Exploring Factors that Influence the Acceptance of Clinical Decision Support Systems in Saudi Arabia

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Abstract

Adopting a useful health information system (HIS) can be considered a vital precondition for providing efficient and high-quality healthcare services. With the rapidly growing technical development in the healthcare sector over recent years, the presence of multiple diseases and increasing patient numbers, healthcare practitioners can benefit from using an advanced HIS, such as a clinical decision support system (CDSS). This is because it is vital to enhance decision-making around care. CDSS may fail as a result of failing to understand the factors that affect general practitioner (GP) acceptance of CDSS. A GP is usually the frontline healthcare professional who diagnoses patients in the early stages of illnesses and their treatment at primary healthcare centres or in hospitals. Primary healthcare centres and hospitals can have long waiting lists, and this can result in hasty medical decisions made without due consideration of other factors. Therefore, a computer-based application such as CDSS may provide better support for health care decisions, based on evidence-based analysis, and with better accuracy and error-free outcomes. Identifying the factors related to CDSS acceptance is vital to the successful adoption of such a system.

This study integrates existing adoption approaches, such as the unified theory of acceptance and use of technology (UTAUT) and task-technology fit (TTF) models to support the investigation of CDSS. The combination of these models helps to create a robust research framework. The two models have been incorporated in different forms in previous studies regarding the acceptance of information technologies. In contrast, this study is significant in its examination of CDSS's adoption in the Saudi Arabian healthcare sector.

The study employs a qualitative approach for collecting views and analysing data. A total of 54 GPs were interviewed, using semi-structured questions. These professionals were selected from various primary health care centres and hospitals in Saudi Arabia to uncover the factors that affected their acceptance of CDSS. A thematic approach was used to analyse the data. The research results confirm that all UTAUT and TTF factors influence GP acceptance of CDSS. These factors include performance expectancy, effort expectancy, facilitating conditions, technology that is fit for the task, technology characteristics and task characteristics. The social influence factor of UTAUT was not explored, as most participants considered this either ineffective or irrelevant. New factors were also discovered through in-depth interviews. These include accessibility, perceived patient satisfaction, informativeness (increased knowledge), connectedness (informing patients), communication and shared knowledge, privacy and security, and perceived risk (functional performance risk and time risk). Of 13 determinants, three (performance expectancy, effort expectancy, and facilitating conditions) correspond to those found in the UTAUT model and three (task-technology fit, technology characteristics and task characteristics) match the TTF model.

This research provides great value and contribution to HIS adoption research, through in-depth interviews of CDSS acceptance in Saudi Arabia. Further, the research offers a new adoption framework for CDSS and a new set of factors that influence GP acceptance, ones that go beyond the existing models. The results of this research contribute to assisting health system researchers, designers and also decision-makers in health care management, to understand what factors promote the successful provision of CDSS.

Statement of Originality

I hereby certify that the work embodied in the thesis is my own work, conducted under normal supervision.

The thesis contains no material which has been accepted, or is being examined, for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made. I give consent to the final version of my thesis being made available worldwide when deposited in the University's Digital Repository, subject to the provisions of the Copyright Act 1968 and any approved embargo.

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Publications related to this PhD thesis

I hereby certify that the work embodied in this thesis contains published papers/scholarly work of which I am a lead author. I have included these as part of the thesis with a written declaration endorsed in writing by my supervisors, attesting my contributions.

Aljarboa, S. & Miah, S. J. (2017). Acceptance of a Clinical Decision Support System for improving Healthcare Services in Saudi Arabia. In *2017 4th Asia-Pacific World Congress on Computer Science and Engineering* (pp. 144–148). IEEE. Mana Island, Fiji.

Aljarboa, S. & Miah, S. J. (2019). Investigating Acceptance factors of Clinical Decision Support Systems in a Developing Country Context. *In 2019 IEEE Asia-Pacific Conference on Computer Science and Data Engineering* (pp. 1-8). IEEE. Melbourne, VIC, Australia.

Aljarboa, S., Miah, S. J. & Kerr, D. (2019). Perceptions of the adoption of Clinical Decision Support Systems in the Saudi Healthcare Sector*. Paper presented at the Proceedings of the 24th Asia-Pacific Decision Science Institute International Conference*, Brisbane, Australia.

Aljarboa, S. & Miah, S. J. (2020). Assessing the Acceptance of Clinical Decision Support Tools using an Integrated Technology Acceptance Model. *Paper presented at the Proceedings of 7th Asia-Pacific Conference on Computer Science and Data Engineering* (CSDE), 2020 IEEE Asia-Pacific Conference, (pp 1–6). Gold Coast, Australia

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Contents

List of Tables

List of Figures

List of Abbreviations

AI	Artificial Intelligence
CDSS	Clinical Decision Support Systems
CPOE	Computerized Provider Order Entry
DSS	Decision Support Systems
e-health	Electronic Health
ECG	Electrocardiogram
EDR	Electronic dental records
EEG	Electroencephalogram
EHR	Electronic Health Record
EMR	Electronic Medical Records
GPs	General Practitioners
HIE	Health Information Exchange
HIS	Healthcare Information System
IS	Information System
IT	Information Technology
m-health	Mobile Health
MM	Motivational Model
OHC	Online health communities
PHI	Public Health Informatics
PHR	Personal Health Records
RFID	Radio Frequency Identification
SCT	Social Cognitive Theory
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
TTF	Task-Technology Fit
US	United States (of America)
UTAUT	Unified Theory of Acceptance and Use of Technology

Chapter 1: Introduction

1.1 Study Background

The medical profession is developing rapidly, and information is abundant. A large number of diseases, health problems and epidemics, in addition to the increasing global population, have ensured that health practitioners face significant challenges. It is difficult for doctors to follow the abundance of new information effectively, especially general practitioners (GPs) who often spend time in their clinics with many different patients. Doctors require extensive knowledge across many disciplines, in addition to accurate and efficient medical decision-making. Moreover, the rapid development and high number of medications require familiarity with side effects and appropriate dosage ratios according to a patient's age and health. This overall situation is a great challenge for physicians to practise within, while maintaining their medical knowledge. Considering these factors and finding appropriate solutions and systems contributes to making appropriate medical decisions and preventing or reducing medical errors. In addition, it contributes to providing a safe environment and effective health care for the community.

This study has adopted a qualitative interview technique for data collection. Fifty-four semi-structured interviews were conducted with GPs currently working in Saudi Arabia's health sector. The interviews were conducted in three stages. In the first stage, 12 GPs were interviewed to explore the factors required for the model by applying convergent interviewing. In the second stage, 42 GPs were interviewed to investigate and discuss factors mentioned during the first stage, to determine the extent of their agreement and investigate perceptions and develop the final model. In stage three, three physicians who participated in the first phase were interviewed to further review and verify the final model.

The presence of advanced and supportive medical systems to assist doctors in making decisions has become vital because of the diversity of cases and the large number of patients. Many disease cases require the accurate and rapid decisions that can be provided by advanced health systems. In addition, doctors must obtain knowledge of a patient's medical history in a timely and effective manner. They must also be able to determine which treatment will be most appropriate. Clinical decision support systems (CDSS) can support this process, because they provide alerts and recommendations to end users, helping them to make the right decisions.

CDSS is an integral part of health information system (HIS). It contributes significantly to diagnoses and the dispensing of appropriate medication. It also provides recommendations and alerts, and relevant information that contributes to decision-making for end users (Khairat, Marc, Crosby & Al Sanousi, 2018). CDSS needs more research and knowledge to reconcile and increase interactions between the physicians and the technology to assist and support the former to adopt and use the system successfully (Miller, Anders, et al., 2015). The implementation and adoption of CDSS is significantly beneficial for medical professionals, as well as for patients in obtaining filtered information, whether from patient data or evidence-based information, that contributes to decision-making (Pereira, Jácome, Amaral, Jacinto & Fonseca, 2019).

This study targets GPs to understand their intentions and perspectives regarding CDSS acceptance. In this thesis, the terms 'doctor' and 'physician' refer to GPs. Several studies have focused on and evaluated the HIS used by GPs (Andrijasevic, Angebrandt & Kern, 2012; Chengbo et al., 2014). The Saudi Ministry of Health encourages patients, on their first visit to a public healthcare centre, to meet their GP. The GP may then refer the patient to a specialist doctor or consultant for any necessary reviews (Alshami, Almutairi &

Househ, 2014). Using advanced systems, such as CDSS contributes to the provision of more accurate medical decisions. GPs have less current medical information (across many disciplines) compared with specialist physicians and consultants, so GPs will have a greater need for systems such as CDSS, especially when a condition or complaint need a specialist referral. Further, according to Robertson et al. (2011), a physician's awareness and knowledge of the importance and value of the CDSS, and the advantages and characteristics that health information systems (HIS) provide are vital to ensure higher adoption and implementation rates. In a study by Alzghaibi (2019) on the status of information systems in Saudi Arabia, a number of research participants recommended adding clinical decision support system (CDSS) tools in order to reduce medication errors in healthcare centers.

GPs are usually the first medical contact to meet and examine a patient (Duarte, da Costa-Pereira, Del-Marmol & Correia, 2018). The results of this initial examination should be accurate and this can be enabled by using an advanced system that contributes to the decision-making process, such as CDSS (Nazarenko et al., 2015). GPs must improve their skills and knowledge regarding some medical practices and specialties (Anderson, Vaillancourt, Maes & Reiter, 2016). Markus Meyer et al. (2018) note that GPs must know the method of determining the appropriate dose of insulin for a diabetes patient; the authors stated that CDSS has contributed successfully to determining the appropriate dose for the patient. In addition, an investigation of the GPs' perspectives on the use of CDSS will contribute to the exploration of challenges and opportunities that support and aid clinician acceptance of the GPs (Hellden, Al-Aieshy, Bastholm-Rahmner et al., 2015). In a Norwegian study that also focused on GP attitudes and opinions, nine GPs were interviewed to uncover their perceptions of four kinds of digital health (Fagerlund, Holm & Zanaboni, 2019). The authors noted outcomes including an increase in work efficiency,

greater accuracy, better communication with patients, organising work and saving patients' time and money.

Furthermore, according to Ahlan and Ahmad (2014), the effective use of information technology (IT) in the healthcare sector may result in restructuring workforce and cost reduction. However, the challenges in implementing IT systems are greater in developing than developed countries (Esmaeilzadeh, Sambasivan, Kumar & Nezakati, 2015) due to the fact that some developing countries suffer from a number of issues that hinder the implementation of medical applications. For example, the issues can be based on power outages or a lack of user knowledge of the systems (Zakane et al., 2014), the cost of acquiring advanced medical systems such as CDSS, and potential concerns over privacy, confidentiality, and data accuracy (Gullapalli, Brungi & Gopichand, 2015).Moreover, CDSS use is low in developing nations. This is attributable to a lack of human and medical resources, computer illiteracy, the poor design of human-technology interfaces and a lack of training and experience (Zakane et al., 2014). Tundjungsari, Sabiq and Kardiana (2017) also found that CDSS may improve outcomes and reduce the cost of treating patients. CDSS is often referred to as a knowledge-based or expert system. The CDSS uses patient data and a chain of symbolic, as well as heuristic reasoning, practices to generate care planning, prescription consultation and treatment advice. CDSS is considered effective in improving the prescription approach to antibiotics, targeting primary care providers (Holstiege, Mathes & Pieper, 2014). Holstiege et al. (2014) suggest that more studies are needed to determine which CDSS characteristics will result in more effective antibiotic prescription approaches.

1.2 Research Context

Technology acceptance is well researched in HIS field. However, studies examining the acceptance of HIS, including CDSS, in healthcare industries remain limited because of the complicated nature and support mechanisms of HIS. CDSS research is a well-recognised area that offers significant decision support benefits in the healthcare sector. Research has outlined its technological progression as well as its general advantages and disadvantages for the healthcare sector. This study extends the knowledge of CDSS use and assesses its acceptance as a decision support tool by medical practitioners in a developing country, specifically Saudi Arabia. The research seeks to identify the factors that influence CDSS acceptance in Saudi healthcare to both increase the knowledge of this field and to contribute to its successful adoption and implementation. While Saudi Arabia as a one of the rapidly developing countries with strong economic growth in the region (Ministry of Finance, 2021), service oriented technologies such as CDSS may provide assistance for delivering better healthcare services.

CDSS is considered the most effective way to minimise medication errors (Sim, Ban, Tan, Sethi & Loh, 2017). CDSS incorporates both expert- and knowledge-based concepts to help physicians determine effective treatment for patients (Benrimoh et al., 2018). The application of CDSS in a healthcare system is a main element in improving decision-making processes and the quality of medical care; it also improves physician performance (Holstiege, Mathes & Pieper, 2015). CDSS assists medical practitioners to make decisions and produce beneficial advice based on current scientific evidence (Liberati et al., 2017). CDSS is defined by Sloane and Silva (2020) as 'CDSS are software-based AI tools that can assist physicians, nurses, patients, or other care-givers to make better decisions' (p. 561). In other words, CDSS is a type of computerised software application developed to assist healthcare providers in making quality decisions regarding patient

treatment, and to improve clinical management (Pope et al., 2013). Medicine has made tremendous and continuous advances over recent years; generally, medical knowledge doubles every seven years (Obreja, Ross & Bednar, 2017). Given this expansion of medical knowledge, it is essential to identify modern systems that support practicing physicians to make the most effective decisions. Expert systems and smart applications are distinguished by their ability to store, retrieve and process data rapidly.

The acceptance of CDSS by medical practitioners is crucial for successful its implementation (Esmaeilzadeh, Sambasivan & Nezakati, 2014). Aggelidis and Chatzoglou (2009) stated that medical services personnel differ from those in other sectors in terms of their acceptance, attitudes and opinions regarding the use of IT. It is vital to investigate physician understandings of CDSS. This is because identifying their experiences, preferences and beliefs will contribute significantly to their acceptance of CDSS (Razmak, Bélanger & Farhan, 2018). The investigation of factors that affect HIS acceptance is crucial for improving healthcare services and patient wellbeing. In addition, determining the factors affecting HIS will contribute significantly to developing fit and appropriate systems for end users (Ahlan & Ahmad, 2014). Ahlan and Ahmad (2014) also recommend further research be undertaken to identify additional variables that may influence the acceptance of HIS. Esmaeilzadeh et al. (2014) indicate that the success of CDSS implementation depends on the acceptance of physicians. Therefore, it is essential to have an in-depth comprehension of how CDSS can assist and serve end users and meet their requirements. Koskela, Sandström, Mäkinen and Liira (2016) indicate that limited data exists regarding end-user perspectives of the barriers and facilitators for successful CDSS implementation.

CDSS has many capabilities and advantages but these have not been exploited due to poor design; this is mainly because designers do not consider user acceptance (Khairat, Marc, Crosby & Al Sanousi, 2018). Physicians are the primary users of HIS and the providers of healthcare services for patients. Therefore, it is important that they accept information systems in hospitals and primary health centres for the successful implementation of health systems (Chen & Hsiao, 2012). Studying and investigating the acceptance of technology will contribute significantly to the health and innovation industry through understanding end-user perceptions and insights (Wijnhoven & Koerkamp, 2019).

According to Sambasivan, Esmaeilzadeh, Kumar and Nezakati (2012), the developers and implementers of medical information systems face a major challenge in developing new CDSSs in developing countries. This is due to systems not being used and the lack of knowledge regarding end-user requirements.

Very few studies have investigated and studied CDSS acceptance by healthcare professionals in Saudi Arabia (Alqahtani, Alshahri, Almaleh & Nadeem, 2016; Alsulame, Khalifa & Househ, 2016). Therefore, this study provides in-depth scientific research regarding what facilitates and what obstructs CDSS acceptance. This will encourage developers and researchers to work on HIS that are commensurate with the needs and tasks of physicians, both in the context of Saudi Arabia and also in developing countries.

Medical errors are costly and harmful. CDSS can prevent and correct medical errors and help to provide quality medical care (Aldekhail, 2014). According to Rajasekar (2015), between 210,000 and 400,000 deaths in the United States (US) In 2015 by medical errors. Additionally, a study of 10 clinics in Riyadh City (Saudi Arabia) found errors in 990 (18.7%) of 5,299 prescriptions (Khoja et al., 2011), whereas Al-Jeraisy, Alanazi and

Abolfotouh (2011) found 56 medical errors in the dispensing of every 100 medication orders in the general paediatric ward at King Abdulaziz Medical City. Further, M. Q. Alanazi, Al-Jeraisy and Salam (2015) evaluated antibiotic prescriptions in the emergency department of a tertiary care facility in Saudi Arabia. The results of this study were disturbing. The authors found that at least one type of antibiotic prescription was not correct or appropriate in 58% of children and 39% of adults. The authors recommend the use of advanced systems that can help doctors make correct medical decisions, reducing medical errors in prescriptions of treatment. Alsafi et al. (2015) distributed a questionnaire to 107 doctors at a tertiary care hospital in Saudi Arabia. The survey covered six different issues: (i) demographic information; (ii) knowledge, perspectives and practices towards reporting medical mistakes; (iii) perceived causes and frequency of medical errors in the hospital; (iv) experiences with communicating medical mistakes; (v) knowledge; and (iv) attitudes with communicating medical mistakes. A third of the respondents were worried that they would experience negative consequences if they reported medical errors, while almost 56% said that reporting medical errors would lead to positive changes in medical care. Regarding medical errors, most were related to late interventions and misdiagnoses (Alsafi et al., 2015).

