions*

Facilitating conditions refer to the degree to which individuals believe that an existing organisational and technical infrastructure supports the use of m-health apps. The level of support provided by healthcare organisations, including technical assistance and training, substantially influenced the physicians' attitudes towards using m-health apps. Several technical issues were a common concern among them. Some faced difficulties with system reliability, including account crashes, unstable applications and cumbersome database interfaces, which can disrupt healthcare delivery: "Sometimes having trouble in communication. . . . trouble with the Internet and the database, and technical issues, like account crashes and problems creating new accounts" (P10). Furthermore, issues of integrating m-health apps and current healthcare systems existed, which often led to increased workloads and inefficiencies: "The apps require doctors to work long hours to add patient data because there is no integration between applications and medical records" (P15). The absence of integration disrupted the smooth progression of patient care, as physicians faced difficulties in obtaining comprehensive patient histories: "When patient data is not connected to an entire health system. . . . I cannot provide complete care to patients, as I do not know their histories" (P8).

Organisational support facilitates the effective incorporation of m-health technologies into daily health practices, enhancing physicians' confidence in and willingness to use these innovations: "Hospital support contributes positively to the effective incorporation of these technologies into our health practices" (P3). Thus, technical support was highly regarded by the respondents because it advances sustained operation and minimises interruptions resulting from technical complications, thereby reducing physician complaints: "If a technical team is available who can provide immediate support, that motivates me to use the apps" (P6). Training from healthcare organisations was also seen as a fundamental source of encouragement for the use of these apps. It effectively reduced the concerns of clinicians regarding the technologies, enhanced their comfort levels, and promoted wider implementation: "Training helps overcome any reservations or concerns that doctors may have about the technology, facilitating its wider adoption" (P11).

### *Organisational culture*

The culture in healthcare organisations was another significant driver of adoption. The presence of a traditional

**Table 4.** Theme 3: Organisational context.

| Subtheme | Facilitators | Barriers |
|---|---|---|
| Facilitating conditions | "Hospital support contributes positively to the effective incorporation of these technologies into our health practices" (P3)<br>"If a technical team is available who can provide immediate support, that motivates me to use the apps" (P6)<br>"Training helps overcome any reservations or concerns that doctors may have about the technology, facilitating its wider adoption" (P11) | "Sometimes having trouble in communication. . . . trouble with the Internet and the database, and technical issues, like account crashes and problems creating new accounts" (P10)<br>"The apps require doctors to work long hours to add patient data because there is no integration between applications and medical records" (P15)<br>"When patient data is not connected to an entire health system. . . . I cannot provide complete care to patients, as I do not know their histories" (P8) |
| Organisational culture | "When the culture in a hospital encourages innovation, accepts technology, and appreciates the need for continuous improvement, this motivates me to use applications effectively" (P11) | "If the culture in a hospital favours traditional methods, with resistance against adopting modern technology, then surely I will not use the technology" (P8) |
| Compatibility with religious and cultural norms | "Being able to choose a provider's gender has really affected patient comfort. It is important for patients, especially women, to feel comfortable during medical consultations for cultural and religious reasons" (P3)<br>"Features that cater to religious practices are important. It helps our patients keep up with their treatments while they fulfil their religious duties" (P7) | No barrier statements provided |

**Table 5.** Theme 4: External context.

| Subtheme | Facilitators | Barriers |
|---|---|---|
| Impact of COVID-19 | "The crisis necessitated a shift to telehealth. . . . This transformation has played a major role in maintaining patient care while adhering to social distancing guidelines" (P7). | "I've always preferred and liked to give advice face-to-face in my own office" (P4). |

culture that places value on conventional practices may engender resistance to new technologies and limit the utilisation of these applications. This impediment stems from the fact that decision-makers might not support the integration of these technologies into healthcare practices: "If the culture in a hospital favours traditional methods, with resistance against adopting modern technology, then surely I will not use the technology" (P8). In contrast, an organisational environment that promotes technological innovation can substantially enhance the acceptance of m-health apps. Physicians are more likely to adopt and effectively use these digital technologies when the workplace encourages the integration of new technologies: "When the culture in a hospital encourages innovation, accepts technology, and appreciates the need for continuous improvement, this motivates me to use applications effectively" (P11).

## *Compatibility with religious and cultural norms*

Cultural norms and religious practices substantially affect the level of acceptability and utilisation of m-health applications. The physicians observed that enabling patients to choose the gender of their healthcare providers through the app significantly enhances user comfort and supports the use of the app. Many female patients prefer female doctors when seeking medical assistance for gynaecological difficulties or general health concerns given considerations of modesty. This feature not only corresponds with cultural and religious norms but also promotes a more open and trusting environment, improving the quality of physician–patient interactions: "Being able to choose a provider's gender has really affected patient comfort. It is important for patients, especially women, to feel comfortable during medical consultations for cultural and religious reasons" (P3). In addition, applications should accommodate religious practices through features that, for example, automatically adjust medication reminders during Ramadan when patients are fasting "Features that cater to religious practices are important. It helps our patients keep up with their treatments while they fulfil their religious duties" (P7).

*Theme 4. External context.* The primary focus of external context was the effects of the COVID-19 pandemic on the adoption of m-health apps. It was intended to capture how the global outbreak has influenced Saudi physicians' perceptions of m-health apps (see Table 5).

## *Impact of COVID-19*

Before the COVID-19 pandemic, some of the physicians preferred face-to-face consultations, but the crisis has changed their perspectives, driving them to reconsider the use of mobile health technologies: "I've always preferred and liked to give advice face-to-face in my own office" (P4). The ensuing social distancing measures highlighted the crucial role and necessity of these innovations in maintaining

continuous patient care: "The crisis necessitated a shift to telehealth. . . . This transformation has played a major role in maintaining patient care while adhering to social distancing guidelines" (P7).

## Discussion

### Summary of main findings

This research represents a pioneering qualitative investigation into determinants of the acceptance and adoption of m-health apps by physicians in developing countries during the COVID-19 pandemic, with a specific focus on Saudi Arabia. Unlike the majority of prior studies, which have adopted quantitative methodologies in combination with the UTAUT model (Azam et al., 2023; Bhatt and Chakraborty, 2022; Diel et al., 2023; Shiferaw et al., 2021; Wu et al., 2022), the current research enhanced the existing framework by integrating both core and peripheral determinants that have been less emphasised in traditional models such as the UTAUT. By employing a qualitative approach, we examined how physicians in a developing country have perceived and prioritised these additional factors amid an unprecedented global health crisis. The results offer valuable insights that can guide the development of targeted strategies for enhancing m-health integration in Saudi Arabia and similar developing countries. They also contribute to the literature by validating known determinants, such as the UTAUT factors, within the unique context of Saudi Arabia. Additionally, they identify context-specific factors influencing m-health adoption, including compatibility with religious and cultural norms, data privacy and security concerns, patient engagement and organisational culture. This advancement emphasises the necessity of modifying and expanding traditional technology adoption frameworks to better align with the realities faced by healthcare professionals in Saudi Arabia and similar contexts (Figure 2).

### Core constructs of the UTAUT model

This subsection presents our exploration of the fundamental components of the UTAUT model in relation to m-health adoption by Saudi physicians: performance expectancy, effort expectancy, social influence and facilitating conditions. By exploring how these core components are validated and manifested in the local context, we illuminated the fundamental drivers of technology adoption among healthcare professionals.

Performance expectancy and effort expectancy critically affected the adoption of m-health apps by the Saudi physicians. Such adoption was driven by the physicians' recognition of the enhancement in healthcare services made possible by m-health, which aligns with prior research (Bhatt and Chakraborty, 2022; Diel et al., 2023; Shiferaw et al., 2021; Wu et al., 2022). Perceived improvements in efficiency and patient care were central to their acceptance, underscoring the need for developers to enhance app functionality and reliability. The respondents also indicated the importance of user-friendly interfaces, consistent with earlier studies (Diel et al., 2023; Shiferaw et al., 2021; Wu et al., 2022). Thus, simplifying user interfaces and ensuring the intuitive use of these apps can increase their usage.

The study also established the importance of social influence in the adoption of m-health apps among Saudi physicians, again in line with the literature (Diel et al., 2023; Wu et al., 2022). Physicians sometimes rely on their colleagues' experiences and achievements as motivation for incorporating new technologies into their own practices. Therefore, leveraging social influence through ambassador programmes or peer endorsements can enhance the adoption of m-health apps among healthcare professionals. Facilitating conditions also exerted a significant impact on the adoption of new technologies. Our findings, in line with previous studies (Della Vecchia et al., 2022; Wu et al., 2022), demonstrated that robust technical support and comprehensive training are crucial determinants of physicians' attitudes towards m-health apps. Providing ongoing support and training may reduce the concerns that physicians may have about using these technologies, making it easier for them to incorporate these tools into their regular routines.

### Extension of the UTAUT in Saudi Arabia and similar contexts

This subsection discusses our extension of the conventional UTAUT model to consider additional factors that significantly influence the adoption of m-health apps in settings such as Saudi Arabia. These factors are compatibility with religious and cultural norms, data privacy and security concerns, patient engagement, organisational culture and the impact of the COVID-19 pandemic. This analysis emphasises how adapting and expanding the model advances a more comprehensive understanding of technology adoption in diverse sociocultural landscapes.