Previous studies have shown limited amount of research that offer new knowledge on the use of medical applications such as CDSS in healthcare in Saudi Arabia means there is a lack of understanding regarding the challenges and opportunities that have an impact on the acceptance of the CDSS in Saudi Arabia. Therefore, in-depth research related to CDSS acceptance in this sector is essential in order to identify the factors that can contribute to its effective implementation. Physicians are the salient CDSS user-group in healthcare. It is therefore necessary to investigate the determinants they face, as key users, to accept and adopt advanced medical applications.

CDSS has many capabilities and advantages but these have not been exploited due to poor design; this is mainly because designers do not consider user acceptance (Khairat, Marc, Crosby & Al Sanousi, 2018). Physicians are the primary users of HIS and the providers of healthcare services for patients. Therefore, it is important that they accept information systems in hospitals and primary health centres for the successful implementation of health systems (Chen & Hsiao, 2012). Studying and investigating the acceptance of technology will contribute significantly to the health and innovation industry through understanding end-user perceptions and insights (Wijnhoven & Koerkamp, 2019).

The study of CDSS acceptance will contribute significantly to identifying the barriers and advantages to adopting the system, providing an opportunity for its successful implementation. The investigation and discovery of the factors that influence CDSS acceptance of end-users are crucial to its successful implementation (Lourdusamy & Mattam, 2020). Several studies have indicated the need to conduct high-quality research that will determine the factors that influence CDSS acceptance by physicians. Arts et al. (2018) examined the acceptance and obstacles around CDSS in general practice; their results indicate a need to conduct more research. This will result in deeper understandings of the CDSS features required by GPs. It will also enable recommendations for direct suppliers and designers in relation to producing more effective systems based on end-user demands and requirements.

1.3 Research Questions

This research seeks an in-depth answer to the main question and to build a theory capable of giving a clear perception of the factors that influence GP acceptance of CDSS. Investigating and answering the main question will contribute to the knowledge regarding

the most prominent opportunities and challenges regarding the successful adoption of CDSS in Saudi Arabia.

This study's main research is: what are the factors influencing the acceptance of CDSS in Saudi Arabia? To answer this question, the following secondary research questions are proposed to acquire more comprehensive answers:

- What advantages and benefits can GPs acquire by using the CDSS in Saudi Arabia?
- What are the challenges and obstacles in relation to GP acceptance of CDSS in Saudi Arabia?
- How can the use of CDSS contribute to the promotion and development of health care in Saudi Arabia?

1.4 Aim of the Research

The main purpose of this research is to determine the factors that affect CDSS acceptance by GPs in Saudi Arabia. This research will seek to discover the influencing factors through developing and expanding the unified theory of acceptance and use of technology (UTAUT) model so that it is suitable and compatible with GP requirements and needs in developing countries. This study also aims to extend the current knowledge and address the challenges of using CDSS in the healthcare sector. This research is particularly important for improving and developing healthcare services by providing consistent, high-quality research and understanding. Further, the study will investigate additional opportunities to provide comprehensive research results that will enhance practitioner and researcher knowledge in this field, to promote healthcare services. In pursuing this objective, the following supporting goals are identified:

- To investigate the further advantages of using CDSS in Saudi Arabia.
- To identify the obstacles facing the use of CDSS in Saudi Arabia.

- To understand how current HIS are being used.

1.5 Research Study Conceptual Model

This research seeks to present a theoretical model that will contribute to a broader overview and comprehensive understanding of the factors that influence the acceptance of CDSS and HIS in Saudi Arabia and other developing countries. Moreover, it provides a starting point for future studies. The UTAUT framework developed by Venkatesh, Morris, Davis and Davis (2003) is the main model used in this study. UTAUT was chosen as it is a flexible and comprehensive model that includes influencing factors. It was built after examining and investigating eight prior models and theories. Notably, the contributions from UTAUT have led to better comprehension of the factors that affect the use of technology when compared with other relevant models and theories (Cobelli, 2020). The UTAUT model is important because it can examine large datasets on a global scale (Im, Hong & Kang, 2011).

UTAUT has been applied widely to determine the factors that affect the acceptance of IT. However, it is considered a simplistic model for HIS, as it focuses on limiting factors (Shachak, Kuziemsky & Petersen, 2019). Shachak et al. (2019) indicate that it is vital for researchers to expand and develop a model to include the different dimensions that contribute to understanding issues related to HIS implementation and use. Bawack and Kamdjoug (2018) indicate that applying UTAUT model to predict acceptance of HIS in developing countries needs further study to modify and develop it, ensuring its appropriateness for developing countries.

This study integrates the task-technology fit (TTF) model, developed by Goodhue and Thompson (1995), with UTAUT to develop the most appropriate conceptual approach from which to construct a reliable framework that can identify the factors that influence

CDSS acceptance. TTF relates to investigate system and task characteristics to determine how a system fits the demands of a task, to improve and support user performance (Goodhue & Thompson, 1995). Several studies have integrated TTF with UTAUT to study technology acceptance (Afshan & Sharif, 2016; Park, Gunn, Lee & Shim, 2015). Further, Khairat, Marc, Crosby and Alsanousi (2018) suggest that integration between models can enhance identification of the factors that influence CDSS acceptance. Wang, Tao, Yu and Qu (2020) suggest that the integration of UTAUT and TTF has identified how users accept wearable healthcare devices. Nurhayati, Anandari and Ekowati (2019) emphasise that combining these models can provide greater detail about end-user acceptance of technology. Integrating these models contributes significantly to explaining user acceptance of a system (Park et al., 2015; Wan, Xie & Shu, 2020). Both models are distinguished by significant clarification of acceptance and the combination of the two provides a significant improvement leading to problem consequences in this research.

1.6 Research Problem

A literature review highlighted the lack of research on CDSS in Saudi Arabia (Alsulame et al., 2016) and in developing countries (Ahlan & Ahmad, 2014; Bawack & Kala Kamdjoug, 2018; Ladan, 2018). Miller et al. (2015) indicate that a high-quality qualitative study is needed to gain a better understanding of interactions between users and CDSS. Additionally, a search of several databases, including IEEE Xplore, EBSCO and ScienceDirect, confirmed that CDSS acceptance has not been sufficiently studied. Thus, it is imperative to emphasise the need for in-depth research to identify the factors that may affect CDSS acceptance in Saudi Arabia. Previous research has demonstrated that the successful performance of a new technology is profoundly connected to levels of understanding regarding the elements that affect user expectations and intentions (Yu, 2012). Improving the quality and safety of preventive and healthcare services continues

to be a challenge in hospitals and primary healthcare centres (Agarwal et al., 2018). This requires further research on the development and improvement of HIS, and greater knowledge of the emerging issues and needs, based on scientific evidence.

A limited number of studies address the current situation regarding CDSS and its acceptance and use. Therefore, it is necessary to investigate both the positive and negative aspects of using CDSS in Saudi Arabia to generate knowledge and recommendations (Alsulame et al., 2016). Moreover, Alqahtani et al. (2016) and Almutairi, Alseghayyir, Al-Alshikh, Arafah and Househ (2012), have noted the urgent need to adopt CDSS to improve health care and increase the quality of medical performance in Saudi Arabia. There is a clear need for more research on medical practitioners' attitudes and perceptions, and on knowledge of the factors associated with CDSS acceptance in Saudi Arabia (Youssef et al., 2015). Al Asmri et al. (2020) has indicated that the state of the HIS in the primary health care system in Saudi Arabia needs to be developed and reformed in order to provide better health care and help physicians provide data that contributes to making medical decisions.

One of the troubling issues which is of great concern in Saudi health organizations relates to the medical errors performed by medical practitioners and which needs an appropriate solution (Al-mazroea & Alturki, 2017). In this context, the CDSS offers an electronic application that contributes to providing information and recommendations that help the doctor in decision making and thereby reduces the risk of medical errors. Alshahrani, Stewart and MacLure (2019) have indicated that additional studies are needed which relate to the acceptance of HIS by Saudi end-users in order to provide advanced health systems that contribute to providing better medical care. Alshehri, Alsabaani, Alghamdi and Alshehri (2021) also stressed the need to adopt the CDSS in primary health care

centers in Saudi Arabia in order to provide accurate and correct information and improve the quality of medical decision-making.

Chana, Porat, Whittlesea and Delaney (2017) mention that although there are benefits to integrating prescriptions with CDSS, no studies have investigated the possibility of CDSS being used to assist GPs to prescribe medication to reduce medical errors and to ascertain appropriate dosages. Further, the factors influencing CDSS acceptability are not well known and there remains a paucity of studies examining broader CDSS areas. The concern remains that not using CDSS is still a significant problem for HIS implementation in developing countries, so it is important to study the factors that inhibit its use (Sambasivan et al., 2012). Some advanced HIS are unavailable or remain unused in developing countries. Therefore, it is necessary to study and investigate the factors that affect user acceptance in the medical field to consider these factors during the development of health systems (Ahlan & Ahmad, 2014). Additionally, Fiks et al. (2015) state that more strategies and studies are needed to more fully identify the factors that will contribute to obtaining more benefits of CDSS for support in medical guideline adherence.

1.7 Significance of the Research

The use of advanced HIS such as CDSS has become vital in the quest to provide efficient health services and care. Adopting CDSS contributes to providing accurate information and reducing medical errors. The importance of this research stems from the need to provide in-depth studies on the challenges and opportunities around CDSS use in Saudi Arabia and developing countries. For the successful implementation and adoption of information systems, especially those that are new and innovative, end users must accept the new system (Arpaci, Al-Emran, Al-Sharafi & Shaalan, 2021). If HIS are not adopted

or accepted, negative effects on patient information, as well as on health care, may result (Ketikidis, Dimitrovski, Lazuras & Bath, 2012).

A limited number of studies have investigated and verified physician acceptance of CDSS in Saudi Arabia and developing countries. Therefore, this study proposes to contribute to a deeper understanding of the factors affecting CDSS acceptance. It will then develop and build a final model through in-depth interviews with 54 GPs. Acceptance of CDSS is crucial to provide better healthcare services: if end users do not accept the technology, the health care and wellbeing of patients may suffer (Khairat, Marc, Crosby & Al Sanousi, 2018). This research uses UTAUT as the main conceptual framework. The study aims to extend and develop this model to explore and identify the factors that influence CDSS acceptance by GPs. Bawack and Kala Kamdjoug (2018) point to the need to broaden the UTAUT model to identify factors that affect acceptance of the system in developing countries. Therefore, this study will conduct in-depth interviews with GPs to identify these factors and provide a comprehensive overview. Jahanbakhsh, Peikari, Hazhir and Saghaeiannejad-Isfahani (2018) have identified the factors affecting acceptance of HIS in primary health centres in Iran; they state that recognition and interest in these factors must exist for the successful implementation of HIS. They also that the implementation of several health system projects that do not consider the factors affecting end-user acceptance will lead to an overall failure of the system. Therefore, exploring the factors that contribute to and hinder physician acceptance, as end users in the Saudi context, will help CDSS implementation to be more efficient and will also enable the design of more effective systems based on user preferences.

This research will contribute to the discovery of opportunities for providing enhanced healthcare in Saudi Arabia and increasing knowledge in this research field. This, in turn,

may lead to further CDSS research, both in Saudi Arabia and internationally. This research will also increase understanding regarding the expectations and needs of medical practitioners around the CDSS, which may contribute significantly to successful CDSS implementation. Several studies have revealed that the use of CDSS could be vital for providing better health services and supporting doctors to make decisions and reduce medical errors (Teixeira, Mori, Usera, Bacigalupo & Luna, 2019). The findings of this study may encourage the acceptance of CDSS by identifying the challenges and obstacles that hinder its acceptance, as revealed by interviews with participating GPs. Further, understanding and identifying CDSS end-user requirements will help health system designers and developers provide a system that is acceptable to GPs.

The final model of this research will contribute significantly by providing relevant information to any future study regarding the acceptance of advanced HIS for health care in Saudi Arabia, as well as in developing countries.

1.8 Thesis Structure

This thesis is divided into eight main chapters:

In the first chapter, several main titles are mentioned which form the background to the current research and which discuss the importance of studying the factors that affect physicians' acceptance of medical decision support systems. In addition, the main research question and sub-questions that contribute to reaching the goal of this study are presented. This is followed by a discussion of the conceptual model for the research.

The second chapter provides an overview of the history and significance of decision support systems in general. Subsequently, a detailed literature review is presented

regarding the importance and necessity of accepting and adopting the CDSS , including a discussion of its benefits and challenges in relation to providing better medical care.

The third chapter presents the general situation in Saudi Arabia including a discussion of the economic, educational and health status of the country. In addition, the role of the Saudi Vision 2030 in promoting the development of the country is explored. This is followed by information regarding the current status of the Saudi health systems based on relevant studies. An overview is then provided on the status of (EMR), social networking, cloud computing, mobile health (m-Health) and CDSS in Saudi Arabia.

In the fourth chapter, the importance of studying the acceptance of technology in the health sector and its role is discussed in detail. Ten different models and theories related to the acceptance of information technology are presented. Then, justification is provided for the conceptual model chosen for this research, which is an amalgamation of the TTF model with UTAUT l, with reference to relevant studies on the effectiveness of the model. Finally, the need to expand the proposed model by adding in-depth interviews with GPs is mentioned.

The fifth chapter describes the methodological approach that was applied for this research. It provides a detailed overview of the qualitative research with a focus on the qualitative semi-structured interview method selected from the relevant studies. In addition, details regarding the ethical considerations related to the research, and how these are dealt with, are covered.

In the sixth chapter, data collection methods are discussed and the justifications for relying on the three main stages of the data collection process are explained. In addition, the data of the participants, and the methods of selecting doctors to participate in the

interviews are presented. This is followed by a data analysis based on the thematic analysis method.

In the seventh chapter, the current situation of the health information systems used in primary health centers and hospitals in Saudi Arabia is discussed in detail, and is based on in-depth interviews with the study's participants. The factors influencing the acceptance of CDSS by GPs, which is uncovered from the in-depth interviews, are then discussed.

The eighth and final chapter presents the main results and the answers to the research questions with the evidences of each factor that affecting the acceptance of the CDSS by GPs from the relevant studies. After that, the limitations of the current research and future research related to this research are discussed. This is followed by the conclusion. At the end of this thesis, all references and appendices are presented.

1.9 Chapter Summary

This chapter has introduced the study's objectives. It also presented the background to and definition of CDSS and its benefits. This chapter has also discussed the research questions and the study's significance and presented the research problem.

Studies indicate that CDSS assists medical practitioners in making decisions and obtaining recommendations, alerts and treatment plans. Thus, it improves doctors' medical performance through reducing medical errors and enabling doctors to providing high-quality health care. Previous studies have identified a lack of research investigating the factors that influence physician acceptance of CDSS, especially in developing

countries. In addition, little research has been undertaken on electronic health systems, including CDSS, in Saudi Arabia and how to develop them.

Several studies have demonstrated the effectiveness of UTAUT in identifying the factors affecting the acceptance of IT. However, the UTAUT model needs expansion and further construction to investigate the factors that affect physician acceptance of CDSS.

The main question of this thesis is: what are the factors influencing the acceptance of CDSS in Saudi Arabia? This will be answered through use of the UTAUT and TTF models and by exploring additional factors through in-depth, semi-structured interviews. This will help to obtain a better understanding of the factors that influence CDSS acceptance in Saudi Arabia, as well as developing countries. This study will also contribute to providing rich information about the factors that can help HIS stakeholders and designers with its successful implementation.

Studies show that medical errors exist in diagnosis, as well as medication prescription. This highlights the importance of studying the acceptance of CDSS and its benefits in finding solutions to reduce and prevent medical errors by providing alerts, reminders and advice to the end user. In addition, this study will increase the relevant knowledge and information in the field of HIS in Saudi Arabia, and the ways in which it can be developed. Further, this research will contribute to the development of health care in Saudi Arabia, and increase the knowledge of opportunities and challenges in this field.

Chapter 2: Literature Review

2.1 Introduction

The first chapter presented and discussed the objective of this research. It also provides the background to the study, including the research methodology, an overview of CDSS and the three data collection stages. In addition, it outlined the investigation of the research problem and the study's importance.

This chapter will provide the history and beginnings of the decision support systems (DSS) will. It will then conduct a literature review regarding the importance and necessity of acceptance and adopting the CDSS. The literature review will present definitions from several studies to give a clearer picture of CDSS. In addition, the main challenges and opportunities in relation to the acceptance of CDSS and HIS will be introduced.

2.2 Decision Support Systems

A DSS is an interactive, adaptable and flexible computer-based information system that can be designed to support the non-structured management problems and improve decision-making processes (Jung, Tuan, Tran, Park, & Park, 2020). The initial idea to include a computer within a system to assist decision-making processes was first published in 1963 by Scott Morton (Bonini, 1963). The term 'decision support system' was introduced by Gorry and Scott Morton (1971). Over time, different scholars have attempted to further define DSS (Aqel, Nakshabandi & Adeniyi, 2011). In 1990, Turban defined it as an interactive, adaptable, and flexible computer-based information system that could be designed to support non-structured management problems and improve the decision-making process.

Zhang, Wang, Zhao, Cao and Wang (2012) defined DSS based on functionality and the use of a knowledge base for supporting decision-making processes in human resource management. However, the definition offered by Turban, Aronson and Liang (2005, p. 77) is the most inclusive. This proposed that a DSS was 'an interactive, flexible, and adaptable computer-based information system especially developed for supporting the solution of a non-structured management problem for improved decision-making. It utilizes data, provides an easy-to-use interface, and allows for the decision-maker's own insights'. A DSS is not designed to supersede decision-making autonomy, but rather to provide decision-makers with the tools and information required to make appropriate decisions (Aggarwal, Goswami, & Sachdeva, 2021). The DSS automates several tasks, including data analysis, required for decision-making processes (Nisheva-Pavlova, Mihaylov, Hadzhiyski & Vassilev, 2005).

Generally, a DSS consists of three main components: (i) the information store, which is the knowledge base; (ii) the reasoning engine; and (iii) the user interface (Iliadis, 2005). DSS enhances the quality of human decision-making: this can be significantly affected in complex cases or high-pressure businesses environments (Beecham, Noll, Richardson & Dhungana, 2011). Most DSSs provide straight-forward user interfaces that help people to obtain valuable data and information; they also have flexible tools that provide users with additional advantages, such as preparing relevant reports and charts (Duan & Xu, 2009). Further, according to Papandreou et al (2021), a DSS is characterised by several capabilities and advantages, including the discovery of errors, information extraction from data, providing accurate data and forecasting future events. In addition, a DSS assists to provide more reliable results, saving time and resources and reducing costs and potential risks (Mannina et al, 2019).

According to Mohammed, Hu, Obrenovic and Aina (2017), a DSS is a data-sorting and analysis tool that contributes significantly to extracting valuable information and knowledge, improving organisational performance. Sharing knowledge and information through available knowledge tools and systems results in effective decisions and improved work performance (Bojan, Slobodan & Akmal, 2015). Chan, Song, Sarker and Plumlee (2017) noted that using a DSS enables contributes to more accurate and faster information provision for decision-making. They also posited that DSS may help to convert the implicit knowledge of employees to explicit knowledge held by a company; this process supports and helps others through the sharing of experience and valuable information.

A DSS provides decision-makers with a possible set of finite alternative solutions to a specific problem; it is an interactive system that fully involves the user (García, Romero & Raventós, 2016). A DSS is designed with core models that include learning from previous experience, business policies and procedures and a manager's ideology. In this way, it can provide comprehensive, acceptable and reliable solutions (Idwar, Fernanda & Haryeni, 2016). It is crucial to understand that a DSS does not replace decision-making processes; rather, it is a tool that guides the final decisions made by managers (Idwar et al., 2016). Further, Mohammed et al. (2017) noted that DSSs have a major role in improving company performance, as they provide an essential competitive advantage.

A DSS will contribute to problem solving and can support complex decision-making by providing necessary and relevant information in addition to recommendations and advice (Al-Rahmi et al., 2019). It supports decision-making through offering alternatives, contributing to choosing the most appropriate solution (Riedel et al., 2011). DSS can help organise knowledge about complex, mysterious and disorganised issues (Riedel et al.,

2011). Other motives can also lie behind the adoption of a DSS, including the desire to avoid errors in decision-making and reduce costs. An additional and essential use of DSS is that it contributes significantly to user satisfaction and thus organisation satisfaction (Tavana, Mousavi, Mina & Salehian, 2020).

In this developing technological age, DSS have been implemented in multifaceted and complex decision-making scenarios in medicine (Njie et al., 2015; J. Yang, Kang & Lee, 2016), finance (Ouahilal, El Mohajir, Chahhou & El Mohajir, 2016), agriculture (Navarro-Hellín, Martínez-del-Rincon, Domingo-Miguel, Soto-Valles & Torres-Sánchez, 2016) and manufacturing (Kasie, Bright & Walker, 2017; Simeone, Luo, Woolley, Rahimifard & Boër, 2016). DSS can also be applied in human resource departments to aid the selection of appropriate resources, employment insurance options, the most effective training programs for employees and the appropriate assignment of tasks (Chatzimouratidis, Theotokas & Lagoudis, 2012). It can also be used by healthcare professionals to support clinical diagnoses (Christopher, Nehemiah & Kannan, 2015; Kunhimangalam, Ovallath & Joseph, 2014; Nazari, Fallah, Kazemipoor & Salehipour, 2018).

Knowledge-based DSS help organisations to develop and improve their performance, as well as enhance their capabilities and products (Meredith, Blake, Baxter & Kerr, 2020). DSS also promotes knowledge sharing between users and works to provide high-quality services to clients (Elshaiekh, 2016). Sharing experiences and knowledge among DSS users is the basis of a successful system (De Meo, Ferretti, Hujala & Kangas, 2013) Further, DSS contributes to enhancing the communication of knowledge between stakeholders and to evaluating and providing alternatives and solutions for some issues (Carmona, Varela-Ortega & Bromley, 2013). It enables access to relevant information

that helps direct decisions (Parker & Sinclair, 2001). DSS is also significant in supporting users to develop their learning skills and expanding their experience (Jakku & Thorburn, 2010).

User acceptance of IT is crucial to ensure the successful implementation and adoption of a DSS. Research into this area has been undertaken different fields, such as education (Al-Rahmi et al., 2019), marketing (Piya, Rahman & Shamsuzzoha, 2016), e-business (Ahmed, Qin & Aduamoah, 2018), manufacturing and production (Kalantari, Rabbani & Ebadian, 2011), strategic enterprise management (Olga & Tatyana Yu, 2011) and agriculture (Mir & Padma, 2020).

2.3 Clinical Decision Support Systems

2.3.1 Definitions and Overview of CDSS

A CDSS is a type of HIS (Balladini, Rozas, Frati, Vicente & Orlandi, 2015): a computerised information management system developed to help healthcare providers make effective decisions regarding patient treatment (Keine, Zelek, Walker & Sabbagh, 2019). CDSS is used for medical prevention, diagnosis and treatment, enabling better clinical decisions and providing better healthcare services. Healthcare providers are professionals working in clinical or non-clinical environments to deliver various healthcare and medical support services. CDSS can be useful for effective decision-making and support in both clinical and non-clinical practices (Pope, Halford, Turnbull & Prichard, 2014). CDSS is described as a computerised system, based on the reasoning of a situation, which assists physicians to assess disease during diagnosis and aid the selection of appropriate clinical decisions and therapies for the disease (Tsang et al., 2017).

Using CDSS can help reduce prescription errors and improve the process of healthcare services, as well as patient outcomes (Jia, Zhang, Chen, Zhao & Zhang, 2016). Pape et al. (2019) suggested that CDSS are not only designed to support decision-making, but also to provide therapeutic interventions (e.g. alternatives for informed support in treatment plan preparation). In CDSS, matching the characteristics of a patient with the computerised database is followed by software algorithms that generate specific information about the situation and the patient's status in the form of recommendations for assessments (Oluoch et al, 2012). The physician interacts with the CDSS, which analyses the patient's situation and condition, and predicts potential critical events, signs of disease, drug interactions and intolerance. The effective analysis of patient condition depends upon the combined knowledge of the physician and the CDSS. For instance, CDSS system may suggest treatment processes or diagnosis processes, and the physician will select the useful information and recommendations that fit to the cases from the system (Dankovicova, Drotar, Gazda & Vokorokos, 2018).

To understand CDSS more fully, Table 2.1 outlines the diverse definitions offered in the extant literature. These definitions have been provided by scholars researching CDSS in the healthcare environment.

Table 2.1. CDSS Definitions

Authors	Definition
Shortliffe and Cimino (2014)	Any type of program developed to support healthcare providers in clinical decision-making processes.
D. Lobach et al. (2012)	A set of tools specifically designed to provide recommendations based on analysis of patient characteristics.
Oluoch et al. (2012)	A computerised knowledge base with patient-specific symptom analysis algorithms used to produce patient-specific recommendations.
Stojkovska and Loskovska (2010)	An active intelligent system with enhanced analysis of patient-specific information and cross-referencing of patient symptoms with inbuilt medical facts for recommendations on appropriate clinical decisions.
Deperlioglu (2019)	A software that medical practitioners use to generate intelligently filtered results to enhance decision-making with recommendations provided by the system.
Nur Raidah Rahim, Nordin and Mohd Dom (2019)	Any computerised information added to the system to aid clinical decision-making processes.
Rezaei-Hachesu, Dehghani-Soufi, Khara, Moftian and Samad-Soltani (2020)	Computerised systems that aid clinical decision-making, where patient characteristics are matched to computerised knowledge to generate patient-specific assessments.
Ltifi, Kolski, Ayed and Alimi (2013)	Computer systems that help the decision-making process by performing data analysis, information storage and retrieval of procedural diagnostic tests.

Kim et al. (2012) asserted that evaluation and investigation of CDSS is needed in hospitals to improve drug safety and user satisfaction and provide better healthcare services. It is also important to develop and continuously research improvements to CDSS to provide the best quality health care and reduce care and treatment costs (Ahlan & Ahmad, 2014). Moreover, the focus should be on developing nations to alleviate the suffering of those who are less fortunate. It is vital to focus on developing countries because of their lack of medical personnel and resources. Research and development in

relation to CDSS in these countries may help to solve health problems and the lack of medical resources. Further, Akhloufi et al. (2019) recommended that CDSS implementation should be evaluated before its final adoption to improve and enhance CDSS safety and effectiveness. In addition, they suggested that priority should be given to the reliability of retrieving the most amount of information automatically from an HIS, as well as to providing clear and specific information for end users, avoiding confusing or irrelevant information. Another recommendation made was to add an 'unknown' option next to any question requiring a 'Yes' or 'No' answer to provide more useful information or related data.

2.3.2 The importance of CDSS

The clinical decision-making process is complex, and physicians make considerable efforts to reduce the gap between knowledge and practice. The incorrect interpretation of patient data, along with insufficient knowledge about medication, could lead to medication errors (Rahim, Nordin & Dom, 2015). Therefore, it is important to implement CDSS to improve both healthcare services and the quality of physician decisions. CDSS performs a key role in providing preventive measures and primary care for patients. The CDSS uses alerts for different clinical procedures; for instance, during blood pressure checks, it configures alerts for caregivers, recommends screening analysis methods and suggests vaccination against viruses such as influenza (Groenhof et al., 2019). Trafton et al. (2010) examined useability-optimised CDSS. The authors noted that CDSS helps to address barriers, such as insufficiencies in the provider's education, dosage calculation complexity and titration schedules and access to relevant patient information. CDSS can a positive effect on medical practitioners' work and practices, including their approach to diagnoses, alerts, disease management systems, drug doses and prescribing systems (Olakotan & Yusof, 2021). Further, these authors mentioned that CDSS have contributed

to improved medical practitioner performance. Adverse drug reactions are a concern when prescribing medications for some conditions. According to Tan et al. (2016), harmful drug interactions cause 100,000 deaths annually in the US, at a significant cost of about US$136 billion. Tan et al. (2016) noted that CDSS helps physicians avoid medications that may cause health problems through following alerts and recommendations.

Further, Chana et al. (2017) identified potential factors for prescribing current medications. The authors interviewed 12 GPs to investigate the use of CDSS in the United Kingdom (through semi-structured interviews). The study results indicated that not using systems to support decision-making around prescriptions can lead to errors due to omission or because of the large number of medical tasks and patients and the lack of necessary medical information. These errors include the inappropriate prescription of medication by non-specialist physicians, or prescriptions made without any review of the approved medical protocol. The authors pointed to the necessity and importance of adopting CDSS to support GPs in prescribing medications, especially specialised drugs, as this will contribute significantly to reducing medication errors and enhancing patient safety.

This type of decision-making support solution can also address the diverse needs and challenges affecting various healthcare sectors. Numerous research studies have concluded that CDSS can be essential in guiding healthcare decision-making (Grace et al., 2013; Lai, Sukhwal & Kankanhalli, 2020). However, research in HIS indicates that failures around CDSS implementation are apparent in several nations and this situation requires urgent attention (Pope et al., 2013). In particular, CDSS uptake by GPs is limited (Shibl, Lawley & Debuse, 2013). Therefore, identifying the barriers to CDSS use, as well

as how to support its adoption and acceptance by GPs is essential to provide better health care (Hellden, Al-Aieshy, Bastholm-Rahmner et al., 2015). AL-Fleit, AL-Ghamdi and Nassif (2019) indicated that having a CDSS may assist GPs in primary healthcare centres to diagnose cancer in patients. This suggests the importance and need to adopt CDSS for diagnosing pathological conditions at the early stages by doctors in primary health centres; this aids both diagnosis and the making of appropriate medical decisions.

Having an appropriate CDSS can be implemented could lead to improved decision-making and also promote the general safety of patients through improving adherence to antimicrobial guidelines (Saddler, Harvey, Jessa, & Rosenfield, 2020). With continuous improvement and updating of CDSS improves, both its own efficiency and the experience of healthcare professionals also improves (Meulendijk et al., 2016). The authors stated that although CDSS implementation is significant for medical practitioners, its acceptance is a relatively complicated matter involving numerous factors. It is therefore of interest to many nations. It is important to understand these factors when evaluating CDSS in the context of a developing country's healthcare sector (this includes Saudi Arabia). Further, the implementation and adoption of a CDSS contributes significantly to improving efficiency and enhancing outcomes by decreasing medical errors. However, a CDSS may fall short of its full potential as a result of a possible lack of acceptance by medical practitioners (Khairat, Marc, Crosby & Al Sanousi, 2018).

2.3.3 Advantages of CDSS

CDSS as used in healthcare units not only enhances the efficiency and effectiveness of physicians, but also improves service quality (Esmaeilzadeh et al., 2014). However, in relation to cost it should be noted that expenditure on CDSS development is undoubtedly high (Kosmisky, Everhart & Griffiths, 2019). Dalaba et al. (2015) noted that, despite its

high costs, CDSS is nevertheless effective and has valuable results. Furthermore, CDSS can be designed in way that incorporates the latest patient information and particular clinical data to produce particular results and summary reports, as well as alerts of possible interactions between medications (Gangula, Thalla, Ikedum, Okpala & Sneha, 2021). A doctor's professional abilities can likewise be enhanced through these systems (Lobach, 2016). Ahn et al. (2014) highlighted the need for specific standards to ensure CDSS quality, which may lead to improved knowledge about medical services and healthcare, as well as ensuring proper use. De Wit et al. (2015) noted three elements that are vital to CDSS improvement: (1) algorithm construction; (2) optimisation; and (3) data delivery.

CDSS assists physicians to increase their knowledge of dosing through its tools and features. Therefore, CDSS can be used effectively to provide advice on patients cases and suggest treatment, as well as provide accurate diagnoses in complex or rare cases (Shemeikka et al., 2015). CDSS are designed to produce valuable information and guidance in real time to healthcare practitioners (Shilaskar, Ghatol & Chatur, 2017). Applying computerised technologies in HIS will support physicians in providing more accurate results and rapid diagnoses (Thiyagaraj & Suseendran, 2018). It is also important to consider effective CDSS design, which can help healthcare professionals in their diagnostic decision-making (Babione et al., 2020). Holstiege et al. (2015) evaluated the influence of using CDSS in enhancing antibiotic prescriptions in primary patient care. The results suggested that CDSS provides a significant positive outcome regarding antibiotic prescriptions in primary care. The authors stated that more research was required on CDSS design in its ability to enhance acceptance and adoption by end users and improve antibiotic prescribing. Further, CDSS features have contributed positively to the management of depression in patients in several aspects, such as examination,

diagnosis, therapy, improvement in symptoms, better health care and required patient referrals. (Trinanes et al., 2015).

CDSS has a wide range of use across various treatments. For instance, CDSS has been used successfully in the treatment of various kinds of cancers (Ehtesham et al., 2017). Ehtesham et al. (2017) suggested that applying strategies of machine learning can assist with data management and improvements in the diagnostic improvement of oral squamous cell carcinoma more effectively and accurately. Another example is CDSS's effective role in examining depression medications that may have a mental health risk: practitioners can recognise how low or high doses of these medications relates to harm or effects on psychological health (Miller, Carreno, Burns, Kapusnik-Uner & Matuszewski, 2017). CDSS also contributes to providing information, advice and assistance to pharmacists' decision-making regarding customer enquiries. Downie et al. (2020) developed a CDSS that provides advice and related information to pharmacists, enabling them to assist people with lower back pain. This system, backed by clinical practice guidelines, helps pharmacists by providing evidence-based information. The study results indicate the high acceptability and useability of CDSS. The authors confirmed a 90% agreement among pharmacists (18/20) for using CDSS, with medication recommendations at 100%, and as a referral advice 88% (22/25). Moreover, the study participants recommended developing the user interface and providing more information. Rasoolimoghadam, Safdari, Ghazisaeidi, Maharanitehrani and Tahmasebiyan (2015) showed that CDSS can assess how medications interact with each other, reducing Type 2 diabetes drug errors, decrease the costs related to adverse medications and enhance healthcare quality. The study's results highlighted the importance of factors such as satisfaction levels and ease of use. Danial-Saad et al. (2015) stated that CDSSs have the potential to enable less-experienced healthcare practitioners improve their professional

performance. Further, CDSS reduces the risks that can affect patient mortality rates and the length of hospital stays (White, 1996). Yılmaz and Ozdemir (2017) also found that CDSS encouraged nurses' decision-making regarding patient requirements and arrangement of care plans.