We found that compatibility with religious and cultural norms is a vital factor for m-health acceptance and adoption in Saudi Arabia, where Islamic traditions strongly influence societal behaviours and everyday life (Alsheddi et al., 2020). This crucial determinant is disregarded in the original UTAUT model (Venkatesh et al., 2003), yet it is essential for the acceptance and utilisation of m-health applications in these regions. Features such as enabling patients to select the genders of their healthcare providers and modify medication reminders in line with religious observances cater to cultural sensitivities. These features not only enhance patient comfort but also improve the quality of physician–patient interactions, leading to more effective consultations, better diagnosis and treatment adherence, and ultimately higher patient satisfaction and health outcomes. Unlike the previous studies (Bhatt and Chakraborty, 2022; Shiferaw et al., 2021; Wu et al., 2022), this study found that an organisational culture that embraces technological innovation can facilitate the adoption of new technologies. Healthcare organisations that promote ongoing education and a culture conducive to innovation are more

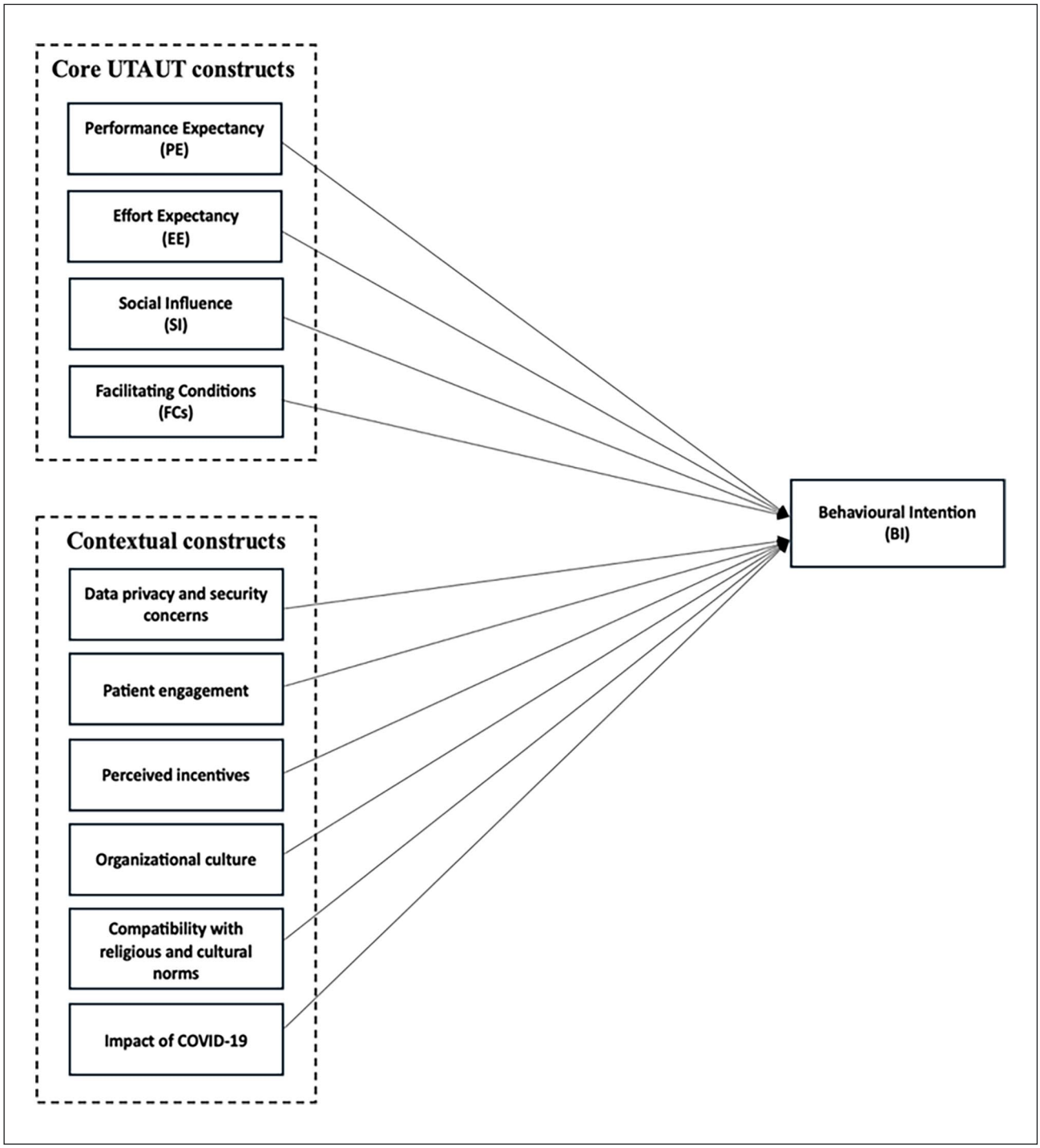


**Figure 2.** Extended UTAUT model for mHealth adoption in Saudi Arabia.
UTAUT: Unified Theory of Acceptance and Use of Technology.

likely to enjoy increased technology adoption rates among their personnel.

Data privacy and security concerns, patient engagement and perceived incentives likewise significantly influence the use of m-health technologies in Saudi Arabia. Conflicting attitudes towards data security highlight the necessity for rigorous data protection procedures in order to enhance trust among healthcare professionals, as noted in other studies (Della Vecchia et al., 2022). Thus, the establishment of strong data protection measures is critical, as these not only foster confidence among healthcare professionals but also ensure the security of patient data and maintain the integrity of healthcare services, thereby enhancing m-health utilisation. The participants also reported that the active participation of patients plays a crucial role in motivating healthcare professionals to adopt new technologies, consistent with prior studies (Della Vecchia et al., 2022). Ensuring that patient needs and preferences are met can enhance patient involvement, thereby encouraging professionals to

integrate these technologies into their practice. Moreover, this study supports the findings of previous research that illustrated the value of financial incentives in encouraging the integration of technology into healthcare environments (Della Vecchia et al., 2022).

Finally, the COVID-19 pandemic has accelerated significant transformations in healthcare industries worldwide, particularly in Saudi Arabia, where physicians have exhibited major changes in their perspectives on m-health apps. This shift aligns with findings from previous studies that suggested the pandemic accelerated the shift toward the use of m-health technologies and emphasised the significance of these innovations in maintaining continuous healthcare provision during crises (Holderried et al., 2023; Shah et al., 2022). Specifically, these technologies have been increasingly acknowledged as instrumental to maintaining healthcare service provision when conventional in-person consultations are rendered impossible by lockdowns and social distancing protocols.

### *Theoretical and practical implications*

This study enhances the theoretical and practical understanding of the acceptance and adoption of m-health apps in developing countries, including Saudi Arabia, particularly amid global health emergencies, such as the COVID-19 pandemic. By integrating qualitative insights into the UTAUT framework and identifying additional context-specific factors, this research highlighted the need for technological acceptance theories to be adapted to the sociocultural and economic realities of developing nations to better reflect their unique circumstances. The aim of the study – to broaden the UTAUT model by incorporating factors such as cultural compatibility, data privacy concerns and organisational support – was successfully achieved. The insights derived also underscored the value of qualitative research methods in capturing the nuanced drivers of adoption, enabling a deeper grasp of the factors that influence m-health uptake among physicians in Saudi Arabia and similar contexts.

From a practical perspective, this study offers actionable recommendations for policymakers, healthcare managers and m-health app developers. These stakeholders should implement several key strategies. First, they should develop m-health apps underlain by respect for cultural and religious norms. For instance, these apps should allow patients to choose their providers' genders and adjust reminders on the basis of religious practices. Second, policymakers should strengthen data privacy by enforcing stricter protection laws and conducting regular audits to build trust. Third, patient engagement should be enhanced by creating features (e.g. personalised health monitoring) that motivate healthcare professionals to adopt m-health technologies. Additionally, fostering a culture of innovation within healthcare organisations through training programmes and peer support will encourage greater technology use. Financial incentives, such as subsidies and rewards for m-health adoption, should also be considered. Finally, comprehensive ongoing training and technical support are essential to ensure the ease of use and successful integration of these technologies into daily practice. By integrating the abovementioned theoretical and practical implications, the study not only advances academic discourse but also provides concrete steps for improving the implementation and acceptance of m-health technologies in diverse healthcare environments.

### *Limitations and directions for future research*

While this study shed light on the factors influencing the acceptance and adoption of m-health apps among physicians in Saudi Arabia, several limitations must be acknowledged. To begin with, the research focused primarily on the perspectives of physicians and did not include the valuable insights that can be gained from other healthcare professionals, such as nurses, allied health workers and healthcare administrators. Exploring these voices in future research would enable a more comprehensive understanding of the barriers and facilitators of m-health adoption across the entire healthcare workforce. Patients' perspectives are also critical, as their engagement and satisfaction are essential to the successful integration of m-health technologies. By expanding the scope to include both healthcare providers and patients, future studies can offer a fuller picture of m-health adoption, helping to address a broader spectrum of needs and challenges. Additionally, this study is specific to Saudi Arabia, a country with unique cultural, religious and organisational characteristics. Although it derived insights relevant to similar developing countries, caution should be exercised when generalising the results to regions with different sociocultural and healthcare landscapes. Future research can examine m-health adoption in diverse settings to compare how different cultural and organisational contexts influence the success of these technologies.

Another limitation is the focus on the short-term adoption of m-health technologies during the COVID-19 pandemic. While this study illuminated how healthcare professionals respond to m-health issues during a crisis, it did not account for the long-term outcomes of using these applications. Other researchers should investigate the lasting effects of m-health app usage on healthcare delivery, patient outcomes and overall system efficiency. Longitudinal studies can explore whether the benefits observed during the pandemic persist and how these technologies evolve to meet ongoing healthcare needs.

Moreover, the current research employed a qualitative approach, concentrating on in-depth interviews with a select group of physicians. Although this method allows for a nuanced understanding of individual experiences, it may limit the generalisability of findings to broader healthcare populations. Future studies would benefit from using mixed methods or larger, more diverse quantitative surveys to capture a wider range of opinions and enhance generalisability. Addressing these limitations and broadening the scope of future research will not only facilitate the more effective integration of these technologies into healthcare systems

globally but also ensure that solutions are adaptable to the unique needs of different healthcare environments.

## Conclusion

This study explored the factors that influenced physicians' acceptance and adoption of m-health in Saudi Arabia during the COVID-19 pandemic on the basis of the UTAUT model, which was enhanced through the incorporation of additional critical factors for m-health app adoption. Beyond encompassing the UTAUT's focus on performance expectancy, effort expectancy, social influence and facilitating conditions, our study highlighted the critical roles of compatibility with religious and cultural norms, organisational culture, data privacy and security concerns, patient engagement, perceived incentives, organisational support and the impact of COVID-19 in adoption. It is important to address these factors to promote the successful integration of m-health apps into clinical practice. This study also emphasised the importance of a tailored approach to the use of technology adoption frameworks to better fit the cultural and organisational contexts of Saudi Arabia and similar developing countries.

The aim of this study was successfully achieved, as it not only validated traditional UTAUT factors but also identified critical context-specific determinants that influence m-health adoption in Saudi Arabia. This comprehensive approach clarified how m-health technologies can be better tailored to suit the unique sociocultural and organisational landscapes of developing nations, particularly those similar to Saudi Arabia. To apply the findings of this study, relevant stakeholders should address data privacy concerns, enhance patient engagement, provide financial incentives and ensure extensive training on m-health usage. Fostering a culture of technological innovation within healthcare institutions is equally essential. In developing countries, such strategies are critical for overcoming the barriers to m-health adoption, and they improve healthcare delivery and outcomes.