2.3.4 CDSS characteristics

A CDSS is designed to promote decision-making processes in clinical studies on the basis of individual patient characteristics, a computerised database of knowledge, and through recommendations based on software algorithms (Rittmann & Stevens, 2019). Physician experience and CDSS practice guidelines are used to create and build on existing knowledge (Cánovas-Segura, Morales, Juarez, Campos & Palacios, 2019). Medical practice expertise and CDSS supplement each other through an increased augmented intelligence that will provide beneficial decision-making for both physician and patient (Pape et al., 2019). The CDSS is based upon three fundamental components. The first is the knowledge compiled through the inclusion of complete information about clinical domain knowledge, an organisation's guidelines and different protocols. The second is the inference engine that connects the knowledge to the information used in decision-making processes and in data reasoning processes. The third is a user interface that presents the data and information input and output; for instance, suggestions, recommendations and the presence of alerts (Rahim et al., 2015).

The CDSS provides a number of different tools, such as automated warnings or alerts, reminders, graphic summaries of complicated details, models for reporting, relevant reference information, clinical guidelines and diagnostic test results (Pereira et al., 2019). Further, a CDSS can be processed with other devices to reveal biomedical signals; for instance, electroencephalograms (EEG) and electrocardiograms (ECG), or it can be used

in conjunction with health records to support clinical decisions (Dankovicova et al., 2018). In addition, a CDSS can process, retrieve and analyse the available information and a patient's previous history to make decisions appropriate to the situation. The goal of the CDSS is not to replace physicians. Rather, it is to help physicians make decisions and provide support through streamlining this process, as well prevent mistakes in the decision-making process by providing early warnings (Amland & Hahn-Cover, 2016).

Mokati and Gadicha (2017) found that CDSS uses data mining, and they indicated that it contributes significantly to an accurate diagnosis. They also note that this supports patient data privacy through encryption technology. A healthcare provider can outsource remotely through external servers on the Internet to provide effective and accurate clinical decision support. However, the privacy and security of patient data may be at risk when using external servers. Rahulamathavan, Veluru, Rajarajan, Phan and Chambers (2014) confirmed that patient information in CDSS can be encrypted. Therefore, data and patient privacy are protected when hospitals store information in external server sources or cloud computing services, where third parties cannot recognise or decrypt the data. Many CDSS include alerts that can inform physicians or users about a recommendation or vital information. This is a knowledge-based system and it is therefore necessary to update the system and its database to offer high-quality health care to patients, founded on evidence-based medicine (Breighner & Kashani, 2017).

The most prominent characteristic of the CDSS is a clinical, knowledge-based dependence. It integrates the knowledge in the system with patient data in EHR to provide directions, recommendations and alerts (Trinanes et al., 2015). The noticeable expansion in HER implementation in primary healthcare centres has contributed to the widespread implementation and adoption of CDSS, which creates the opportunity to provide and

afford better, evidence-based health care (Minian et al., 2019). CDSS play a vital role in the integration of HER, assisting medical services professionals to organise data and improve the efficiency of information collection (Miller, Anders, et al., 2015). The CDSS quality proposals rely upon the EHR data quality (Liaw, 2013). Shirazian, Maesaka, Imbriano and Mattana (2014) determined that integrating CDSS with EMR contributed to better care for diabetics and patients with related chronic kidney diseases. Further, CDSS can identify patients with chronic kidney disease and prevent and reduce medication side effects. A CDSS can also identify patients who do not respond to treatment and provide recommendations to aid in their treatment, and involve them in understanding their condition and treatment plan (Shirazian et al., 2014).

2.3.5 Examples of CDSS

Several studies have shown that CDSS has a positive effect on the treatment of many medical conditions, such as diabetes (Sim, Ban, Tan, Sethi & Loh, 2017), heart disease (Nazari et al., 2018), asthma (Harber, Redlich, Hines, Filios & Storey, 2017), cancer (Ehtesham et al., 2017), hypertension (Anchala et al., 2015), depression management (Aragones et al., 2017), psychiatric disorders (Koposov et al., 2017) and allergic rhinitis (Christopher et al., 2015). This comprehensive application shows that CDSS can been used effectively for multiple medical conditions, with the potential to improve health care both dramatically and globally.

Tundjungsari, Sofro, Sabiq and Kardiana (2017) identified several examples of CDSS applications, such as ATHENA, ISABEL and LISA. ATHENA is a CDSS software application that helps users identify which guidelines support patients with hypertension. ATHENA assists patients to manage their blood pressure and recommends suitable and relevant treatments. ATHENA also provides information about hypertension medicines

and protocols regarding hypertension control. The same study also mentioned ISABEL, an internet-based application for doctors. ISABEL's database includes extensive medical knowledge and information, such as internal medicine, surgery and paediatrics. ISABEL helps users find an appropriate diagnosis by analysing symptoms and test results, and then dispensing medical and pharmacological advice. A third CDSS application is LISA, a medical application that contains all patient data, including treatment schedules and test results. It also contains a decision support unit, which provides users with tips for treatment dosage and assists in preparing long-term treatment plans. In this way, LISA contributes significantly to reducing medical errors. Further, Danial-Saad, Kuflik, Weiss and Schreuer (2015) investigated the Ontology-Supported Computerized Assistive Technology Recommender (OSCAR), which assists clinicians to make use a prescription system efficiently. OSCAR supports physicians in learning about and achieving greater efficiency in their decision-making processes. The mentioned study concluded that OSCAR was effective because novice users showed an overall efficiency, thus indicating its positive effect.

2.3.6 Challenges of CDSS

Despite the importance of its use and benefits, CDSS is not without risk (including both system failure and misuse). When developing CDSS, it is vital to ensure the application is error free and without shortcomings because it is a technology that provides advice and recommendations for patient care. Therefore, an important factor in CDSS effectiveness is the amount of data and knowledge it can store (Syomov, Bologva, Kovalchuk, Krikunov, Moiseeva & Simakova, 2016). A lack of sufficient information, or an error in using the information has the potential for misdiagnosis or incorrect procedures. These can both adversely affect patient wellbeing and health (Castillo & Kelemen, 2013). Therefore, the CDSS program must be tested multiple times by experts to ensure the

integrity and validity of data flow and to provide a safe work environment. One of the challenges of CDSS is the repetition of alerts, and the emergence of unrelated alerts, due to drug dosage adjustment and the absence of a specific drug (De Wit et al., 2015). De Wit et al. (2015) asserted that it was important to develop and improve systems continuously to ensure their efficiency and effectiveness. Castillo and Kelemen (2013) indicated that CDSS had a greater likelihood of negative, rather than positive consequences, especially if the system does not function optimally. According to Castillo and Kelemen (2013), these issues could 'significantly slow down the workflow, efficiency, quality and safety in the delivery of patient care (p. 321)'.

Because of the changing healthcare industry, some studies have examined what factors to consider when developing and implementing CDSS applications. Esmaeilzadeh et al. (2014) suggested that the positive acceptance of CDSS by physicians will support the successful implementing of CDSS. It is important to identify the core reasons for using CDSS and how CDSS may serve basic purposes. Khong, Holroyd and Wang (2015) found that many factors affected a physician's use of CDSS. These included the concepts relating to clinical information systems, individuals, organisational and personal factors (Kilsdonk, Peute & Jaspers, 2017). Moreover, Lugtenberg, Weenink, van der Weijden, Westert and Kool (2015) identified three barriers to using CDSS: (1) user knowledge of the system; (2) users' assessment of system features, such as its functionality, format or content; and (3) CDSS interaction with environmental or patient-related factors (external factors). Lugtenberg et al. (2015) highlighted commonly perceived barriers, such as insufficient knowledge of CDSS by users, many unnecessary alerts, the technical support required, time factors around operating CDSS, the CDSS's learning capability, communication and the time spent with patients. Gurupur and Gutierrez (2016, p. 7) noted

these factors comprised an: '(a) adherence to statutory regulations; (b) ease of use and access; and (c) protecting patient data from malicious use'.

A number of developing countries face challenges and concerns around the adoption of CDSS. A significant issue for HIS developers is medical practitioners' perceived professional independence (Sambasivan et al., 2012). Implementing CDSS in rural health care in developing countries faces challenges such as power failures, insufficient technical knowledge of the system and problems in interpreting the generated information (Zakane et al., 2014). Other significant obstacles may also exist. These include the high number of alerts, the cost of introducing CDSS into healthcare practice settings, and the potential negative effects on privacy, confidentiality, data accuracy and alert desensitisation (Gullapalli, Brungi & Gopichand, 2015). One study has examined the challenges facing the adoption of HIS in Saudi Arabia from the perspective and experience of medical professionals (Khalifa, 2016). The results indicate that challenges can be listed from the most to the least important are as follows: financial and organisational challenges. The authors highlight the importance of seeking experienced help from external sources to implement and examine HIS, along with the importance of working on compatible workflows to ensure the health application's success. They add that it is necessary to define a time frame for the implementation process and allocate appropriate budgets for the various stages of system implementation. The technical challenges faced by clinical staff were shown to be potential barriers to CDSS use in this particular context. Another barrier relates to the cost of technology; for example, the costs of acquiring devices and providing relevant training can be prohibitively expensive (Khalifa, 2016). Roshanov et al. (2013) found that requesting reasons from physicians before overriding providing advice and recommendations from the system might improve chances of success. These authors also suggested that CDSS developers should have

detailed knowledge about the use of CDSS and the settings of its assessment. Also, they recommended the patients be involved in using the system, for example, through the Patient Portal in order to take advantage of the medical advice available.

The lack of interaction between end users and the system is a problem that affects CDSS acceptance. In relation to physicians and CDSS regarding decision-making, this lack is a major reason for its poor implementation and use (Miller et al., 2015). The difficulties of using CDSS can result in an unsuccessful implementation (Jung et al., 2020). Further, Laka, Milazzo and Merlin (2021) indicated that participants in their study (doctors in a hospital and primary care centres in Australia) confirmed the important role played by the system's useability and flexibility in its uptake. In addition, if the CDSS provides insufficient information or if a user lacks knowledge of how to use it most effectively, the outcomes may be negative. (Castillo & Kelemen, 2013). Wright et al. (2016) found that CDSS malfunctions can go unnoticed and may persist for long periods, for several reasons including software upgrades, modifications to codes and fields, and unintentional deactivation. On the other hand, Johnson et al. (2015) concluded that data entry may be difficult with CDSS, and structural and practical obstacles to effective use were also present. A major shortcoming of a CDSS is that it may not have characteristics that are compatible with other operational programs (Marcos, Maldonado, Martínez-Salvador, Boscá & Robles, 2013).

2.3.7 Factors influence the acceptance and adoption of CDSS

Grout, Cheng, Carroll, Bauer and Downs (2018) investigated physicians' long-term CDSS acceptance**.** They highlighted some CDSS tools that have contributed to supporting short-term user acceptance. These include actionable suggestions and advice, integration of the CDSS with electronic health records (HER), physician feedback and comments

and active technical support teams. In addition, the authors also mentioned the continuous improvement of system quality, end-user support and patience are all critical to achieving long-term CDSS use. Jeng and Tzeng (2012) explored how social influence concerns may affect medical practitioner behavioural intentions regarding their practice around using a new CDSS. This study implemented a decision-making trial and evaluation laboratory to examine the causal connection, using variables from Venkatesh et al. (2003) UTAUT. The authors noted that the social influence factor was not considered important regarding medical practitioner behavioural intentions to use CDSS.

In general, a CDSS can positively influence physician performance and behaviour, which will lead to better healthcare services. Chang, Hwang, Hung and Li (2007) discussed the implications of CDSS acceptance in relation to its ability to support healthcare practitioners to use and apply the technology. The authors listed three elements an organisation needed before CDSS would be accepted: (1) enhance the utility and improve the display of technology; (2) improve performance strategy and provide technical assistance, along with training; (3) produce an innovative climate to enhance the intention of healthcare practitioners to use the new technology. In addition, Esmaeilzadeh et al. (2015) indicated that for the effective and successful adoption of CDSS in a developing country, a number of factors should be considered. These include: (1) that CDSS supports the exchange of knowledge between specialists and their subordinates; (2) that it engages medical practitioners as they decide on treatment and diagnoses while simultaneously using CDSS; (3) that it provides appropriate training for doctors; and (4) that it adopts a CDSS that gives doctors opportunities to cooperate and engage with the application when making medical decisions.

Liberati et al. (2017) investigated obstacles and facilitators, to understand the approach of different health professional users in hospitals towards adopting CDSS. The authors applied a qualitative method to collect data through in-depth interviews with 30 participants, including physicians, nurses, IT staff and board members, using semi-structured interview questions. The authors noted that medical practitioners perceived that a CDSS could decrease professional autonomy or could cause medical or legal problems. The authors also mentioned that it was essential to consider factors such as medical practitioner attitudes regarding scientific evidence and guidelines, the quality of relationships between disciplines, and organisational issues of transparency and responsibility regarding the provision assistance. All of these factors affected practitioner willingness to adopt CDSS.

Devaraj, Sharma, Fausto, Viernes and Kharrazi (2014) identified and classified the possible obstacles and facilitators that influence clinical practices by adopting CDSS. Several scientific databases were searched to identify relevant articles that discussed these issues: 26 articles were identified. The authors constructed a list classified under the four determinants of the UTAUT model. The authors noted that:

> [a] lack of time or time constraints, economic constraints (e.g., finance and resources), lack of knowledge of system or content, reluctance to use the system in front of patients, obscure workflow issues, less authenticity or reliability of the information, lack of agreement with the system, and physician or user attitude toward the system'. (Devaraj et al., 2014, p. 36)

They stated that a more comprehensive qualitative study that sought and explored further factors that affected the use of CDSS was necessary.

Rahimi, Moghaddasi, Kazemi, Rafsanjani and Bahoush (2019) assessed the effect of using CDSS in prescribing chemotherapy. They conducted a systematic review of

previous studies to obtain more knowledge regarding the satisfaction and acceptance of end users and to identify related aspects. The results revealed the effectiveness of using CDSS in prescribing chemotherapy in terms of reducing medication errors, especially when calculating the appropriate dose and CDSS use also contributed to reducing treatment times. The study results also highlighted the importance of conducting more high-quality research to improve satisfaction levels and user acceptance in relation to CDSS. They also recommended conducting both qualitative and quantitative studies to identify and discover the influences of CDSS acceptance and use.

Esmaeilzadeh et al. (2014) indicated that studies around the acceptance of CDSS adoption are limited, especially those focusing on physician perspectives. These authors aimed to identify and gain a better understanding of the determinants that influence physician acceptance of CDSS. They found significant factors in medical practitioner acceptance of CDSS, and their intention to use the technology, including the threat to professional autonomy, the perceived interactivity with HIS, its usefulness and the ease of use.In addition, Zakane et al. (2014) investigated the perceived requirements and perspectives amongst healthcare employees to reach WHO guidelines using CDSS in maternal and neonatal care in rural Burkina Faso (Africa). The CDSS used had four components: (1) physician interface; (2) database; (3) algorithms to review recorded clinical data in the database; and (4) training and knowledge documentation regarding the application of WHO guidelines for maternal and neonatal health care. Forty-five informants were interviewed using semi-structured interviews in two rural districts. The results showed: (a) the desire of the study's participants to adapt and adopt modern technologies; (b) a positive attitude towards easy access to guidelines and the benefits from decisions and support; (c) a concern that the CDSS may take too much time to use; and (d) an attitude that the CDSS was complex and requires significant training. The authors noted that there

was a need to continuously follow up the fit of the CDSS with user needs, to achieve successful implementation.

Ritter (2019) examined possible future artificial intelligence (AI) users in the healthcare sector. The author sought to identify the factors that affected users' behavioural intentions to adopt AI. The author examined the UTAUT model factors, along with trust, perceived risk, anxiety and attitudes toward AI. The results indicated that social influence and trust significantly affected the participants' behavioural intentions to use AI, and that facilitating conditions were important considerations that influenced behavioural use. The author noted that the UTAUT model was weak when studying and examining the acceptance of AI in the health domain. Therefore, Ritter (2019) recommended conducting further studies to identify new factors through changes to the UTAUT model. Alternatively, a new model could be developed that would contribute to finding solutions and ideas for developers of AI applications, assisting with successful adoption and implementation of AI in health.