### Author note

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### Author contributions

Sultan Alsahli, the first author: conceptualisation, methodology, investigation, writing – original draft. Mary Lam and Su-yin Hor: supervision, review – editing.

### Declaration of conflicting interests

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# CHAPTER 6

## CHAPTER 6: DISCUSSION

## 6.1 Overview

This mixed-methods thesis aimed to identify the critical factors that influence the willingness of physicians in Saudi Arabia—a representative developing country—to use mHealth applications during the COVID-19 pandemic. To achieve this goal, the research was conducted in three main phases: a systematic review, a quantitative study and a qualitative exploration. Each phase provided unique contributions toward understanding the factors driving mHealth adoption among physicians in Saudi Arabia. While each publication that recounts these phases has been presented separately in previous chapters, the purpose of this chapter is to synthesise and elaborate on the combined principal results of the three phases to elucidate how they relate to enhancing the usage of mHealth apps in Saudi Arabia and provide a comprehensive mixed-methods perspective on the identified issues. This synthesis offers a deeper understanding of the barriers and facilitators influencing mHealth adoption in Saudi Arabia and proposes actionable recommendations for improving its uptake within the healthcare system. Furthermore, these findings offer new contributions to the literature on mHealth, outlining significant implications for policy, practice, and future research, particularly in developing countries. Figure 6.1 demonstrates how the thesis process integrates systematic review, quantitative survey, and qualitative interviews to extend the UTAUT model.

This chapter is organized into two main sections. The first, extending the UTAUT model, includes three subsections. Insights from the systematic review highlights the technological, individual, and organizational factors influencing mHealth adoption globally, while identifying gaps in the literature regarding developing countries. Insights from quantitative and qualitative studies: a mixed-methods perspective examines the UTAUT factors along with additional context-specific determinants of mHealth adoption. The proposed extension of the UTAUT presents a tailored model for mHealth acceptance, incorporating unique sociocultural and healthcare dynamics. The second section describes the research

contribution of this thesis, outlining the theoretical and practical implications, offering recommendations for policymakers, and contributing to the expansion of the UTAUT framework in Saudi Arabia and similar developing countries.

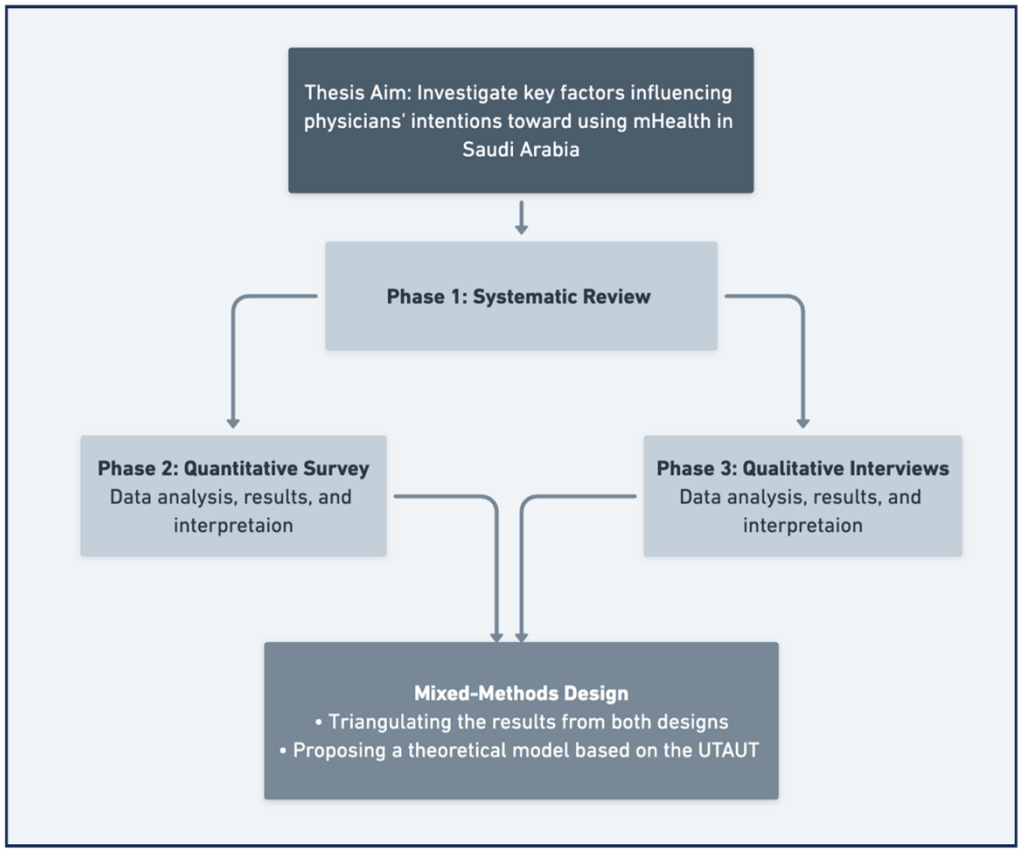


Figure 6.1: Thesis phases.

## 6.2 Extending the UTAUT model

The UTAUT model has been expanded in numerous studies to explore the factors that influence technology adoption among patients. Alam, Hoque, et al. (2020), for example, introduced perceived reliability and price value to the UTAUT framework, finding that these factors, along with performance expectancy and social influence, positively affect mHealth adoption by patients. Similarly, Hsu and Peng (2022) extended the model by incorporating ageing-related factors, such as inertia and self-actualisation needs, which significantly

influence older adults' intention to use mobile registration apps. These studies illustrated how the UTAUT model can be tailored using patient-specific variables to enhance the understanding of mHealth adoption. However, while patient-focused research has enriched the understanding of mHealth adoption, the factors driving physicians' use of such applications may differ because these practitioners engage with technology in a professional, clinical context, where adoption drivers are tied to occupational, ethical, and practical considerations.

Research extending the UTAUT model to physicians' adoption of mHealth remains relatively scarce. The few studies that do exist primarily rely on factors predefined by earlier studies to modify the model (Azam et al., 2023; Wu et al., 2022). These factors include altruism, cognitive trust, online rating, and self-concept. Although these quantitative studies offer valuable insights, they often overlook the detailed, context-specific factors that may influence physicians' adoption of mHealth applications. To bridge this gap, this thesis employed a mixed-methods approach to more comprehensively explore the unique drivers of mHealth adoption among physicians. This approach not only enabled the acquisition of data on factors already identified in the literature but also shed light on other dimensions, uncovering different perspectives on the professional and contextual factors that shape physicians' decision-making regarding mHealth technologies.

The proposed extension of UTAUT was developed through a multi-phase research process, beginning with a global review of the literature, followed by empirical testing of UTAUT's core constructs in the Saudi context, and concluding with qualitative exploration of factors not captured by the original model. Each of these phases offers distinct contributions, and when combined, they provide a holistic view of mHealth adoption in Saudi Arabia. This thesis was conducted during the COVID-19 pandemic, which significantly shaped the research design. The urgency and scale of the pandemic accelerated the adoption of mHealth applications, allowing the study to capture a unique moment of rapid technological integration

in healthcare. The pandemic's pressures influenced both the selection of factors examined and the way physicians engaged with mHealth, reflecting the need for remote care solutions. The impact of this global emergency on the findings and implications will be described later in this chapter. By examining both UTAUT constructs and context-specific factors, the proposed model integrates global technology acceptance frameworks with localised sociocultural considerations.

### 6.2.1 Insights from the systematic review

The first phase, a systematic review (published and discussed in Chapter 3), provided the foundation for identifying the factors that influence mHealth adoption in healthcare settings globally, with a specific focus on the COVID-19 pandemic. The review showed that the factors influencing the acceptance and adoption of mHealth by physicians could be categorised into three major thematic areas: technological, individual and organisational determinants. On these bases, our review indicated that the pandemic not only substantiated the validity of existing factors, consistent with the literature (Jacob et al., 2020; Zakerabasali et al., 2021), but also introduced new context-specific challenges. Notably, patient engagement and compliance emerged as critical determinants, shifting the focus from predominantly technological considerations to more patient-centred issues. The review likewise identified the unique challenges arising from the pandemic, such as the rapid transition to hybrid care models and the heightened demand for enhanced organisational support and targeted training to effectively integrate mHealth solutions into routine practice.

Our findings further underscored significant gaps in the literature, particularly that the majority of studies were conducted in developed countries. This limits our understanding of mHealth adoption among physicians in developing nations such as Saudi Arabia, where infrastructure, policies, and cultural factors create unique barriers. This phase laid the

foundation for the subsequent empirical studies by establishing the need for a more context-specific model. It demonstrated the necessity of expanding traditional frameworks, such as UTAUT, to better suit the complexities of healthcare delivery in Saudi Arabia. It also showed the importance of mixed methods approaches in capturing both quantitative outcomes and qualitative exploration.

### 6.2.2 Insights from quantitative and qualitative studies: A mixed-methods approach

The second and third phases of this thesis are related to identifying the key factors that influence the willingness of Saudi physicians to use mHealth applications. Specifically, the second phase was to examine the associations between the UTAUT factors and Saudi physicians' intention to use mHealth applications, while the third phase was to explore other factors that are unaccounted for in the UTAUT that might influence the acceptance of mHealth applications by the population of interest.

The quantitative study, published and presented in Chapter 4, tested the traditional UTAUT model in Saudi Arabia, examining the impact of performance expectancy, effort expectancy, social influence, and facilitating conditions on physicians' intentions to adopt mHealth applications. The results confirmed the relevance of the UTAUT model in predicting mHealth adoption but also suggested that additional context-specific factors needed to be explored. This study also examined whether gender, age, and experience moderated the UTAUT factors and physicians' intention to use mHealth apps. The results showed nonsignificant moderation effects, likely due to Saudi Arabia's uniform healthcare system and the rapid tech advancements during COVID-19, which minimized demographic barriers. Figure 6.2 displays the results.

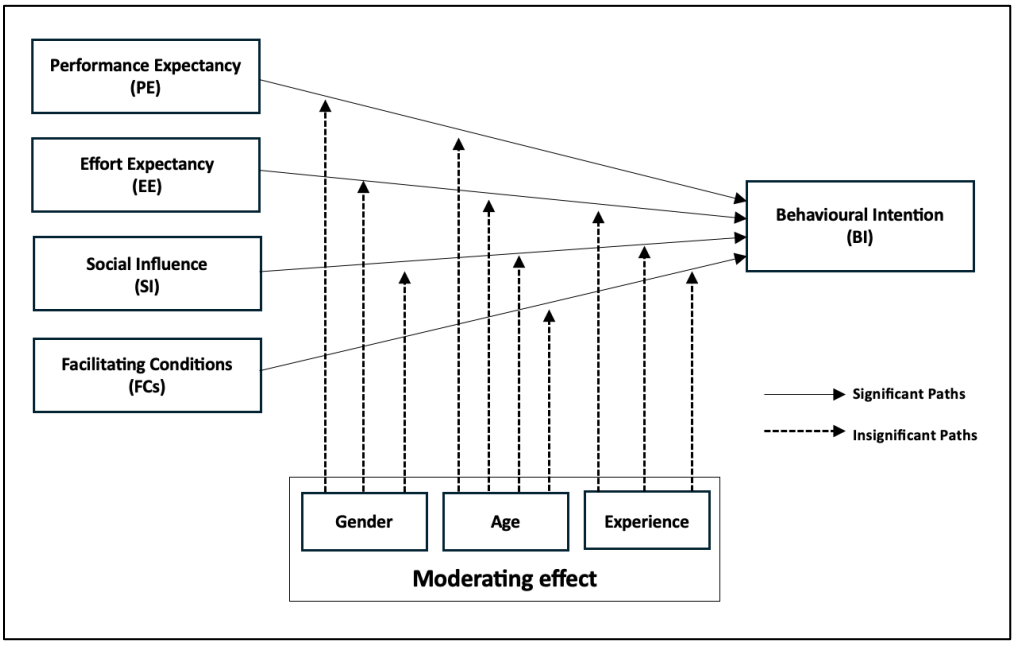


Figure 6.2: Quantitative results.

Recognising the limitations of UTAUT in fully capturing the nuances of technology adoption in a non-Western context, the qualitative study discussed in Chapter 5 explored additional factors that influence physicians' acceptance of mHealth in Saudi Arabia. These additional determinants included compatibility with religious and cultural norms, data privacy and security concerns, perceived incentives, patient engagement, organisational culture and the impact of the COVID-19 pandemic. Figure 6.3 shows the results of the qualitative study.

The combined quantitative and qualitative studies provide a robust mixed-methods perspective, extending the traditional UTAUT model by incorporating both validated constructs and additional factors unique to Saudi Arabia's healthcare and cultural context. This comprehensive approach offers deeper insights into the key drivers of mHealth adoption, highlighting the importance of modifying and expanding traditional technology adoption frameworks to better suit the realities of healthcare professionals in Saudi Arabia and similar settings.

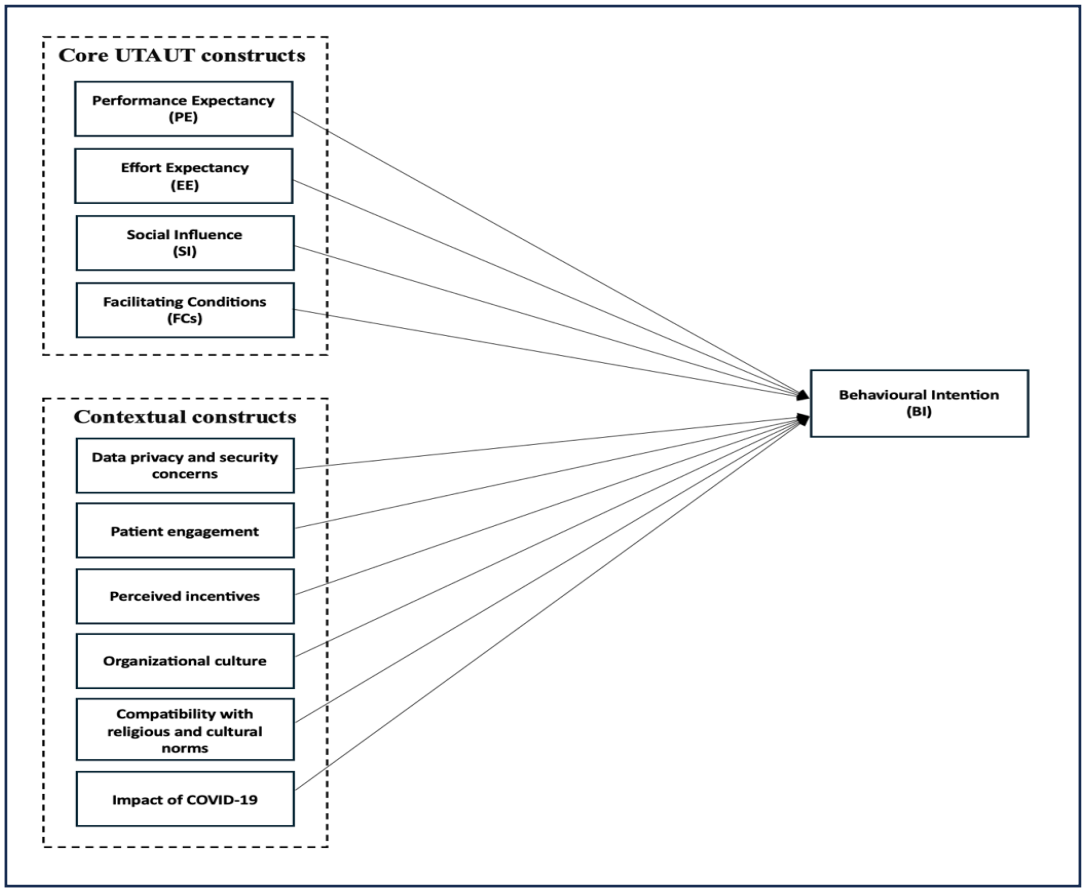


Figure 6.3: Qualitative results.

### 6.2.3 The proposed extension of the UTAUT

Building on the insights gained from the systematic review, quantitative study, and qualitative exploration, the fourth objective of this thesis was to propose an extended version of UTAUT. The proposed model incorporates both the traditional UTAUT constructs along with additional factors identified (e.g. compatibility with religious and cultural norms, data privacy and security concerns, and impact of the COVID-19 pandemic) as critical to the healthcare context in Saudi Arabia. This model aims to offer a comprehensive understanding of the multifaceted issues that influence the acceptance and adoption of mHealth, ensuring the framework is sensitive to the complexities of the local context. By adapting and extending the UTAUT, this thesis intends to align the model with the unique sociocultural, technological and healthcare dynamics of developing countries. The model reinforces the idea that technology

acceptance theories should be modified to account for the unique circumstances and obstacles that confront developing nations, particularly in contexts that are strongly influenced by cultural and religious traditions. This orientation not only enhances the theoretical landscape of technology adoption but also ensures that technological advancements effectively contribute to healthcare improvements in these regions, especially during crises like the COVID-19 pandemic. The pandemic has had a significant impact on the adoption of mHealth technologies, and its influence on the findings will be discussed in more detail below. Figure 6.4 illustrates the proposed extension of the UTAUT.

Some of the UTAUT extension factors identified in this thesis align closely with those found in studies on technology adoption among physicians (Breil et al., 2022; Della Vecchia et al., 2022). Key factors such as data privacy and security concerns, patient engagement and perceived incentives significantly influence the use of mHealth technologies. Additionally, conflicting attitudes towards data security underscore the need for robust data protection measures that build trust among healthcare professionals, as highlighted in previous research (Breil et al., 2022; Della Vecchia et al., 2022). The participants in the present study also emphasised that active patient participation is pivotal in motivating healthcare professionals to adopt new technologies, a finding consistent with those of earlier studies (Della Vecchia et al., 2022). Meeting patient needs and preferences can foster greater patient involvement, thereby encouraging physicians to integrate these innovations into their clinical practice. The current investigation likewise supports previous research that has shown the value of financial incentives in promoting the integration of technology in healthcare settings (Della Vecchia et al., 2022).

More importantly, the UTAUT model extension carried out in this thesis revealed new factors that were not previously emphasised in the literature. An example is compatibility with religious and cultural norms emerged as a critical factor in influencing physicians' acceptance

of mobile health applications. In contexts where religious traditions and cultural practices are deeply ingrained in daily life, it is imperative that new technologies, particularly those for healthcare, correspond with these norms to facilitate widespread adoption (Alsheddi et al., 2020). In Saudi Arabia, for instance, physicians have expressed concerns about using mobile health applications that do not accommodate religious practices, such as gender segregation in healthcare provision or the scheduling of daily prayers. This finding is especially relevant in countries where religious beliefs shape both personal and professional conduct, highlighting the importance of developing mHealth applications that are culturally and religiously sensitive to ensure their successful adoption.

The COVID-19 pandemic has acted as a catalyst for rapid changes in healthcare sectors around the world, as healthcare systems worldwide were forced to rely on digital solutions to maintain continuity of care during lockdowns and restrictions (Mbunge et al., 2022; Taylor et al., 2020). Our findings showed that the pandemic has shifted Saudi physicians' perspectives considerably towards mHealth application in their clinical work. It was important to incorporate this shift into the extended UTAUT model because it highlights how external pressures, such as global health crises, can accelerate technology adoption. The pandemic may have reduced initial barriers to acceptance, a trend supported by the literature, with studies noting a significant increase in the adoption of various technologies (De' et al., 2020; Umair et al., 2021). By incorporating this pandemic-driven shift into the extended UTAUT model, we can better understand the long-term potential of mHealth technologies. This addition also ensures that the model reflects not only normal circumstances but also how healthcare systems can be resilient and adaptive in the face of global challenges, such as pandemics.