Moxey et al. (2010) investigated the obstacles and facilitators that influenced the uptake of CDSS when used by medical practitioners to guide decisions around prescribing medications. The authors conducted an in-depth systematic review and concluded that the factors influencing CDSS use included: hardware availability; system integration into workflows; proper training and technical support; and the aptness of clinical messages. They confirmed the need for greater communication levels with end users to identify the pre-implementation factors that affected the use of CDSS. Further, Rahmner et al. (2012) assessed the perceived needs for information about medications among doctors in Sweden. The information was collected using a qualitative method, conducting three focus groups with 18 physicians from three different disciplines. The study indicated that

the participants wanted to know about a system that would contribute to their decision-making in terms of dispensing drugs and to their awareness of the doses and side effects, also obtaining necessary alerts in cases of inconsistency. The participants also suggested that there was a need to communicate with colleagues and make medication information more searchable through the CDSS. They added that most requisite information regarding medications could be conveyed in a current summary of medication product characteristics from the CDSS.

Zakane et al. (2017) piloted the CDSS in six rural maternity units in Burkina Faso. Reports were prepared after two years of CDSS use; these showed that the CDSS was not used regularly in healthcare practice. This study wanted to identify the reasons why healthcare workers failed to use CDSS. The CDSS was designed to assist and support health professionals in maternal and newborn care in rural Burkina Faso. The system included the World Health Organization's (WHO) guide to maternal and newborn care, which contains a list that assists in storing and managing patient data, alert features and recommendations based on algorithms that rationalise the CDSS user. Workshops and discussions were held with 13 participants to identify the relevant issues that affected their use of the CDSS and to consider their suggestions to improve the CDSS. The participants identified some restrictions affecting their use of the CDSS, including power supply problems, ease of use, the CDSS not being integrated into workflows and employees lacking incentive to use the technology. Conversely, the study participants also highlighted the benefits of using the CDSS. These included learning from alerts and guidance provided by the CDSS, which resulted in preventing and reducing errors and avoiding harmful situations. The authors indicated that it was necessary to conduct an in-depth study to understand the needs of end users, and that this should occur during the

process of designing the CDSS. This will result in better acceptance of the system, and increase the ability for continuous evaluation by the implementer.

In an evaluation of the use of a renal CDSS, its effectiveness concerning drug doses and the satisfaction of GPs in relation to this, Hellden, Al-Aieshy and Bergman et al. (2015) examined the focus group responses of eight GPs from primary care centres. The GPs acknowledged the speed and ease of use of the renal CDSS in their work and confirmed their desire to continue to use it and also to recommend it. The authors also suggested that the CDSS contributed to providing high-quality healthcare services and valuable outcomes for GPs in primary healthcare centres.

Bawack and Kamdjoug (2018) reviewed the effectiveness of UTAUT in identifying the determinants that influenced HIS accreditation by medical practitioners in developing countries. Their case study focused on Cameroon. The authors reiterated that there has been very little research regarding the acceptance of CDSS in developing countries. They stated that the UTAUT model performed poorly when investigating the variance in physicians' intentions to use HIS. The results showed that the initial UTAUT was not adequate in defining constituents that affected HIS accreditation by medical practitioners in developing countries. They also found that younger doctors were more willing to adopt HIS compared with older practitioners. They concluded that user acceptance and use was a critical factor in HIS accreditation. They concluded that it was necessary for researchers to use additional factors through modifications in the UTAUT model to enhance its explanatory power and competence in developing countries.

2.4 Contribution to knowledge

The above literature contributed to formulating the goal of the study and the main research question by delving into the relevant studies into the factors that affect the physician's acceptance of the CDSS. Previous studies discussed in this chapter regarding the CDSS and related HIS, have indicated the importance of research on CDSSs to provide better healthcare services. Studying CDSS acceptance contributes significantly to understanding the factors that help GPs to approve of and thus successfully implement the CDSS. This is especially important in developing countries because of the need to provide greater medical care and help make more informed medical decisions.

Focusing on GPs is vital because they are usually the first to see patients at the beginning of an illness, before they are referred to specialists and medical consultants. The lack of medical knowledge in some medical specialties, and the large number of patients who see GPs, suggests that it is necessary to adopt medical systems to aid appropriate medical decisions, such as diagnoses, calculating medication doses and developing future treatment plans. Studying GP acceptance of the CDSS can therefore contribute to the design of medical systems commensurate with the needs and requirements of GPs' tasks. In addition, investigating the opportunities and challenges from the physician's point of view regarding the CDSS enables to support the successful adoption of the system. Moreover, the studies indicate the importance of building or developing a model based on qualitative research in order to identify the factors that affect the acceptance of the CDSS.

2.5 Chapter Summary

This chapter has reviewed the literature regarding DSSs, followed by a detailed review of the literature regarding CDSSs. The various definitions of CDSSs, as well as their main advantages, disadvantages and challenges have been identified in these studies. This

chapter has explained the role and benefits of DSS in various areas and has examined how DSSs have contributed to obtaining useful information that assists decision-making. This literature review has also discussed the role and importance of adopting CDSS in health care by investigating relevant studies that examined the advantages, opportunities and challenges of CDSSs, as well as the organisational environment.

These studies have shown that CDSS contributes to the reduction of medical errors, provides necessary alerts to physician, reduces the cost of health care in the long term, provides accurate information and data, provides recommendations and directions to users, and helps to propose and present treatment plans to patients. Moreover, a lack of sufficient information, or the failure to use that information, creates the potential for misdiagnosis or incorrect procedures, which could adversely affect patient wellbeing and health. Additional challenges to the adoption of CDSS in developing nations include power failures, insufficient technical knowledge of the system, and problems in interpreting the information generated by the CDSS. There are also principal obstacles possibly connected with the CDSS: the large number of alerts, the high cost of combining CDSS in healthcare practice settings and providing relevant training. In addition to the need to overcome these external obstacles, a failure to investigate the factors affecting the acceptance of CDSS based on the GP's perceptions, will contribute to implementation failure.

In this chapter, the literature review related to the factors affecting CDSS acceptance were also reviewed. Several factors that affect CDSS acceptance, as mentioned in these studies, include attitudes, the medical practitioners' perceptions that CDSS may reduce their professional independence, economic constraints (such as funding and resources), lack of knowledge of the CDSS or its content, issues with information reliability, perceived

interactions with medical IT, perceived benefits, and ease of use and training. However, the previous studies above confirmed that it is necessary to investigate the factors that contribute or hinder the doctor's acceptance of the CDSS, especially in developing countries due to their need to improve the quality of medical care. Hence the main research question which was "What are the factors influencing the acceptance of CDSS in Saudi Arabia?" was designed. Saudi Arabia was chosen because the relevant studies indicate the need for Saudi Arabia to study and investigate the health systems that used. The aim is to understand the opportunities and challenges in the system from the doctor's point of view and to help design a system that matches the aspirations and desires of the doctors as end-user. Secondary questions have also been added that help to reach the answer to the main question. Additional questions included:

• What benefits can GPs acquire by using the CDSS in Saudi Arabia?

•What are the obstacles to GP acceptance of CDSS in Saudi Arabia?

• How can the use of CDSS contribute to the promotion and development of health care in Saudi Arabia?

In addition, the previous literature confirmed the need to develop a theory that contributes to the understanding of the factors that affect the physician's acceptance of the CDSS. Some studies indicated the poor performance of the UTAUT model and the need to extend it by conducting qualitative studies.

Providing a more comprehensive qualitative study that explores the factors influencing CDSS use is important to identify clear and specific strategies that will contribute to its successful implementation. Future research is also required to identify additional factors

while modifying the UTAUT model to enhance its explanatory power and efficiency in developing countries preparing to use CDSS.

Chapter 3: Overview of Saudi Arabia

3.1 Introduction

This chapter provides an overview of Saudi Arabia, outlining the country's economic, educational and health situation and in particular the role of *Saudi Vision 2030* in the country's development. The chapter also discusses the current state of HIS, EMR, social networks, cloud computing, mobile health (m-Health) and CDSS in Saudi Arabia.

3.2 Saudi Arabia

Saudi Arabia is one of the largest countries in the Middle East, with an area of more than 2,150,000 square kilometres. It has a strong economy, with the world's richest oil reservoirs (Ministry of Foreign Affairs, 2017). The total annual budget for 2021 is estimated to be 849 billion Riyals (US$226.39 billion); this is expected to reach 864 billion Riyals (US$ 230.39 billion) in 2022, and 928 billion Riyals (US$ 247.45 billion) in 2023 (Ministry of Finance, 2021).

The health sector has received generous support from the government, with expenditure for the Ministry of Health in 2020 amounting to almost 75.5 billion Riyals, which is more than $US20 billion (Ministry of Health, 2021). Saudi Arabia has 504 hospitals, with around 78,596 beds, and 2,257 healthcare centres (Ministry of Health, 2020). The government aims to support the development and upgrade of healthcare. As noted in *Saudi Vision 2030* (Saudi Vision 2030, 2016), a vital objective is to improve healthcare services through effective technologies. Public healthcare services are free for Saudi Arabian citizens (Salloum, Cooper & Glew, 2015). The government supports the development and upgrade of healthcare; one of its vital objectives is to develop effective technology-enabled healthcare services (Saudi Vision 2030, 2016).

3.2.1 *Saudi Vision 2030*

Saudi Vision 2030 is a strategic plan by which the Saudi government aims to reduce the country's excessive dependence on oil and diversify its income sources by using its available resources and capabilities. Through this plan, the country seeks to improve its economic, developmental, health, technical and educational situation, as well as to encourage the maximum exploration of competitive resources that will encourage economic growth. By identifying the needs of all economic sectors, *Saudi Vision 2030* ensures that economic developments in the country are considered. This is facilitated by identifying Saudi Arabia's objectives, general directions, goals and policies. According to Saudi Vision 2030 (2016), Saudi Arabia will extend the bridge of international business between three continents; namely, Africa, Asia and Europe. Saudi Arabia's geostrategic position enables it to promote and stimulate global trade. One of the plan's is to promote and facilitate increased private sector expenditure, as this will enhance service provision (Vision 2030, 2021). The government is keen to increase the number of skilled workers in Saudi Arabia through capacity building to maximise the number of citizens who participate in available economic opportunities (Saudi Vision 2030, 2016).

Saudi Vision 2030's operational plan will empower the private sector through privatising government healthcare services. This strategy is expected to increase private sector contributions by 35% in 2020, up from the current 25%. This initiative is aimed at improving the efficiency of healthcare services at all three levels (primary, secondary and tertiary) by increasing the capacity of healthcare facilities. The program hopes to encourage international participation from relevant organisations that may consider investing in the country's healthcare system. The government intends to increase

technology use in the health sector. This will be facilitated by investing in digital transformation and IT infrastructure.

3.3 Health Information System in Saudi Arabia's Primary Healthcare Centres

HIS is currently widespread among healthcare service providers. This contributes to the effective organisation of patient data, which may lead to new knowledge acquisition (Nesheva, 2019). Heart, Ben-Assuli and Shabtai (2017) defined HIS as any clinical information system that manages and stores patient data electronically. Daud, Hoon, Abushaar, Husain and Othman (2019) provided another definition: 'an integrated electronic system that is used for storing, collecting and restoring any patients' data needed such as registration information, medical history, lab results, previous diagnosis, billing and any other related hospital procedures' (p. 107).

In Saudi Arabia, patients are initially admitted to a primary healthcare centre. However, they will be transferred to hospitals if their condition needs more intensive medical attention. Primary health care is the basis of Saudi Arabia's comprehensive health coverage. It is therefore important to evaluate its performance and identify the challenges and opportunities that contribute to providing and providing better quality health care (Al Asmri, Almalki, Fitzgerald & Clark, 2020). According to Alyasin and Douglas (2014), most patients who attend hospital emergency departments in Saudi Arabia do not have urgent problems: this results in overcrowding, long queues and delays in delivering services to more acutely ill patients. The major reason for most patients visiting emergency departments is the lack of trust in primary healthcare centres regarding the quality of services offered: these are considered substandard (Alyasin & Douglas, 2014).

Paper-based records are still used in some primary healthcare institutions managed by the Ministry of Health. At the same time, IT is seldom exploited Almaiman, Bahkali, Alfrih, Househ & El Metwally, 2014). Nevertheless, basic primary healthcare revamps positively associated with the usage of new HIS are affected, thanks to recent policy initiatives.

Al Asmri et al. (2020) noted that the primary healthcare system in Saudi Arabia needs reform. Their study results suggest that challenges in the healthcare system require appropriate solutions, including 'scope, structure, infrastructure, finance, increased demand, increased costs, workforce, inequitable access to the services, concern regarding the quality and safety of services, a growing burden of chronic diseases, information system, management and leadership issues, as well as gaps in the current referral system' (Al Asmri et al., 2020, p. 473).

Almaiman, Bahkali, Alfrih et al. (2014) investigated the use of HIS among primary healthcare centres in Saudi Arabia. The results demonstrated that the use and application of HIS in primary healthcare centres is in the early stages, although it continues to grow. They note that issues must still be addressed, such as taking a realistic approach to implementing HIS in primary healthcare centres and addressing the obstacles to IT implementation. In a study conducted at the general clinics of primary healthcare training centres in Abha City, patients were not satisfied with their experiences of healthcare consultations. (Tabekhan, Alkhaldi & Alghamdi, 2018) According to the interview data, 53% were dissatisfied, 27% were neutral, and 20% were satisfied. The authors concluded that physicians at these centres should increase patient satisfaction through improvements to their medical consultation services. According to Al-Khaldi (2013), physicians at primary healthcare centres in the Aseer City need more training concerning patient safety. Therefore, it may be important to adopt CDSS, which can contribute significantly to

enhancing patient satisfaction and supporting physicians in providing more accurate and appropriate medical consultations (Shaker & Samir, 2014).

Sandars and Esmail (2003) identified the nature and frequency of errors in primary healthcare centres. This study showed that medical mistakes occurred from five to 80 times per 100,000 of medical visits and are overwhelmingly connected to medical attention and diagnosis. However, medication mistakes are estimated to occur in about 11% of the total number of medical prescriptions. Khoja et al. (2011) determined that doctors' prescription errors were estimated a 19%: this study was conducted in a primary healthcare centre setting in Riyadh City. Al Ali and Elzubair (2016) stated that 49% of patients interviewed in 2013 at a primary healthcare centre in Dammam were not satisfied with physician communications. In Riyadh, another study evaluated patient opinions regarding the existing quality of primary health care; this study revealed that patients did not trust the services that provided (Alzaied & Alshammari, 2016). This study suggested that continuous development and training was required to increase staff performance and help to regain trust in those services.

Senitan, Alhaiti and Gillespie (2018) evaluated the electronic referral system 'Elahlati', which is used in some primary healthcare centre (*elahlati* is an Arabic term meaning 'my referral'). Nineteen doctors were interviewed across 15 primary healthcare centres in Riyadh, using semi-structured interviews. The results of this study indicate that the approved referral system was much less effective than was ideal in integrated care. The participants reported that there was no feedback in the system; that is, doctors did not know about patient conditions or diagnoses after referring the patient to a hospital, nor could doctors track patient conditions unless the patient informed them. The authors highlighted the importance of improving the referral system, training physicians in

primary health care, increasing awareness of feedback from hospitals. They also recommended that patients be involved in assessing the electronic referral system.

Aljarullah, Crowder and Wills (2017) investigated the factors that may influence primary care physician acceptance of HER. The authors noted that factors with a significant influence on physician acceptance of EHR include 'attitude, perceived usefulness, perceived ease of use, social influence, computer self-efficacy, perceived threat to physician autonomy, confidentiality concerns, and physician participation' (Aljarullah et al., 2017, p. 49). The authors also recommended that considering these factors will support policy makers significantly in their quest to facilitate and improve EHR implementation. Furthermore, Alzghaibi (2019) investigated the wide implementation of EHR in primary healthcare centres. The author indicated that no previous research had examined the implementation of primary healthcare centres. The results indicated that there were good primary healthcare facilities at both the organisational and individual level. The study also mentioned that facilitators for implementing EHR include strong leadership, appropriate management, primary healthcare specifications, ease of use, perceived benefit and efficiency. In contrast, EHR implementation challenges included the size of a project, the lack of expertise in health informatics, a lack of training and support, geographical challenges, program selection and end-user participation. The author identified the importance of providing training and technical support to increase end-user satisfaction and of allocating sufficient budget and time to mitigate specific challenges. A recent study assessed patient satisfaction when EMR was used (compared with paper medical records) in five primary health centres in Saudi Arabia (Wali, Alqahtani, Alharazi, Bukhari & Quqandi, 2020). The study results indicated that patient satisfaction throughout clinical diagnosis had increased, and that doctors were perceived as listening more effectively. In addition, the participants stated that general satisfaction

with different primary healthcare services had improved with implementation of an EMR system.

Previous studies make the lack of research into HIS acceptance by Saudi health centres evident. These centres are often a patient's initial point of contact with health services, prior to any referral to specialised clinics or hospitals. The electronic information systems used in these centres are a vital part of raising the quality of health care and helping GPs to provide more effective and efficient medical services.