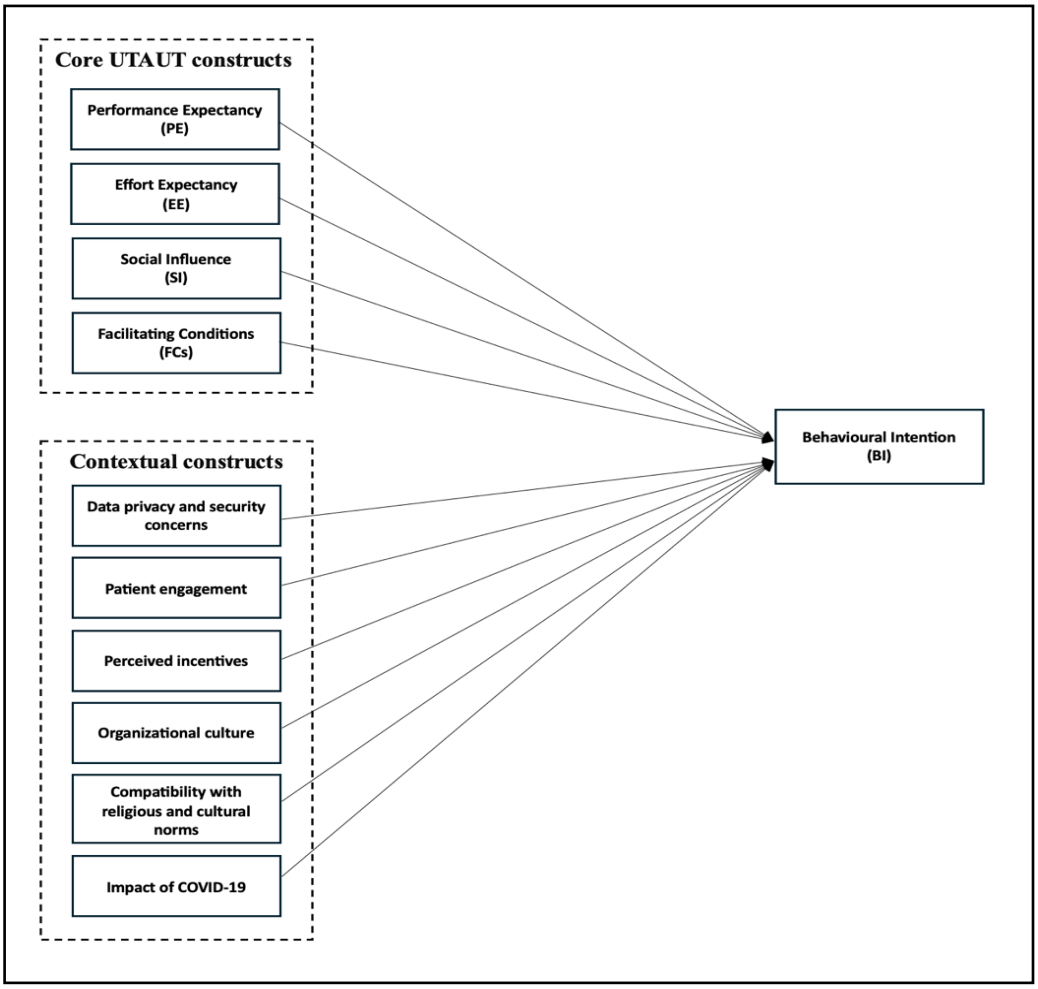


Figure 6.4: The proposed extension of the UTAUT.

## 6.3 Research contribution

This section outlines the key contributions of this thesis, which has both theoretical and practical implications for the field of mobile health technology adoption. By examining the factors influencing Saudi physicians' acceptance and use of mHealth applications, this research advances the theoretical understanding of technology acceptance models, particularly the UTAUT framework, within a unique and evolving healthcare context. Additionally, the practical implications of this research offer valuable insights for policymakers, helping them to design and implement more effective strategies for supporting the adoption of mHealth technologies in Saudi Arabia and similar countries. These findings provide a strong foundation for future studies and practical applications in healthcare.

### 6.3.1 Theoretical implications

This thesis contributes to the theories underlying technology acceptance models, with particular focus directed to the healthcare sectors in developing countries. The UTAUT was used to examine the acceptance and adoption of mHealth apps by Saudi physicians during the COVID-19 pandemic. Traditionally, the UTAUT has been predominantly applied in developed nations and within broader technological environments, where infrastructure and technological readiness are more established (Arfi et al., 2021; Ben Arfi et al., 2021; VanDeWiele et al., 2023; Venkatesh et al., 2003). By deploying the UTAUT model in the distinct context of Saudi Arabia, a developing country, this research validates the model's adaptability and relevance in less-explored environments. The findings show that UTAUT remains robust in predicting behavioural intentions in these settings, thus expanding its theoretical applicability beyond the stable, technologically mature environments in which it has typically been employed. This extension underscores the potential of the UTAUT to effectively account for the diverse socio-economic and infrastructural conditions in developing countries.

This thesis demonstrates that the UTAUT model required an additional external construct—accounting for the impact of the COVID-19 pandemic—to adequately capture the specific crisis context. This adaptation resulted in a more exhaustive understanding of physicians' acceptance and adoption of mHealth technologies during the pandemic. The extended model, which incorporates crisis-related factors, not only proves to be highly effective in the context of COVID-19 but also has the potential to predict technology adoption during future crises. This extension enhances the UTAUT's utility beyond the noncrisis environments for which it was initially designed (Venkatesh et al., 2003). By addressing technology acceptance in high-pressure, dynamic situations, the extended model contributes to the theoretical expansion of the UTAUT, making it more applicable to healthcare systems that experience significant upheavals.

The adaptation of the UTAUT model likewise enabled a more accurate reflection of the contexts in which cultural elements can considerably determine technology acceptance (Kelly et al., 2023; Stoumpos et al., 2023). The adjustments carried out in this research rendered the model more sensitive to the features of local culture and the limitations imposed by existing infrastructure. Therefore, the adaptation effectively advanced a nuanced understanding of the dynamics underlying technology acceptance in a specific context. This tailored approach reflects the importance of considering local realities that shape the use and acceptance of technology, thus adding to the depth of the theoretical comprehension of technology adoption. Since Saudi Arabia is essentially a collectivist society (Alotaibi & Campbell, 2022), as opposed to the individualist Western context, this study expanded the academic discussion of the societal values and social dynamics that influence technology acceptance. From this point of view, this research encourages the further expansion of the UTAUT by adding variables that specifically target cultural dimensions. In this way, the model can be refined to more accurately reflect a variety of cultural settings and improve its prediction of technology acceptance behaviours in these regions. Such a broadening of the model's theoretical and practical relevance can, in turn, drive more effective and culturally tailored strategies for technology implementation, ultimately enhancing the adoption and integration of technology globally. The integration of qualitative insights within the UTAUT framework, and the identification of additional factors unique to the Saudi context, underscores the critical need to adapt technological acceptance theories and models to guarantee alignment with the sociocultural and economic contexts of developing countries. This thesis adds to the literature by not only validating established determinants (e.g. the UTAUT factors) within the unique context of Saudi Arabia but also by uncovering context-specific factors that influence mHealth adoption. These additional factors—such as compatibility with religious and cultural norms, data privacy

and security concerns, patient engagement, organisational culture, and the impact of the COVID-19 pandemic—are critical in shaping physicians' acceptance of mHealth technologies.

The identification and incorporation of these context-specific factors into the analysis reinforce the importance of adapting traditional technology adoption frameworks to accurately reflect the complexities faced by healthcare professionals in developing nations like Saudi Arabia. These findings contribute to a deeper understanding of the multifaceted nature of technology adoption in healthcare, particularly in regions where infrastructural and cultural challenges are prevalent. By addressing these unique factors, this research opens the door for future studies to explore and adapt technology acceptance models in other rapidly evolving environments, offering a more comprehensive understanding of the dynamics influencing technology adoption.

This thesis also makes a theoretical contribution by reinforcing the importance of mixed methods approaches in technology acceptance research. By combining quantitative findings with qualitative insights, the study offers a more nuanced understanding of the factors influencing technology adoption (Venkatesh et al., 2013). Traditional UTAUT-based research often relies on quantitative data, but this thesis demonstrates that qualitative exploration is essential for uncovering local, contextual factors that quantitative surveys may miss. Prior studies have suggested that it is necessary to incorporating qualitative methods to uncover additional acceptance-related factors that the model may overlook, particularly those less pronounced in Western contexts (Bawack & Kala Kamdjoug, 2018; Swidi & Faaeq, 2019; Venkatesh et al., 2013). The mixed-methods approach allows for a comprehensive perspective that captures both the statistical relationships between UTAUT constructs and the sociocultural nuances that influence physicians' decisions to adopt mHealth technologies.

### 6.3.2 Practical implications

The results also offer valuable insights to stakeholders in healthcare sectors, especially in Saudi Arabia and similar countries, where technology adoption is considerably influenced by cultural factors and infrastructural conditions (Kelly et al., 2023). This research highlights the critical need for healthcare policymakers, managers, and IT developers to address not only the infrastructural requirements but also the intricate sociocultural dynamics that can either support or hinder the successful adoption of mHealth applications.

In particular, healthcare policymakers should invest in better infrastructure for mHealth, including improved internet connectivity, upgraded digital platforms, and access to necessary devices for healthcare workers. However, infrastructure alone is insufficient. This research emphasises that facilitating conditions, such as organizational support and comprehensive training programs, are critical to encouraging physicians to adopt new technologies (Wu et al., 2022). Organizational support can be demonstrated through leadership endorsement of mHealth solutions, the provision of ongoing technical support, and the creation of an enabling environment where physicians feel confident in using mHealth apps. Comprehensive training programmes designed to meet the specialised demands of healthcare professionals should also be established. These endeavours should exemplify the practical benefits of mHealth apps alongside developing the skills necessary for physicians to effectively utilise the technologies involved. These initiatives would not only cultivate awareness among healthcare providers regarding the full potential of mHealth solutions but also develop the proficiency that they need to realise this potential. Both infrastructural resources and user training are prerequisites for the optimal effectiveness of mHealth technologies (Della Vecchia et al., 2022; Wu et al., 2022).

Additionally, the importance of social influence dynamics, particularly in a collectivist culture such as Saudi Arabia, cannot be overstated (Alotaibi & Campbell, 2022). To take

advantage of these dynamics, promotional strategies for mHealth app usage should, for example, include endorsements by professionals and influencers who are respected by medical communities (Wang & Lee, 2021). These endorsements could be featured in targeted promotional campaigns that highlight the practical benefits of mHealth apps, emphasizing their success in enhancing patient outcomes and streamlining clinical workflows. Moreover, successful case studies and peer testimonials can be leveraged in dedicated promotional programmes to effectively harness social influence in a way that considerably enhances adoption rates. This strategic approach accentuates the practical benefits of mHealth apps as well as their acceptance and effectiveness in the healthcare community so that they become more broadly integrated into everyday healthcare practices. By strategically leveraging social influence, healthcare leaders can significantly accelerate mHealth adoption rates and enhance the overall integration of these technologies into routine healthcare practice.