3.4 Health Information system Status in the Healthcare Sector in Saudi Arabia

The Saudi government encourages healthcare providers to implement better systems (Alqahtani et al., 2016) through the promotion and implementation of clinical technologies and improvements in healthcare services. According to Alsulame et al. (2016), the provision of e-health care in Saudi Arabia is increasingly being conducted through organisational, as well as individual, initiatives. Other initiatives include provision of a supportive care pathway function and integrated EHR: these are used in the setting of a CDSS and become a part of the system, which is intended to generate information based on specific cases to enrich decision-making (Aldosari, 2017b).

Informational health projects may be adversely affected by inadequate preparation and the insufficient exploration of factors around HIS acceptance. An estimated loss of $US10 million occurred because of 52 failed IT healthcare projects between 2007 and 2011 in Saudi Arabia (Abouzahra, 2011). Alharthi (2018) highlighted that there is an urgent need to promote HIS through financial support and research that will contribute to the successful adoption of these systems, as many hospitals and primary health centres in Saudi Arabia currently rely on paper-based methods or use only basic technology. It is

also essential to motivate physicians to accept EHR. Aldosari (2017a) noted that health systems in Saudi Arabia face many challenges. It is thus necessary to conduct in-depth studies to investigate the failure of HIS in Saudi Arabia and to determine solutions and recommendations to their success. Further, Ebad (2016) stated that many developing countries suffer from the failure of software project implementation. He indicated that the main factors influencing the failure of software projects in Saudi Arabia include a lack of support from top management levels and the lack of training. Technical and financial factors are not considered influential, because of the financial capabilities that are available. According to Alsulame et al. (2016), investigating the effect of e-health services in Saudi Arabia is crucial so that the appropriate knowledge is made available. They also acknowledged the need to computerise the healthcare system to provide efficient services that will meet the healthcare demands of the Saudi people. Further, Alkraiji, Jackson and Murray (2011) stated that Saudi Arabia has faced many problems in the implementation of advanced HIS. Further, according to Alqahtani et al. (2016), although the Saudi government encourages the implementation of up-to-date health systems, organisations still face many problems.

One issue of concern to health organisations in Saudi Arabia is the number of medical errors in physician practices (Al-mazroea & Alturki, 2017). Al-Jeraisy et al. (2011) found 56 medical errors in the dispensing of every 100 orders of medication in the general paediatric ward at King Abdulaziz Medical City. These studies highlight the importance of adopting strategies to prevent or minimise medical errors. Almaiman, Bahkali, Alfrih et al. (2014) mentioned that despite improvements in existing healthcare systems, they remain in their infancy and will need considerable effort and potential to address the challenges of adopting HIS. According to the Ministry of Health (2019b), in Saudi Arabia the vast majority of primary health centres rely heavily on manual methods, and their

work is paper based. With regard to hospitals in Saudi Arabia, the degree of system use varies from hospital to hospital, but most have little, if any, automation. The Ministry of Health is seeking to adopt EHR in all its hospitals and healthcare centres, to implement the basic functions of a new health system that includes admission, discharge and transfer, scheduling and registration modules (Ministry of Health, 2019a).

Alsulame, Khalifa and Househ (2015) stated that HIS in Saudi Arabia faces challenges related to organisational and cultural issues and end-user attitudes. The researchers recognised a need to assess the status of information systems used and to explore more opportunities for HIS in relation to its contribution to the development and improvement of health services. Bahkali, Almaiman, Almadani, Househ and El Metwally (2014) pointed out that public HIS used in the Saudi health sector are not developed enough to provide effective quality health services. The authors stated that there are various challenges that must be addressed with the implementation of HIS, 'such as the need for readiness assessment, resistance to change, integration of systems' (Bahkali et al., 2014, p. 257). Gasmelseid (2014) investigated emergency responses and the implementation of different agent systems to orchestrate emergency responses resulted in the increased efficiency and effectiveness of medical services and major decision-making processes. Additionally, improving the HIS contributed to addressing emergency situations, their ability to anticipate emergency trends and to control capacity.

According to Aljohani, Davis and Connolly (2018), the need to use health technology in public healthcare institutions in Saudi Arabia is pressing. With a lack of attention to the effect of HIS on acceptance and innovations, modern initiatives in the healthcare industry and the level of successful uptake in HIS by the Saudi Ministry of Health have been limited to certain regions (Hasanain, Vallmuur & Clark, 2014). Hasanain and Cooper

(2014) highlighted other technical barriers, such as the uncertainty of EMR vendors and the lack of computers for healthcare providers. Because of these barriers, the process of implementing e-health services in Saudi Arabia continues to face challenges. According to Alharbi, Atkins and Stanier (2015), the complexity and high cost of e-health programs and low-level IT skills among practitioners are major barriers to their realisation. Although the process is experiencing implementation difficulties, some hospitals have already adopted e-health services and are showing clear benefits. For instance, the King Faisal Specialist Hospital and Research Centre (KFSH) is a success story, with an almost complete adoption of its EMR system (Hasanain & Cooper, 2014).

Alkraiji, Jackson and Murray (2016) investigated the factors that affect the adoption of health data standards in Saudi organisations. The study results indicated that technological factors include the 'complexity and compatibility of health data standards, IT infrastructure, switching costs, market uncertainties, systems integration and enhancing the use of advanced systems' (Alkraiji et al., 2016). In addition, they noted the lack of appropriate policies, procedures, resistance to change and a lack of professionals. Further, Al Saleem, Househ and El Metwally (2014) highlighted the challenges that Saudi Arabia faces in trying to benefit from advanced HIS. Their study indicated that adopting health technologies would contribute to improved communication between doctors, decision-makers and epidemiologists through the rapid access to data, as this would enable more accurate decisions. However, the use of HIS faced a number of challenges, mostly in relation to practitioner training and ensuring that the workforce was educated and skilled enough to use the disease surveillance systems. In another study of the challenges in implementing HIS, Zaman et al. (2018) examined three hospitals in Makkah to determine the most important obstacles facing HIS implementation. The study sample included 51 people, including administrative and medical personnel. The study results

showed that the main challenges were the lack of computers and technical expertise in the workforce, in addition to the high costs associated with IT. In addition, Bahkali et al. (2014) led an exploratory study to identify the state of Saudi Arabia's public health informatics (PHI). Using interviews with public health and PHI authorities, and a literature review, the results show that PHI is not well developed. This has a negative effect on the delivery of proficient health care. Numerous obstacles were also identified, such as the need for readiness assessment, resistance to change, systems incorporation and the confidentiality of health information. Future challenges were also noted, such as developing national PHIs, profiling users and reviewing the influence of PHIs on healthcare outcomes.

Almuayqil, Atkins and Sharp (2016) examined and categorised the obstructions to e-health based on the perspectives of three stakeholders. Their findings indicated that the public categorised the connectivity of an information system as the greatest hindrance, scoring a mean of 4.0, while cultural barriers were seen as the least obstructive, with a mean of 3.1. In contrast, healthcare providers categorised information connectivity systems as the greatest obstacle, with a mean score of 3.5, while technical expertise and computer skills provided the least obstruction, with a mean score of 2.2. From the IT specialist perspective, medication safety was the top barrier, with a mean score of 3.5, while security and privacy barriers were of the least concern, with a mean score of 2.2 (Almuayqil et al., 2016). Here, practitioners and the public perceived the absence of connectivity in Saudi Arabian HIS as the major cause of e-health failure, while IT experts believe that the lack of medication safety is the leading factor.

Research conducted by Alshami et al. (2014) described the experiences of establishing the 'EHALA' electronic referral system at a regional medical institution. The electronic

referral network EHALA was established in 2013 and was implemented by the Ministry of Health as a cohesive health information network to connect almost 40 hospitals with nearly 380 primary healthcare centres. One hospital that has benefited from this system is the King Saud Chest Diseases Hospital. The study's initial conclusions are that the EHALA has modernised and advanced its course of action for communication between medical institutions and has improved health and social care for patients as a result. Despite this, a number of concerns remain, such as the lack of staff skills in relation to computer use, the lack of staff interest in using the electronic referral system, and no comprehensive management structure and procedure. The combination of these barriers will negatively affect the application of EHALA (Alshami et al., 2014).

Further, Barakah, Alwakeel and Shira (2017) found that HIS at the King Saud Medical City was similar to that of comparable medical organisations in leading countries globally, as well as having more progressive academic resources in the medical field. The study mentioned that most professionals in King Saud Medical City, and its associated medical facilities, had the relevant skillset and knowledge base to acculturate to IT for medical roles and healthcare practices. Similarly, healthcare professionals would need to participate in continuous IT training, as well as being introduced to complex academic resources on the IT database.

Alshahrani, Stewart and MacLure (2019) revealed that it is still essential to investigate the opinions of end users and stakeholders regarding the acceptance of HIS in Saudi Arabia. Their perspectives must be considered when designing these systems. The health technologies used in hospitals and health clinics vary across Saudi Arabia. Failures in adopting health systems have resulted in financial losses and burdens on health facilities. However, successful experiences are also apparent, and the implementation of effective

health applications and systems have contributed to providing better health services and patient care. It is important to identify HIS studies that contribute to understanding the preferences of end users that will support technology acceptance.

3.4.1 Electronic Medical Records in Saudi Arabia

The implementation of EMRs as central health records in Saudi Arabia's healthcare has recently increased. This will provide better health care and improve the effectiveness of access to patient data more efficiently (Aljohani et al., 2018). This situation is connected to strong government support for data automation and implementation of the strategies outlined here to support the interconnectedness of government organisations. However, as Aldosari (2014) has mentioned, there remain a few health centres without EMR or HIS. In addition, the computer skills needed for EMR are lacking (Hasanain, Vallmuur & Clark, 2015); this may lead to poor performance. The results of the study indicate that computer skills and English language proficiency are needed to use EMR effectively. Therefore, it is important to increase the skills of health practitioners, as well as employees in computer skills and English proficiency, as this will contribute significantly to increasing EMR acceptance.

Twelve significant impediments were identified by Alqahtani, Crowder and Wills (2017) regarding the hurdles to EMR adoption in Saudi Arabia. These are computer skill illiteracy for end users (18%), lack of system usefulness (15%), low ease of use regarding the system (15%), the technical constraints of HIS (15%), the lack of team support for users (9%), confidentiality concerns (9%), reluctance to change (6%), poor system quality regarding patient information (6%), the lack of EMR standards (3%), doubts regarding EMR developers (3%), the size of healthcare facilities and organisations (3%), and the standard of health care provided in a health organisation (3%).

Aldosari and Alanazi (2018) evaluated the HIS used in the Ministry of National Guard Health Affairs in Riyadh, which includes the QuadraMed and BestCare systems. In-depth interviews were conducted with end users to investigate the systems' capabilities in terms of authorship and privacy. The overall findings in the study were similar, particularly regarding the degree of compliance, with around 88% availability of the authoring function. However, a single non-compliance problem found in the QuadraMed software was the lack of diagnostic documentation. As a result, providers cannot document diagnoses for users. Conversely, the BestCare system has promising solutions, because of its expanded functionality (Aldosari & Alanazi, 2018).

An exploratory study was conducted at the National Guard Health Affair hospitals to assess the implementation of electronic dental record (EDR) systems. The major hindrance to EDR implementation was the lack of computer knowledge among healthcare providers. Also of concern was the degree of system useability, low levels of interest in using EDRs and poor management strategies to support the required changes (Almaiman, Bahkali, Bahkali et al., 2014). In addition, Aljarullah et al. (2017) also identified the key factors that can affect EDR acceptance by primary care physicians in Saudi Arabia. This study was based on literature reviews and the findings of other research. Eight factors were identified as playing a role in influencing physician acceptance of EHR: attitude, social influence, computer self-efficacy, perceived threat to physician autonomy, confidentiality concerns, perceived usefulness, physician participation and perceived ease of use.

According to Hasanain et al. (2015), regarding the knowledge, acceptance and preferred use of EMR by public hospital healthcare providers in the west of Saudi Arabia, the delay in EMR implementation was the result of several barriers. The authors mentioned that

EMR implementation was delayed by the lack of technical knowledge and experience in using EMR, along with employee resistance to the application. Among the individuals surveyed, employees whose first language was not Arabic were more willing to use EMR than were native Arabic-speaking employees. The study suggested that increased computer and English literacy were directly proportional to increased EMR system implementation. Healthcare institution management must first examine the level of computer and English literacy among staff before implementing an EMR system. They should also offer training in specific educational programs to staff to EMR knowledge. Saudi public hospitals could also recruit professionals with appropriate foundation skills for using these system (Hasanain et al., 2015). The study also concluded that the size of a healthcare facility did not determine whether its employees preferred to use EMR systems. Furthermore, Hasanain and Cooper (2014) sought to identify the solutions to the technical and social hindrances of EHR implementation in Saudi Arabia health care. They identified the lack of knowledge and experience in EHR systems as the major barrier. However, they also noted the need for further investigation to facilitate successful implementation of the system to achieve better healthcare delivery processes. They also found that EHR complexity was an obstacle. Those interviewed suggested that testing the system for ease of use before implementation could assist the process. Additionally, they suggested that conducting end-user interviews for feedback concerning the system would also facilitate HER use. Healthcare administrators should also conduct training sessions for end users. This is considered vital, as it would give users the skills needed to run a system, overcoming illiteracy and poor technical knowledge (Hasanain & Cooper, 2014). In an analysis of electronic patient record (EPR) system use in central and eastern regional Saudi hospitals with diabetes care pathways, three key barriers to successfully using or

adopting EPR systems were identified as: data capture, data sharing and human factors (Alkadi, 2016).

Mahalli (2015) analysed the implementation process and barriers to EHR system acceptance by nurses. Three different public hospitals that proposed adopting the same EHR systems and functionalities (in eastern Saudi Arabia) were surveyed. Here, the minimal use of most EHR functions by all three hospitals meant that any benefits were not realised; some services and patient care may have been affected. Further, none of the three hospitals allowed their patients Internet access to view any of their health records. For these hospitals, the most common hindrance to acceptance the loss of transient access to medical records if the computer broke or the power failed (88.6%). Another issue was the absence of ongoing training and assistance from an IT team (85.9%). A third reason was the additional time required for data entry (84.9%), with a fourth reason being the problem of stopping or suspending the system (83.8%). The researcher therefore suggested the formation of an EHR committee mandated with discussing and resolving EHR system-related problems.

Predictive analytics are crucial to any healthcare system. EMR is vital for countries such as Saudi Arabia to improve analytic capabilities in relation to health care (Alharthi, 2018). Alharthi (2018) has stated that many Saudi hospitals still rely on paper-based records: this factor was a significant issue and created challenges regarding understanding EMR data to realise its benefits and facilitate its exploitation. Alharthi also concluded that there was an urgent requirement for hospitals to adopt and implement an EMR system. Finally, this study suggested that data analytics would provide a great opportunity for Saudi Arabia. This would be produced through researchers and others highly competent

professionals in universities exploring and analysing data, which would create an opportunity for health sector development.

Alsohime et al. (2019) studied the level of satisfaction among physicians employed at the Department of Pediatrics in King Saud University Medical City regarding the hospital's new EHR system. One goal of the study was to establish the different aspects of, and hindrances to, EHR implementation processes. The perceived usefulness of the system was rated 64%, while physicians satisfaction was 52%. The ability to reduce errors of record, thereby improving the quality of healthcare services, was the top indicator of a EHR system's usefulness. The researchers concluded that a lack of IT support and hardware, as well as time-consuming data entry processes, were the main challenges to HER system implementation and use processes. Further, Shaker and Farooq (2013) highlighted the computer literacy needs of physicians in Makkah. The authors stated that physicians required improvements to their computing skills to enhance and improve the quality of their medical care.

3.4.2 Clinical Decision Support Systems in Saudi Arabia

Barakah et al. (2017) examined the competence and enforcement of IT-based technologies among healthcare professionals, as well as in medical education and practice, in Saudi general tertiary hospitals. The study was conducted in Riyadh, at King Saud Medical City. The researchers concluded that of the most suitable electronic medical systems chosen by staff, the Computerized Provider Order Entry (CPOE) system was used most frequently, with nearly 53% of staff professing this, whereas the electronic medical system used least was the Laboratory Information Management System, at 19%. Mominah and Househ (2013) studied the effectiveness of the performance of the CPOE, which can help to reduce medical errors. Several hospitals in Saudi Arabia have

implemented CPOE over the last years. These authors assessed the effects of CPOE on the frequency of medication errors. Data about identifying errors in medication prescriptions by supply pharmacists were reviewed and reported. The authors recommended that procedures and policies should be developed for a safer working environment in dispensing medications.

Alqahtani et al. (2016) outlined new knowledge regarding the challenges to improving the overall CDSS effectiveness that could result in improved clinical practices. In addition, the authors suggested that to successfully implement a CDSS, the technical content and collected healthcare data must be correct, reliable and periodically updated, while the advice provided by the system must be simple and efficient in relation to any patient-specific conditions (Alqahtani et al., 2016). In addition, various CDSS software have been implemented with the aim of transforming hospital systems, especially in children's wards, such as radio frequency identification (RFID) and ZigBee to better track clinical matters and mitigate risks (Alharbe & Atkins, 2016). The number of studies on CDSS in Saudi Arabia is limited, and there is a need to investigate the preferences, opportunities and obstacles to its acceptance, to implement more efficient and productive medical systems. The adoption of CDSS will enable physicians to make more accurate medical decisions and reduce medical errors.