The findings are equally beneficial for developers of mHealth applications, enabling them to design user-friendly applications that satisfy professional expectations and align with the accepted practices of healthcare providers. Applications should be intuitive, requiring minimal training to use, and they must seamlessly integrate into the daily routines of physicians without adding to their workload (Wu et al., 2022). Developers should focus on adding features that improve job performance, such as real-time data access, enhanced communication tools, and streamlined patient management systems. Additionally, in a conservative society like Saudi Arabia, it is imperative that mHealth applications be designed with cultural and religious sensitivity in mind. For instance, apps should offer patients the option to choose healthcare providers of their gender, a consideration that aligns with cultural preferences (Alsheddi et al., 2020). Similarly, the design of reminder systems or notification features should accommodate religious practices, such as daily prayer times or fasting periods during Ramadan. By ensuring

that mHealth applications respect cultural and religious norms, developers can enhance both physician and patient acceptance of these technologies.

Patient engagement is another key factor in the successful adoption of mHealth technologies. Stakeholders should focus on designing mHealth applications that actively involve patients in their own healthcare. Features such as personalized health information, real-time feedback, and interactive tools that track health metrics can help keep patients engaged with their care. When patients are more engaged, physicians are more likely to integrate mHealth technologies into their practice, as these tools provide direct benefits to their patients' health outcomes.

In addition to fostering a supportive culture, financial incentives can play a vital role in accelerating mHealth adoption (Della Vecchia et al., 2022). Policymakers and healthcare administrators should consider offering subsidies for mHealth app subscriptions, providing performance-based bonuses for physicians who successfully integrate mHealth tools into their practice, or offering grants for pilot programs that explore the use of mHealth applications in clinical settings. These incentives not only motivate physicians to adopt mHealth technologies but also demonstrate the tangible benefits of doing so, both for patient care and professional development.

One of the major barriers to mHealth adoption identified in this study is concern over data privacy and security. To overcome this obstacle, healthcare organizations and developers must implement robust security measures that safeguard sensitive patient data. This includes encryption, secure login procedures, and stringent access controls. Additionally, transparent data handling practices should be put in place, ensuring that both healthcare providers and patients understand how their data is being stored and used. Building trust is essential to increasing the adoption of digital health technologies, especially in regions where there may be greater scepticism about data protection protocols (Della Vecchia et al., 2022). Policymakers

can also consider developing legal frameworks that address data privacy issues in the context of mHealth, ensuring that patients and providers have legal recourse in the event of a data breach.

# CHAPTER 7

# CHAPTER 7: CONCLUSIONS, RECOMMENDATIONS AND FUTURE DIRECTIONS

## 7.1 Overview

This chapter presents the overall conclusions drawn from the findings. The thesis was organised based on five key objectives, which were approached through a systematic review, a quantitative study and a qualitative exploration (Figure 7.1). This chapter summarises the key results related to each research objective and discusses their implications for theory, practice and future research.

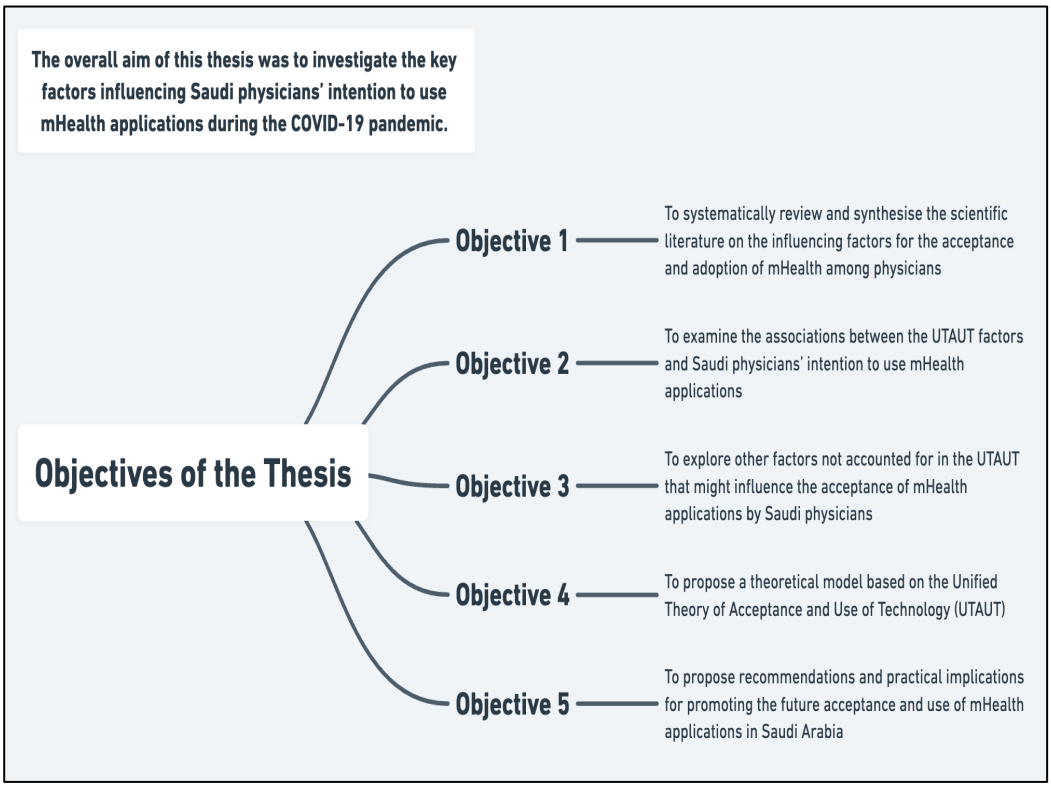


Figure 7.1: Thesis aim and objectives.

## 7.2 Summary of key findings

The principal outcomes of this thesis showed that the acceptance and adoption of mHealth apps among the participating physicians are influenced by a combination of technological, individual and organisational factors. The systematic review, which covered

studies from various countries, identified these factors broadly, while the quantitative analysis using the UTAUT model and the qualitative exploration of the Saudi context highlighted the significance of performance expectancy, effort expectancy, social influence and facilitating conditions as core determinants of mHealth adoption. The research also identified critical context-specific factors, namely compatibility with religious and cultural norms, data privacy and security concerns and the impact of the COVID-19 pandemic. The insights derived thus were integrated into a proposed extension of the UTAUT model, tailored to the Saudi Arabian context, to provide a comprehensive framework for understanding and enhancing mHealth adoption in developing countries. The findings and their implications are explored in detail in the succeeding subsections.

The primary research question that guided the research was:

*What are the key factors influencing Saudi physicians' intention to use mHealth applications during the COVID-19 pandemic in Saudi Arabia?*

This investigation was further informed by the following sub questions:

### 7.2.1 Research Question 1.1:

*What are the key factors identified in the scientific literature that influence the acceptance and adoption of mHealth applications among physicians?*

The systematic review revealed several factors influencing the acceptance and adoption of mHealth applications by physicians, and these were categorised into three major themes: technological, individual and organisational determinants. The COVID-19 pandemic intensified existing challenges and introduced new patient-centred issues, such as engagement

and compliance, alongside unique demands linked to hybrid care models and increased organisational support. Notably, the review uncovered a significant gap, with research focused on developed countries and thereby limiting our understanding of mHealth adoption in developing contexts. Future studies should address these underrepresented regions using mixed-methods approaches to thoroughly disentangle the factors affecting mHealth adoption and accordingly advance the effective integration of mHealth technologies into healthcare systems worldwide.

### 7.2.2 Research Question 1.2:

*What are the associations between the UTAUT factors and Saudi physicians' intention to use mHealth applications in Saudi Arabia?*

The quantitative study identified the factors influencing Saudi physicians' acceptance and adoption of mHealth apps during the COVID-19 pandemic using the UTAUT. The key findings are as follows. The participating physicians expressed the belief that mHealth apps will enhance their professional performance, particularly under pandemic pressures (performance expectancy). The results indicated that ease of integration into routine practices positively influenced the physicians' intention to use mHealth apps (effort expectancy). In addition, the collectivist culture in Saudi Arabia significantly affected the participants' behavioural intentions, highlighting the importance of peer recommendations and collective opinions (social influence). Finally, adequate technical support and training programmes were crucial for fostering favourable attitudes towards mHealth adoption (facilitating conditions). These findings underscore the importance of user-friendly interfaces, robust infrastructures and comprehensive training programmes in promoting mHealth adoption.

### 7.2.3 Research Question 1.3:

*From the perspectives of Saudi physicians, what factors other than those covered by the UTAUT might influence their intention to use mHealth applications?*

The qualitative study extended the investigation beyond the UTAUT model, capturing additional factors of technology acceptance in the Saudi context. For instance, compatibility with religious and cultural norms highlighted the importance of aligning mHealth apps with Islamic values and cultural practices for acceptance. Data privacy and security concerns alerted us to the necessity of robust data protection measures to build trust among healthcare providers and patients. Perceived incentives and patient engagement, including financial rewards and active patient participation, significantly influenced the physicians' willingness to adopt mHealth technologies. Organisational culture—one that supports innovation and continuous learning—was equally essential for increasing technology adoption rates. Lastly, the impact of the COVID-19 pandemic accelerated the adoption of mHealth technologies, demonstrating their importance in maintaining healthcare services during crises. These findings punctuate the need to modify and expand traditional technology adoption frameworks for enhanced correspondence with the realities of healthcare professionals in Saudi Arabia and similar contexts.

### 7.2.4 Research Question 1.4:

*What theoretical model can be developed based on the UTAUT framework to explain Saudi physicians' acceptance and use of mHealth applications?*

The fourth objective was to propose a theoretical model that integrates traditional UTAUT constructs with additional factors identified as significant in the Saudi context. The proposed

model encompasses the traditional UTAUT factors as well as additional determinants, namely compatibility with religious and cultural norms, data privacy and security concerns, patient engagement, perceived incentives, organisational culture and the impact of the COVID-19 pandemic. The extended model clears the way for an encompassing view of multifaceted influences on mHealth adoption, ensuring sensitivity to the complexities of a local context. It enables the formulation of valuable recommendations for policymakers, healthcare administrators and technology developers for designing and implementing culturally appropriate, technically supportive and widely accepted mHealth technologies.