3.4.3 Social Networks in Saudi Arabia

In Saudi Arabia, the number of individuals who use the Internet and smartphones in their daily lives is increasing at a rapid rate. By the end of 2019, the number of smartphones being used in Saudi Arabia was expected to have risen to 19.1 million. Many studies have investigated the use of social networking applications by citizens to obtain medical and health information in Saudi Arabia. Alhaddad's (2018) study found that WhatsApp was

the most popular, with 83.8% of respondents using the application. They mentioned that friends were the most likely source of medical information on social media, with 28.5% of responses. Conversely, information obtained from health professionals on social media was 20.1%. The authors advised that it was important for health professionals to educate the community to only obtain information from reliable medical sources. Additionally, Al-Qahtani et al. (2018) distributed questionnaires to a sample of 400 hospital patients in an eastern region of Saudi Arabia. The results indicated that a common goal in patients who used social media was to take care of their health by identifying possible treatment methods. However, a small number of respondents also indicated that social networking might risk the confidentiality and security of their information.

Alshakhs and Alanzi (2018) assessed the attitude of healthcare specialists regarding the use of social networks in providing health care. Eighty per cent of these professionals agreed on the advantages of using social media in the health sector and deemed that the utility of these applications would improve their expert knowledge and that it was a proper technology for patient health awareness. Nevertheless, 20% of respondents thought that there were various risks in using social networks, such as legal challenges, factors that might affect patient health situations, or consequences for patient privacy. They indicated that social networks could be a helpful in that medical practitioners could expand their services and present health information. However, there were possible obstacles to using social media that could result in negative outcomes for patients. Bahkali et al. (2015) analysed 5,167 Tweets from Saudi *Twitter* to promote female healthcare. The outcome indicated that most Twitter users were searching for gynaecological information (61%), followed by pregnancy information (27%). Information on breastfeeding was the search focus of 9%, and other health-related information was the search topic for 3%. The

authors asserted that there was an improvement in health consciousness among Twitter followers.

Alsobayel (2016) investigated the use of social networks for improving professionalism among healthcare specialists. The survey involved 231 healthcare professionals who used social media. Nearly 71% of those surveyed used social networks to develop their professional skills. Social networks were seen as more useful for professional development in terms of the influence on user knowledge and problem-solving skills, but they were of more limited use in improving clinical skills. Alsobayel (2016) recommended that social networks should be considered efficacious applications for engaging healthcare professionals to improve their knowledge and skills. An earlier study by Almaiman et al. (2015) determined the ability of medical practitioners to obtain health information online and how often they did so. Of those surveyed, 79% mentioned that *Twitter* was a major influence in improving their medical knowledge and developing their clinical work. More than half of the participants acknowledged the need to invest in establishing accurate and reliable health-related Twitter accounts. This study concluded that using social networks to search for medical information was common among medical practitioners, particularly among the younger cohort.

Alanzi, Alobrah, Alhumaidi and Aloraifi (2018) examined the practicability and efficacy of Snapchat in terms of developing breast cancer knowledge among female students in the Dammam District. The study determined that the increased number of individuals using smartphones had ultimately increased the population of social networks in Saudi Arabia, with applications such as Snapchat, WhatsApp, Facebook and Twitter being activated and accessed regularly. Snapchat has been particularly popular, with written messages, videos and pictures being shared regularly by 13% of individual respondents.

This study revealed that social network systems available via mobile phones could be efficacious in medical facilities and sectors. This is supported by the number of medical systems that have been implemented within various healthcare services and sectors in other districts and globally.

Alanzi, Istepanian and Philip (2016) suggested a blueprint for a new health system developed for mobile phones, dedicated to social behavioural conversion, and specifically for diabetes patients. This study is the Saudi Arabia Networking for Aiding Diabetes (SANAD). This network was established with mobile phone technology. It implements communication-based educational programs on social networking and the management of diabetes. The study found that many individual patients liked the system, with its improved operability for those with Type 2 diabetes (Alanzi et al., 2016). The authors found that acceptability of the system among diabetic patients was very high. Patients with Type 2 diabetes were gratified with the complete system. The study reported the participant as noting SANAD's 'ease of use, perceived powerfulness, stimulating, and flexibility' (Alanzi et al., 2016, P. 8). The vast distribution of this system is timely and it would benefit from being specifically required within the Gulf region, with the widespread use of social networking and mobile phones.

3.4.4 Cloud Computing in Saudi Arabia

Although cloud computing continues to develop, there is insufficient research regarding its use within the Saudi healthcare system (Alharbi, Atkins & Stanier, 2016). Several studies have reviewed and identified the determinants that effect the use of cloud computing in Saudi medical institutions. The five crucial elements have been identified as 'soft financial analysis, relative advantage, hard financial analysis, attitude toward

change and pressure from partners in the business ecosystem' (Alharbi, Atkins & Stanier, 2016, p. 155).

Cloud computing contributes to elucidating a number of the governance dilemmas faced by medical institutions. Among these are the financial issues that affect clinical health technology health ventures. Cloud computing can assist by lowering the initial costs of clinical technology ventures in medical institutions (Alharbi, Atkins & Stanier, 2016). Further, cloud computing may resolve IT deficiencies, as it enables health informatic professionals to implement the technology with fewer technicians, resulting in lower costs for medical organisations (Sultan, 2014).

Alharbi, Atkins, Stanier and Al-Buti (2016) investigated the application of the Balanced Scorecard cloud computing application in a Saudi hospital e-health unit. The application was examined from four angles: internal processes, customer perspectives, financial aspects and organisational ability. The results showed that private cloud computing contributed to strategic advantages across all aspects, with a better forecast for the financial perspective.

Alharbi et al. (2015) studied the challenges faced by traditional healthcare services, reviewed the issues for e-health and how cloud computing could assist in addressing these issues. The authors identified that the costs and difficulties of e-health projects, and the lack of skilled employees in IT, were barriers to a project's success. They argued that cloud computing provided opportunities to solve e-health implementation challenges, but to adopt cloud computing in healthcare, a strategic plan incorporating all aspects was necessary. The authors introduced a framework that could assist healthcare providers to adopt cloud computing. This framework has five elements: organisations, technology, environment, human and business.

3.4.5 M-health in Saudi Arabia

It is estimated that by 2022, the number of people accessing and using smart phones in Saudi Arabia will have increased to over 24 million. Similarly, Internet use will have increased to over 26 million people. M-health (electronically based medical health services) can provide many benefits. According to Alnasser et al. (2018), the use of m-health may change user feelings about breastfeeding in positive ways, through making educational materials available.

Alanzi (2018) examined the technologies used in m-health for diabetes and outlined mobile health technology's current position in Saudi Arabia in relation to the self-management of diabetes, also overviewing the clinical evidence. This study reviewed the drawbacks of using m-health for diabetes care, including the disclosure of pertinent information and proposals. The study suggested that m-health technologies, in terms of self-management for diabetes, had not yet been adequately transliterated into the Saudi Arabian context. These conclusions were reached by conducting a survey of senior physicians and management decision-makers throughout Saudi Arabia. The results revealed that a lack of m-health expertise, staff deficiencies, legal issues, funding and infrastructure investments, organisational and bureaucratic impediments, and privacy standardisation and regulatory obstacles were all obstacles to the application of m-health technologies in diabetes self-management.

One study examined smart phone or device clinical applications presently favoured by doctors in Saudi Arabia, and the perceived effects of these apps on patient care (Al-Ghamdi, 2018). In total, 300 doctors participated in the study and the questionnaires had a response rate of almost 78.5%. Over 88% of doctors had a smart device of some kind, and about 86% had at least one form of medical application downloaded. Over 50% of

doctors admitted using one of these apps at least once a day and were generally in favour of using them. Indeed, doctors were increasingly depending upon the apps. Al-Ghamdi (2018) found that medical apps also had a favourable influence on clinical academia, doctor effectiveness and overall patient care. The study concluded that, at least in Saudi Arabia, the use of mobile medical apps was advantageous to all professionals in health care: this is mainly due to the apps making current and relevant medical information readily available, together with up-to-date clinical information. The author suggested that further studies were needed to appraise the influence of medical apps for use in clinical and patient care. These should also include specific studies that analysed the influence of medical apps on patients.

Alqahtani and Atkins (2017) introduced a framework for guiding the planning process, to help with decision-making and to ensure mobile device use in e-health was more effective. Their study was based on an outpatient department of a Riyadh hospital, and the authors recommended solutions to some m-health problems. The hospital wanted minimise the workloads of its reception and front desk staff through increased use of mobile-based apps. One proposed solution was adopted and this resulted in positive outcomes. Improvements included a reduction of up to 30% in patient waiting times, with patient satisfaction rising by up to 10%. This kind of outcome is only possible if mobile-based applications are practical.

Al-Mahadeen (2015) studied the willingness of physicians and patients to adopt smartphones for communication. The findings showed that a patient's rural location greatly affected their readiness to use smartphones. The willingness of users to adopt smartphones was also associated with trust, ease of use and perceived usefulness. The author emphasised that the increased use of smartphones, iPads and other devices in

healthcare departments resulted from an acceptance of using these technologies in health care.

3.5 Chapter Summary

This chapter has presented an overview of medical care in Saudi Arabia, including its economic, educational and health status, and the purpose of *Saudi Vision 2030* in the country's evolution. The current state of HIS, EMR, social networks, cloud computing, health and CDSS in Saudi Arabia were also discussed.

Only a limited number of studies have examined the factors, challenges and opportunities in adopting HIS in Saudi Arabia. Saudi Arabia has a high financial capacity, with resources that include its significant oil reservoirs: it can contribute to spending heavily on the health sector. Technical support solutions such as CDSS will improve and assist in the provision of high-quality health care, and also help GPs to make correct decisions and reduce medical errors. The Saudi government is also keen to move forward to develop both the public and private sectors, as part of its *Saudi Vision 2030* strategic plan. This includes development of the country's health sector.

Paper-based records are still being used in some primary healthcare institutions managed by the Ministry of Health. Some studies also indicate that the level of patient dissatisfaction is high in primary healthcare centres. Therefore, developing physicians' skills through training and adopting advanced medical systems such as CDSS is a significant factor in raising levels of patient satisfaction. Understanding the factors that affect the implementation of medical systems is crucial to a project's success, as failures here have resulted in significant losses and costs in many health projects, despite the Ministry of Health's initiatives and efforts, especially in IT. To successfully implement HIS, it is important to consider the factors that influence its acceptance. These include

the lack of computers for healthcare providers, the complex standards, transition costs, uncertain conditions, a lack of adequate policies, the unavailability of IT professionals, the requirement for readiness assessment and a resistance to change.

This chapter has also reviewed the literature related to other medical systems already approved in some primary healthcare centres and hospitals. Of these, the implementation and certification of EMR as a central record system in Saudi Arabia's healthcare institutions has increased recently. However, some challenges were experienced in its implementation, including low computer literacy levels, and low English language proficiency. These elements were in addition to the more general barriers to adopting EMR; namely, the lack of perceived benefits, the perceived ease (or difficulty) of use, technical limitations of the software and poor user support, resistance to change and low-quality patient information.

An abundance of untapped information and data exists in the Saudi health sector in predictive analytics. This situation has resulted in the available knowledge that could be gained from the data and therefore contribute to healthcare services and increase the quality of care, being underused. Studies have confirmed the importance of encouraging researchers to undertake further research that will contribute to identifying how predictive analytics to facilitate and support medical decisions. CDSS is considered the most appropriate health care in Saudi Arabia, as it contributes to reducing medical errors. However, there is a significant deficiency in studies about CDSS in the Saudi health sector: its preparation (prior to implementation) is one of the main factors that will contribute to its successful implementation.

This chapter reviewed the literature related to other electronic applications applied in Saudi Arabian health care. These included social networking applications, and the extent

of their importance in relation to communication. Social media applications can promote education and correct misinformation about health concepts, and they must provide reliable information from reputable medical organisations. Social networks can be efficient in engaging healthcare professionals, encouraging them to improve their knowledge and skills. Studies show that Twitter has had a major influence on improving medical professionals' information levels and in developing their clinical work. Twitter has also contributed to raising the level of awareness of health information among followers.

Among the new technologies used for health, cloud computing must be considered. Although it is still developing as a technology, there is little research into its use in the Saudi healthcare setting. Cloud computing can support medical practice, both in primary health care and generally, by reducing the initial costs of technology ventures in medical organisations. Another technology used in Saudi healthcare are the m-health apps that can provide several benefits to users. The use of mobile medical apps is advantageous to professionals in health care, mainly because of its ability to make current and relevant medical information readily available, alongside up-to-date clinical information.

In conclusion, the studies reviewed here also indicate that more research is needed regarding HIS's ability to positively assess the influence of medical apps for use in Saudi clinical and patient care. Notably, the small number of studies on the acceptance and adoption of CDSS in Saudi Arabia instigated this research into the factors that affect GP acceptance of CDSS. This qualitative study, through in-depth interviews with GPs, has provided rich data regarding the facilitators and obstacles that can contribute to supporting developers and providers in designing HIS that will be accepted by physicians.

Chapter 4: Evaluation of Technology Acceptance Theories

4.1 Introduction

This chapter provides an overview of what 'technology acceptance' means and the importance of studying it. The chapter also reviews the existing literature on acceptance of technology theories that embrace the technology acceptance model (TAM), the theory of reasoned action (TRA), the unified theory of acceptance and use of technology (UTAUT), the theory of planned behaviour (TPB), social cognitive theory (SCT), the diffusion of innovation theory, the unified theory of acceptance and use of technology (UTAUT2), the motivational model (MM) and task-technology fit (TTF). Finally, a justification of the TTF model integrated with UTAUT l as a conceptual framework is presented. This is complemented by relevant studies that outline the importance of extending the model by exploring the factors that affect CDSS acceptance through GP consultation.

4.2 Technology Acceptance

Understanding user decisions to use technology has proved quite critical in IT management and implementation (Arpaci et al., 2021). When introducing new technology, organisations usually aim to achieve a strategic advantage, decrease costs and enhance performance. However, unless the technology is accepted by users, these aims are not realised (Garavand, Ghanbari, Ebrahimi and Ahmadzadeh, 2015). Various conceptual models have been designed to explain user acceptance of technology, operationalised as attitudes and positions toward it (Al-nassar, Rababah & Al-Nsour, 2016), as well as behavioural intentions to use the technology (Venkatesh et al., 2003).

Acceptance can be defined as the willingness to use IT for the different tasks it was created to complete (Taherdoost, 2019). 'Acceptance' also refers to when a new IT is being used or where the technology has not been implemented but there is an intention to use it (Kamal, Shafiq & Kakria, 2020). In addition, acceptance of technology has been defined as the attitudes of individuals toward using specific technologies (So, Ryoo, Park & Choi, 2019). Each group of users possesses different attitudes, facilitators and obstacles; this is why it is significant to research the acceptance of technology in user target populations. These are the factors that can influence technology implementation effectively to meet the needs of end users (Momani & Jamous, 2017).

Since these systems can significantly influence patient care, their acceptance and use by physicians is important (Pynoo et al., 2012). HIS acceptance is considered an important part of the effort to reduce healthcare costs (Sevani & Marpaung, 2018). The results suggest that the level of acceptance of clinicians in terms of CDSS is correlated with their different attitudes concerning their attitudes and role towards the part of the computer in decision-making and disease management (Chua et al., 2018).

4.2.1 The Importance of Studying Acceptance

There is a need to study HIS acceptance by exploring the knowledge, opportunities and challenges from experts in health care to provide more efficient and effective systems (Ifinedo, 2012). To improve healthcare services, physicians and other medical professionals should accept HIS (Esmaeilzadeh et al., 2015). To identify the factors that are important to a certain organisation, the initial stage of an implementation plan should be researched. Further actions are then required to refine models that weigh the significance of components in the medical context. Moreover, some researchers note that attention must be given to features of a model that can help to attain standards (Ward,

2013). Understanding the aspects that contribute to technology acceptance by physicians is significant for new technologies (Lin, Roan & Lin, 2012). IT acceptance motivations are connected directly to the idea that systems can completing the required daily activities (Lin, Roan & Lin, 2012). A lack of acceptance by different intended users of the tools that relate to a particular technology is one reason for unsuccessful IT system implementation (Al-Emran, Mezhuyev & Kamaludin, 2020). Therefore, user acceptance may affect implementation effectiveness.

Generally, technology acceptance refers to the positive attitudes of users towards adopting and using technology (Schomakers, Lidynia & Ziefle, 2019). Studies of user participation in technology acceptance can enable organisations to make efficient decisions about the management and implementation IT systems (Oturakci & Oturakci, 2018). Identifying the elements that influence IT system use and acceptance provides an advantage for organisations to enhance performance systems and minimise the negative effects related to changes in these systems (Haryaka, Agus, & Kridalaksana, 2017).

Technology acceptance is one of the biggest challenges facing HIS designers and developers (Nadal, Doherty & Sas, 2019). Therefore, the importance of this research stems from developing and building a model that will contribute to providing the factors that affect HIS acceptance in general, and CDSS in particular. Studying and investigating the perception of healthcare providers about HIS is necessary; if these perceptions are not considered, user acceptance can be affected (Sekhon, Cartwright & Francis, 2017).