### 7.2.5 Research Question 1.5:

*What recommendations and practical implications can be proposed to promote the acceptance and use of mHealth applications in Saudi Arabia in the future?*

The findings of this thesis highlight several recommendations and practical steps that can be taken to enhance the acceptance and use of mHealth applications among Saudi physicians. These include addressing both infrastructural and sociocultural factors, as well as providing targeted support for healthcare professionals.

- Invest in infrastructure: Improved internet connectivity, upgraded digital platforms, and access to necessary devices are foundational to support the widespread use of mHealth technologies. Healthcare policymakers should prioritize investments in these areas to ensure that healthcare providers have the tools needed to effectively implement mHealth solutions.
- Provide comprehensive training: Organizational support and well-designed training programs are crucial. Training should not only demonstrate the practical benefits of mHealth but also provide physicians with the skills required to effectively utilize these

technologies. This training should address both the technical and contextual challenges associated with mHealth adoption, including cultural considerations.

- Leverage social influence: In a collectivist society like Saudi Arabia, social influence plays a critical role in technology adoption. Prominent medical professionals and influencers should endorse mHealth apps in targeted campaigns, emphasizing their benefits for patient care and clinical efficiency. Success stories and peer testimonials can further enhance adoption rates.
- Develop user-friendly applications: mHealth applications should be intuitive and seamlessly integrated into physicians' daily routines. Features that improve job performance, such as real-time data access and enhanced communication tools, should be prioritized. Additionally, the apps must align with cultural and religious norms, such as offering gender-specific healthcare provider options and accommodating religious practices.
- Enhance patient engagement: Engaging patients through personalized health information and interactive tools will encourage physicians to adopt mHealth technologies. When patients are actively involved in their healthcare, physicians are more likely to integrate these tools into their practice, as they provide tangible benefits to both parties.
- Offer financial incentives: Financial incentives, such as subsidies for mHealth apps, performance-based bonuses, and grants for pilot programs, can motivate physicians to adopt these technologies. These incentives demonstrate the direct value of mHealth for both patient care and professional development.
- Ensure data privacy and security: Robust security measures, including encryption and secure login procedures, are essential for safeguarding sensitive patient data. Transparent data handling practices and the development of legal frameworks to

address data privacy concerns will help build trust among physicians and patients, encouraging wider adoption of mHealth technologies.

## 7.3 Limitations and suggestions for future research

This research utilised the UTAUT framework to investigate the acceptance and adoption of mHealth apps by physicians in Saudi Arabia during the COVID-19 pandemic. As with any other research, this study was encumbered by certain limitations that also translate to opportunities for future research. First, the selection of Saudi Arabia as the sole context for investigation potentially hinders the generalisability of the results to other countries. While this specific setting offers unique perspectives, cultural, infrastructural and regulatory disparities limit the applicability of our findings to different contexts. Future research would benefit from expanding this study to multiple countries characterised by varied sociocultural environments and healthcare systems to validate the model's robustness and explore regional differences in mHealth adoption.

Second, although this study cast light on the factors influencing the acceptance and adoption of mHealth apps among physicians in Saudi Arabia, it is important to discuss the scope of our focus. This research concentrated on physicians' viewpoints, but a comprehensive understanding of mHealth adoption necessitates considering the perspectives of other healthcare professionals, including nurses and allied health workers, as well as those of patients. This broader consideration is expected to generate more complete knowledge of mHealth uptake and address a wide range of needs and obstacles, thus enhancing the generalisability and applicability of mHealth solutions across various healthcare settings.

Moreover, our study focused on the factors influencing the acceptance and adoption of mHealth apps rather than on the outcomes of their use. Therefore, we did not explore the long-

term impact of mHealth adoption on healthcare delivery or patient outcomes. A longitudinal examination is critical. Future studies can build on the present research by investigating the sustained effects of mHealth applications using longitudinal designs to assess how these technologies impact clinical practice and patient care over extended periods.

Finally, the quantitative study entailed a multigroup analysis of the moderating effects of gender, age and experience on mHealth adoption among Saudi physicians, revealing evidence of moderation effects. Moderation effects typically require a large sample size to detect. Our study was likely to detect only substantial effects (e.g. crossover moderation effects), wherein the association in one group is large and contrary to that in another group. Correspondingly, the results of this study cannot be interpreted as definitive evidence that such effects do not exist. Future research investigating the potential moderating effects of gender, age and experience should consider a larger sample and collect more diverse data from cultural or healthcare contexts. Conducting such research would not only confirm or challenge our findings but also enhance our understanding of the factors that impact the uptake of mHealth technologies.

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# APPENDICES

## Appendix A: Ethics approval

Ethics approval confirmation email (ETH21-6751).

Your ethics application has been approved as low risk - ETH21-6751

1 attachment

Dear Applicant,

**Re: ETH21-6751 - "The Adoption of Mobile Health Applications by Physicians in Saudi Arabia"**

Your local research office has reviewed your application and agreed that it now meets the requirements of the National Statement on Ethical Conduct in Human

Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application, subject to any conditions detailed in this document.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

Your approval number is UTS HREC REF NO. ETH21-6751

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

## Appendix B: E-Poster in UTS

5 Minute E-Poster at Faculty of Health Research Student, UTS Conference on 24th November 2021.

# Appendix C: Invitation Letter

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

*INVITATION LETTER*

**Understanding Factors Influencing the Acceptance and Adoption of Mobile Health Applications by Physicians during the COVID-19 Pandemic in Developing Countries: The Case of Saudi Arabia**

Dear Sir or Madam,

My name is Sultan Alsahli and I am a PhD candidate at the University of Technology Sydney.

I am conducting research into mobile health applications adoption and would welcome your assistance. The purpose of this research is to identify key factors that influence the adoption of mobile health applications by physicians in Saudi Arabia. By identifying these factors, the Saudi Ministry of Health would develop and implement policies that can increase adoption rates.

The research will involve two parts, online survey which should take no more than 10 minutes and interview which should take no more than 30 minutes. You could participate in both parts or only one of them.

I have asked you to participate because you are a Saudi physician who is working in ministry of health hospitals. The outcome of this research are envisaged to determine the factors that influence Saudi physicians to adopt mHealth apps. Shedding light on such factors can help government and institutional policymakers develop and implement policies that can increase adoption rates.

If you are interested in participating in the online survey, please click this link www.qualtrics.com

If you are interested in participating in the interview, please click this link www.google.com/forms

You are under no obligation to participate in this research.

Yours sincerely,

Sultan Alsahli, PhD candidate at University of Technology Sydney

**NOTE:**
This study has been approved by the University of Technology, Sydney Human Research Ethics Committee. If you have any complaints or reservations about any aspect of your participation in this research which you cannot resolve with the researcher, you may contact the Ethics Committee through the Research Ethics Officer (ph: +61 2 9514 2478 Research.Ethics@uts.edu.au), and quote the UTS HREC reference number. Any complaint you make will be treated in confidence and investigated fully and you will be informed of the outcome.

# Appendix D: The Survey

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

**ONLINE SURVEY INFORMATION SHEET AND CONSENT FORM**

**ETH21-6751**
**The adoption of mobile health applications by physicians during the COVID-19 pandemic in developing countries: The case of Saudi Arabia**

## WHO IS CONDUCTING THIS RESEARCH?

My name is Sultan Alsahli, and I am a PhD candidate at Faculty of Health at University of Technology Sydney. My supervisors are Dr. Mary Lam and Dr. Suyin Hor.

## WHAT IS THE RESEARCH ABOUT?

The purpose of this research/online survey is to identify key factors that influence the adoption of mobile health applications by physicians in Saudi Arabia. You have been invited to participate because you are a Saudi physician who is working in Ministry of Health.

## FUNDING

This project has received funding from Umm Al-Qura University via the Saudi Arabian Cultural Mission (SACM) in Australia.

## WHAT DOES MY PARTICIPATION INVOLVE?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part. If you decide to participate, please follow the steps below:

- *Read the information carefully (ask questions if necessary);*
- *Complete an online survey, which should take no more than 10 minutes;*
- *After you complete and submit the survey, a confirmation of submission message will be displayed to confirm that your answers have been sent successfully and ask you to register for further interviews if you are interested.*

The online interview registration form is a separate form to separate identifiable information from the anonymous responses to the survey. Thus, all responses in the survey will remain anonymous and confidential, and no one will be able to identify you. You can change your mind at any time and stop completing the survey without consequences. Your ideas and feedback are highly valued and therefore we encourage you to complete the survey. We appreciate your participation and thank you for your time.

## ARE THERE ANY RISKS/INCONVENIENCE?

We do not expect this research will cause any harms or discomfort. However, If you feel distress while participating in this research, please contact the researcher (Sultan Alsahli), who will be more than happy to assist you.

## WHAT WILL HAPPEN TO INFORMATION ABOUT ME?

The survey is hosted by Qualtrics, and submission of the online survey is an indication of your consent. Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law. No personal information about you will be collected, and all data will be anonymous in any publications related to this research.

## WHAT IF I HAVE ANY QUERIES OR CONCERNS?

If you have any queries or concerns about the research that you think I or my supervisor can help you with, please feel free to contact me by phone ( ) or via email: or my supervisor by email:

If you would like to talk to someone who is not connected with the research, or if you have any concerns or complaints about any aspect of the conduct of this research that you wish to raise independently of the research team, please contact the Ethics Secretariat on 02 9514 2478 email or Research.ethics@uts.edu.au and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

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**A brief explanation about mobile health applications in Saudi Arabia:**

Mobile health applications, mHealth apps, refer to use mobile devices to collect healthcare-relevant data from patients in real-time and use such information to monitor, diagnose and treat patients. The Saudi Ministry of Health developed some mHealth apps to improve healthcare services in Saudi Arabia. These apps enable physicians to conduct medical consultations with Saudi citizens through audio-video conferencing. The purpose of this research is to investigate the key factors of Saudi physicians' intentions toward using mHealth applications in Saudi Arabia. This survey measures the adoption of mHealth apps by using the Unified Theory of Use and Acceptance of Technology (UTAUT) model, including performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intention to use these apps.

**The Survey**

**Part 1: Demographic information**

- What is your gender?
  ☐ Male ☐ Female ☐ Rather not say
- What is your age?
  ☐ 25- 30 ☐ 31- 40 ☐ 41-50 ☐ 51-60 ☐ 61- more
- Are you a Saudi National?
  ☐ Yes ☐ No
- What is your specialization?
  ☐ G.P ☐ Others, specify …
- Have you heard about the implementation of mHealth apps in Saudi Arabia?
  ☐ Yes ☐ No
- Have you used the Saudi mHealth apps before?
  ☐ Yes ☐ No
- How many years have you been using it?
  ☐ Never use ☐ 1-2 years ☐ 3-4 years
- What type of mHealth services have you used?

☐ Providing online consultations ☐ Creating e-prescriptions ☐ Personal use ☐ Never use

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The Unified Theory of Acceptance and Use of Technology (UTAUT)

Please indicate your agreement or disagreement with the following statements about mobile health applications. The rating scale is as follows. 1 – Strongly disagree, 2 – disagree, 3 - neutral, 4 – agree, 5 – strongly agree

| No. | Statements | Strongly disagree | disagree | neutral | agree | strongly agree |
|---|---|---|---|---|---|---|
| **Performance Expectancy (PE)** | | | | | | |
| **PE 1** | I would find mHealth apps useful in my job. | 1 | 2 | 3 | 4 | 5 |
| **PE 2** | Using mHealth apps enable me to accomplish tasks more quickly. | 1 | 2 | 3 | 4 | 5 |
| **PE 3** | Using mHealth apps increase my productivity. | 1 | 2 | 3 | 4 | 5 |
| **PE 4** | If I use mHealth apps, I will increase my chances of getting a raise. | 1 | 2 | 3 | 4 | 5 |
| **Effort Expectancy (EE)** | | | | | | |
| **EE 1** | My interaction with mHealth apps would be clear and understandable. | 1 | 2 | 3 | 4 | 5 |
| **EE 2** | It would be easy for me to become skillful at using mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **EE 3** | I would find mHealth apps easy to use. | 1 | 2 | 3 | 4 | 5 |
| **EE 4** | Learning to operate mHealth apps would be easy for me. | 1 | 2 | 3 | 4 | 5 |
| **Social Influence (SI)** | | | | | | |
| **SI 1** | People who influence my behaviour think that I should use mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **SI 2** | People who are important to me think that I should use mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **SI 3** | The senior management of my organisation has been helpful in the use of mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **SI 4** | In general, my organisation has supported the use of mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **Facilitating Conditions (FCs)** | | | | | | |
| **FCs 1** | I have the resources necessary to use mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **FCs 2** | I have the knowledge necessary to use mHealth apps. | 1 | 2 | 3 | 4 | 5 |
| **FCs 3** | mHealth apps are not compatible with other systems I use. | 1 | 2 | 3 | 4 | 5 |
| **FCs 4** | A specific person (or group) is available for assistance with mHealth app difficulties. | 1 | 2 | 3 | 4 | 5 |
| **Behavioural Intention to Use the System (BI)** | | | | | | |
| **BI 1** | I intend to use mHealth apps in the near future. | 1 | 2 | 3 | 4 | 5 |
| **BI 2** | I predict I would use mHealth apps in the near future. | 1 | 2 | 3 | 4 | 5 |
| **BI 3** | I plan to use mHealth apps in the near future. | 1 | 2 | 3 | 4 | 5 |

# Appendix E: The Interview

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**PARTICIPANT INFORMATION SHEET**

**ETH21-6751**
**Physicians' acceptance and adoption of mobile health applications during the COVID-19 pandemic in a developing country: Extending the UTAUT model**

## WHO IS CONDUCTING THIS RESEARCH?

My name is Sultan Alsahli, and I am a PhD candidate at Faculty of Health at University of Technology Sydney. My supervisors are Dr. Mary Lam and Dr. Suyin Hor.

## WHAT IS THE RESEARCH ABOUT?

The purpose of this research is to identify key factors that influence the adoption of mobile health applications by physicians in Saudi Arabia. You have been invited to participate because you are a Saudi physician who is working in Ministry of Health.

## FUNDING

This project has received funding from Umm Al-Qura University via the Saudi Arabian Cultural Mission (SACM) in Australia.

## WHAT DOES MY PARTICIPATION INVOLVE?

If you decide to participate, please follow the steps below:

- *Read the information carefully (ask questions if necessary);*
- *Read and sign the consent form;*
- *Participate in a half-hour online interview that will be audio recorded and transcribed for analysis.*

## ARE THERE ANY RISKS/INCONVENIENCE?

We do not expect this research will cause any harms or discomfort. However, If you feel any inconvenience while participating in this research, you have the complete right to stop participating without giving any reason.

## DO I HAVE TO TAKE PART IN THIS RESEARCH PROJECT?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part. If you decide not to participate, or to withdraw from the study, it will not affect your relationship with the researchers, the University of Technology Sydney, or the Saudi Ministry of Health.

## WHAT IF I WITHDRAW FROM THIS RESEARCH PROJECT?

If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting the researcher. If you withdraw from the study your data will be destroyed. However, data cannot be destroyed after the point of it being analysed as it is anonymised.

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## WHAT WILL HAPPEN TO INFORMATION ABOUT ME?

By signing the consent form you consent to the researcher collecting and using your information about you for the research project. All this information will be treated confidentially. The interview will be recorded and transcribed and will be kept private online in secure folder hosted by UTS and only be accessed by the researcher and his supervisors. You have the right to review your data after it has been collected.

Your information will only be used for the purpose of this research project and it will only be disclosed with your permission, except as required by law. It is anticipated that the results of this research project will be published and/or presented in a variety of forums.

In any publication and/or presentation, information will be provided in such a way that you cannot be identified, except with your permission.

In accordance with relevant Australian and/or NSW Privacy laws, you have the right to request access to the information about you that is collected and stored by the research team. You also have the right to request that any information with which you disagree be corrected. Please inform the research team member named at the end of this document if you would like to access your information.

## WHAT IF I HAVE ANY QUERIES OR CONCERNS?

If you have any queries or concerns about the research that you think I or my supervisor can help you with, please feel free to contact me by phone ( ) or via email: or my supervisor by email:

If you would like to talk to someone who is not connected with the research, or if you have any concerns or complaints about any aspect of the conduct of this research that you wish to raise independently of the research team, please contact the Ethics Secretariat on 02 9514 2478 email or Research.ethics@uts.edu.au and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

You will be given a copy of this form to keep.

**NOTE:**

This study has been approved in line with the University of Technology Sydney Human Research Ethics Committee [UTS HREC] guidelines. If you have any concerns or complaints about any aspect of the conduct of this research that you wish to raise independently of the research team, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au], and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

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**CONSENT FORM**

**ETH21-6751**
**Physicians' acceptance and adoption of mobile health applications during the COVID-19 pandemic in a developing country: Extending the UTAUT model**

I _____ agree to participate in the research project being conducted by Sultan Alsahli, a PhD candidate at University of Technology Sydney.
Email: [redacted]

I understand that funding for this research has been provided by Umm Al-Qura University via the Saudi Arabian Cultural Mission (SACM) in Australia.

I have read the Participant Information Sheet, or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions, and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I am aware that I can contact Sultan Alsahli if I have any concerns about the research.

_____ ____/____/____
Name and Signature [participant] Date

_____ ____/____/____
Name and Signature [researcher or delegate] Date

## Interview Guide

**Discussion questions guide**

- Time for this session is approximately between 20-40 minutes.
- This session will be audio-recorded.
- No one will be able to identify your personal responses. Anonymised data will be used for research.
- Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

**A brief explanation about mobile health applications in Saudi Arabia:**

Mobile health applications, mHealth apps, refer to use mobile devices to collect healthcare-relevant data from patients in real-time and use such information to monitor, diagnose and treat patients. The Saudi Ministry of Health developed some mHealth apps to improve healthcare services in Saudi Arabia. These apps enable physicians to conduct medical consultations with Saudi citizens through audio-video conferencing. The purpose of this research is to investigate the key factors of Saudi physicians' intentions toward using mHealth applications in Saudi Arabia. This survey measures the adoption of mHealth apps by using the Unified Theory of Use and Acceptance of Technology (UTAUT) model, including performance expectancy, effort expectancy, social influence, facilitating conditions, and behavioural intention to use these apps.

**The Interview**

**Part 1: Demographic information**

- What is your gender?
  ☐ Male ☐ Female ☐ Rather not say

- What is your age?
  ☐ 25- 30 ☐ 31- 40 ☐ 41-50 ☐ 51-60 ☐ 61- more

- What is your specialization?
  ☐ G.P ☐ Others, specify …

- What is your professional category?
  ☐ Resident ☐ Registrar ☐ Consultant

- Where do you currently work?

  Primary Healthcare - Ministry of Health sector
  Hospitals - Ministry of Health sector
  Medical cities - Ministry of Health sector
  Private sector
  Military sector
  Ministry of Education sector

**Part 2: Interview Questions:**

General Open questions:

I would like to know what you think about using mHealth applications.

Have you used the Saudi mHealth apps before?
If yes:

- Which app/s have you uses?
- When did you start using them?
- Are you still using them?

If no:

- Can you tell me what you think about the apps – e.g. what you have heard about them, what they are for, what your colleagues or patients say about them?
- Do you think you might use them in the future? Why/why not?

In-depth questions:

- How has the COVID-19 pandemic influenced your perception and usage of mHealth applications?
    - Prompts, you mentioned…?
- What factors motivate or limit you from using these apps?
    - Prompts, you mentioned…?
- Do you think organisation supports affects your intention to use mHealth apps? How so?
- Do you think organizational culture affects your intention to use mHealth apps? How so?
- Do you have any concerns about the privacy or security of the information shared using these apps? How so?
- Do you think financial incentives play a role on using mHealth apps? How so?
- Do you think patient involvement affects your intention to use mHealth apps? How so?

Closing question:

- Are there any other factors that may influence you to adopt these apps?

Thank you for participating in this study, your answers to these questions are very important to us, and we really appreciate you taking the time to complete this interview. Please contact me if you have any questions or would like to discuss this topic further.