4.3 Evaluation of Technology Acceptance Theories

4.3.1 The Technology Acceptance Model

As a basis of technology acceptance research, the TAM was introduced by Davis (1989). This theory was developed from the TRA. The TAM explains the processes that a user

undergoes to predict the acceptance or otherwise of a particular technology (Bach, Čeljo & Zoroja, 2016). According to this model, when exposed to unfamiliar technology, users are influenced by many factors that may determine their decision on how and when to use it (Bach et al., 2016). The TAM has been used in many information system studies (Yalcin & Kutlu, 2019). The model depends on two main determinants of user acceptance. The first is perceived usefulness, which refers to the belief that the technology will improve performance. The second, perceived ease of use, refers to the belief that using a particular system will facilitate a particular task. Figure 4.1 outlines this model.

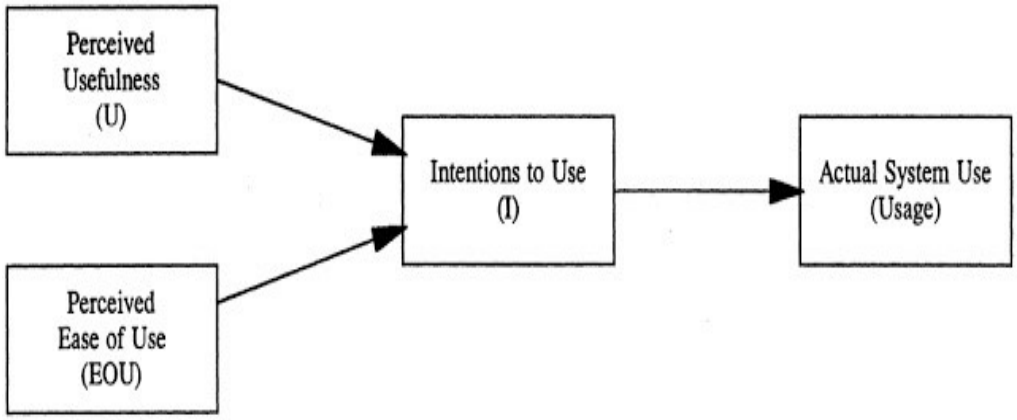

Figure 4.1. Technology Acceptance Model by Davis (1989).

Burton-Jones and Hubona (2006) have described TAM as IT with four rules. First, external variables affect user beliefs regarding use of the technology. Second, user views affect attitudes regarding use of the technology. Third, user attitudes affect their intentions to employ the technology. Fourth, a user's intentions determine use of the technology. According to TAM, intention is a principal factor in using IT. Intention can be defined by a participant's attitude toward using the technology and its perceived Usefulness.

Despite many studies using TAM, Hsiao and Tang (2014) indicate that TAM's effectiveness in relation to technology acceptance behaviour is low. Venkatesh and Davis (2000) had stated earlier that TAM demonstrates 40% of technology use intentions and behaviours. Further, Straub (2009) mentioned that TAM neglects other determinants despite the model's two important factors. Moreover, Al Shibly and Tadros (2010) state that the performance of technological components as external variables has not been adequately investigated for assessing TAM. According to researchers, another limitation of TAM is that it should include additional variables, particularly social factors (Legris, Ingham & Collerette, 2003).

Orruño, Gagnon, Asua and Abdeljelil (2011) investigated the factors that influence physician intentions to use teledermatology through applying the TAM model, extending

it to include the factors of subjective norm, facilitators, compatibility and habit. The results indicate that the TAM model was more effective at predicting physician intentions to accept a system after adding these factors. Tubaishat (2018) investigated nurses' perceptions of the usefulness and useability of EHRs by adopting the TAM model. The results revealed a positive attitude toward the usefulness and useability of EHRs. Further, Mohammadhiwa, Maryam, Alireza and Mohmoudreza (2016) studied the influence of physician characteristics on the adoption of an electronic healthcare record by adopting the TAM model. The outcomes showed that physicians' characteristics did not have any significant influence on accepting electronic healthcare records. The authors suggested further examination was required into the factors that influenced acceptance. Rahimi, Nadri, Lotfnezhad Afshar and Timpka (2018) have studied and reviewed scientific articles that incorporated TAM when examining HIS implementation and model extensions. The authors noted that no optimal TAM extension for performance or use in HIS has been developed. However, the study's outcomes revealed the model's continuous improvement, and found that TAM could be extended and developed to enhance predictive use.

4.3.2 Theory of Reasoned Action

The TRA was developed by Fishbein and Ajzen (1975). The TRA is considered an important theory and has been used extensively in many studies, as it can predict various behaviours successfully (Malhotra & Galletta, 1999). The TRA depends on two main determinants: attitudes toward behaviour and subjective norms. 'Attitudes towards behaviour' refers to the feelings of an individual or a group of people, whether positive or negative. 'Subjective norms' refers to beliefs regarding whether the surrounding society is critical or supportive of a particular behaviour (Fishbein & Ajzen, 1975). According to the TRA, attitude toward behaviour and subjective norms significantly

affect the behavioural intent that leads to actual behaviour (Fishbein & Ajzen, 1975). Figure 4.2 illustrates this model.

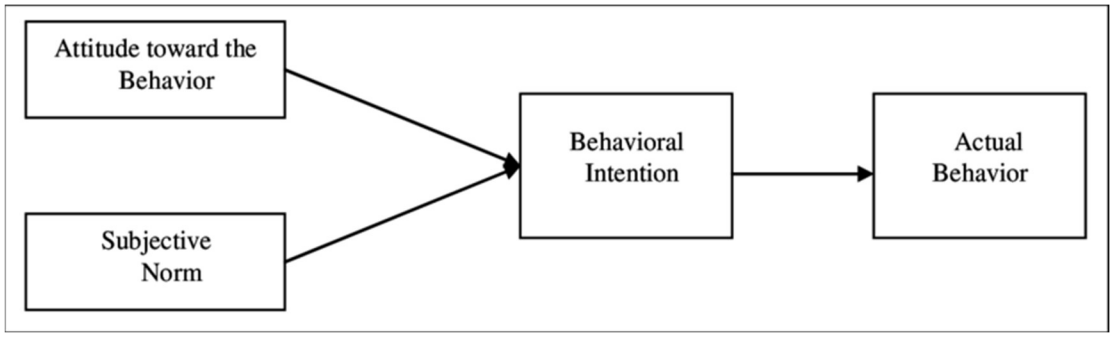

Figure 4.2. Theory of Reasoned Action by Fishbein and Ajzen (1975)

According to TRA, the effort applied in the performance of a behaviour will increase only when intentions are very strong. According to Yen-Tsang, Csillag and Siegler (2012), TRA was developed from the theory of attitude to explain the relationship between habits and behaviour in humans.

The TRA predicts the actions of a person based on that individual's current intentions and attitudes (Ghasrodashti, 2018). This is because an individual will decide to engage in a particular behaviour only after considering the outcomes of the behaviour. The TRA seeks to understand a person's voluntary actions. In most cases, the intention to engage in a particular behaviour will determine whether that behaviour will actually occur. This is because intentions have a significant relationship with real behaviour (Ghasrodashti, 2018). Boster, Shaw, Carpenter and Massi Lindsey (2014) have argued that, overwhelmingly, what determines an individual's intention is the attitude that person has developed regarding a particular behaviour and the subjective norms. Zhang, Guo, Lai, Guo and Li (2014) investigated the factors that influence m-health adoption intentions. They extended the TRA model to include additional factors. The outcomes of the study showed that facilitating conditions, attitude and subjective norms had considerable effect

on the intention to use m-health. The authors mentioned that men have a higher level regarding the intention to use m-health than the level of females. Also, Kim (2015) identified the implications of applying TRA on health in a widespread manner. The authors stated that both self-efficacy and perceived usefulness had a high positive influence on behavioural intentions of the m-health system. The authors indicated that there were important factors in addition to the formulations used in this study that needed to be identified and studied. Sadeghitabar, Shobeiri and Zakeri (2020) assessed the factors influencing the implementation of mobile learning in continuing medical education programs through employing the TRA model in Iran. The results revealed that attitude, subjective norms, knowledge and mindset, and intentions toward learning were significant influencing factors

One limitation of the TRA is that it does not consider a person's voluntary behaviour; hence, Ajzen (1985) developed and extended the TRA, contributing to the theory of planned behaviour (TPB). In addition, Schwarz, Schwarz, Jung, Pérez and Wiley-Patton (2012) recognised two other limitations of the TRA: the absence of explicit visualisation of the role of personal differences, and the exclusion of attitude. Another shortcoming of the TRA, as stated by Yang, Zhou, Hou and Xiang (2014) is that it cannot be applied to certain types of behaviour.

4.3.3 Theory of Planned Behaviour

In 1985, Ajzen expanded the TRA. He developed the TPB. This model emphasises the rule of intention. The theory posits that actual behaviour is proportional to the degree of control exercised by individuals over their behaviour and the power of the user's intentions to perform this behaviour. Ajzen (1985) assumed that self-efficacy is important in determining the power an individual over their intention to behave.

The theory declares that three components lead to intent, and thus to behaviour. The first component is the attitude towards behaviour. This means the degree to which individuals have a positive or negative perspective regarding an issue. The second factor is the subjective norm, the perceived pressure to a particular behaviour from an influential person. The third factor is perceived behavioural control. This indicates a person's perspective regarding their capacity for a particular behaviour. The model assumes that there is a powerful perceived behavioural control, along with positive attitudes and subjective norms. Further, this theory proposes the various motivational forces that influence intent and behaviour, as well as the degree of effort that one might exert in performing the action.

Zheng, Chib, Gao and Wang (2011) aimed to obtain a better understanding of m-health adoption intentions. They extended the TRA model to include additional factors. The outcomes showed that facilitating conditions, attitude and subjective norms are important predictors of m-health adoption intentions. Biezen et al. (2019) investigated how GPs use guidelines and EMRs to support their clinical decision-making in regard to prescription antibiotics in Australia. They undertook a qualitative study that adopting TPB. The findings of the study indicated that the challenges affecting access to, and the use of antibiotic guidelines, included 'familiarity of embedded practice, needs of individual patients and perceived pressure from patients to prescribe against guidelines. Cost, design and format, and the need to access guidelines' (Biezen et al., 2019, p. 6). Moreover, Chen-Chung, Kuang-Ming, Alexander, Ma and Kuo (2016) used TPB to examine the determinants that enabled nurses to preserve privacy in EMR. The results showed that the determinants of attitudes, subjective norms and behavioural control all predicted nurse intentions to maintain EMR privacy.

One of the main issues of the TPB, along with the TRA, is that these factors only consider individual, and not institutional or social aspects (Al-Faresi, 2014) .Further, Rizzo and Columna (2020) mentioned that the TPB does not allow enough precision for predictions. The factors in this theory do not investigate emotional components (Conner, Godin, Sheeran and Germain, 2013), even though emotions might be significant in risk contexts where sentimental decisions can affect conduct (Slovic, Finucane, Peters & MacGregor, 2004). There are factors that can influence behavioural intention and impulses, including past knowledge, dread, limits and dangers, and one's state of mind. These are not represented in TPB. While the model considers regularising influences, it does not consider the environmental or economic components that can influence a person's intention to behave in a particular way.

Most TPB studies have concentrated only on key connections between the variables explored. What has been neglected are demographic contrasts in relation to social cognitive elements, which are there in the TPB (Othman, Yap & Wee, 2011). Nevertheless, TPB has prompted the further improvement of frameworks, including Perugini and Bagozzi's (2001) goal-directed behaviour, as well as the modified framework of Webb, Soutar, Mazzarol and Saldaris' (2013) goal-directed behaviour. Nevertheless, TPB has prompted the further improvement of models such as goal-directed behaviour (Perugini & Bagozzi, 2001) and the modified goal-directed behaviour (Webb et al., 2013).

4.3.4 Social Cognitive Theory

The idea behind social cognitive theory (SCT) was initiated in 1941 by Miller and Dollard, using the preliminary name of social learning theory (SLT). They introduced the idea of modelling into the principle of learning. Numerous researchers have developed

SLT, including Bandura's key contribution. From the 1960s, Bandura developed and expanded the SCT as one of the most dominant theories of human conduct (Bandura, 1989). Bandura's SCT is a hypothetical evaluation that comprehends and anticipates exercise behaviour (Bandura, 1977). It focuses on a triadic proportional determinism in communication between individuals, their conduct and surroundings (Bandura, 1986). SCT reasons that the environment influences behaviour by restraining and altering beliefs (Bandura, 1977).

Human behaviour results from three main elements: personal factors, behaviour and the environment. SCT, as developed by Bandura, defines personal characteristics, behaviour and the environment as interacting in a triadic, dynamic and reciprocal way to produce behaviour. Additionally, SCT can also distinguish strategies that can change conduct. The theory also clarifies how individuals obtain and maintain certain behavioural patterns while simultaneously creating a premise for intervention tactics. Behavioural factors are predominantly centred around performance, use and acceptance issues in the SCT model. Additionally, the SCT suggests that most conduct is learned indirectly. It postulates that past encounters ensure that the expectation of results correlates to certain behaviours.

Lin and Chang (2018) investigated the antecedents of health information exchange (HIE) in a social network by combining SCT with perceived interactivity. The outcomes showed that interaction of person-to-person and person-to-information interactions result in an anticipation of self-management capabilities in relation to health. The results anticipation in social relationships has a significant influence on HIE behaviour. Further, Kong, Deng and Zhang (2019) used SCT to study the factors that affect university student intentions to engage in online health information activities. The authors noted that self-efficacy, information quality, social support, information literacy and information quality all had a

substantial influence on university students' desire to access online health information. Nonetheless, the effect of perceived risk and the efficiency of IT is not considerable. Additionally, Zhou and Fan (2019) studied the factors that affect patient e-health literacy in online health communities (OHC), based on SCT. The findings revealed that health information searching and social communication ties have a favourable effect on patient e-health literacy in OHCs, whereas social communication ties reduce the effect on patient e-health literacy.

SCT is thus an important theory that elucidates human behaviour. Human tasks are identified interactively by conduct, psychological and individual factors; for example, self-adequacy and environmental effects. SCT clarifies how individuals learn and endure with behavioural patterns. Observational learning results as an individual perceives the actions of someone else and strengthens their own behaviour (Bandura, 1977). An alteration in environment does not necessarily result in a change to one's behaviour, and a limitation of the SCT is this assumption that a change in the environment will lead to a change in a person's behaviour (LaMorte, 2018).

4.3.5 Diffusion of Innovation Theory

The diffusion of innovation theory (DIT) attempts to investigate how new ideas or technology can spread. This theory was established by Everett M. Rogers in 1962. Diffusion is the manner in which an innovation is transmitted to specific channels over time by those associated with a particular social system. Innovation is an idea or object regarded as new by society or an individual (Rogers, 2010). This theory introduces the concept of how a particular social group accepts some new ideas and adds their reactions to that idea (Mori & Mlambiti, 2020). Rogers highlighted four different elements within the diffusion of innovations: innovation, communication channels, time and the social

system (Rogers, 2010). He mentioned that these four principal factors affect the spread of a new idea. Decision-makers perform within these elements (over time) to overcome uncertainties regarding the results of the innovation; this may lead to its adoption or rejection. In any social set or system one can consider five ways in which decisions are reached (Rogers, 2003).

The mechanism of diffusion in the theory of innovation can be explained using these five stages:

- Knowledge: in this stage, a person learns more regarding the innovation and improves his or her information and knowledge through focusing on the questions of 'what', 'how' and 'why'.
- Persuasion: this stage is when the person has a negative or positive position or view about an innovative idea.
- Decision: in this stage, the person will analyse both the positives and negatives of the innovation and will thus decide whether to accept or reject the innovation.
- Implementation: in this step, an individual will put the innovation into practice. However, uncertainty regarding the results of the innovation could be an issue. The individual will seek to identify if the innovation is dependable and will look for additional information about its uses and effectiveness.
- Confirmation: after the individual makes a decision, they will look for assistance or encouragement for the implementation (or otherwise) of that innovation.

Gharaibeh, Gharaibeh and de Villiers (2020) examined the principal factors that affect the acceptance of m-health applications between elderly people in Jordan, based on DIT. The results showed that relative advantage, observability, trialability and compatibility affected the acceptance of m-health apps. Further, system complexity had a negative relationship with the acceptance of m-health. In addition, Emani et al. (2012) conducted exploratory research on the applicability of DIT to the investigate perceptions regarding personal health records (PHR). The results showed that DIT was appropriate for

perceptions regarding PHR and provided a fit framework to identify the determinants that defined the users. The ease of use and relative advantage granted through the PHR began as the most significant factor in perceptions of PHR usage and in foretelling its advantages. The authors highlighted the necessity of using other factors in future studies to obtain a better understanding of the influencing factors. Hsu, Liu, Weng and Chen (2013) examined the determinants that affected nurses' intentions toward the use of mobile EMR, based on DIT. The results revealed three innovative components—compatibility, complexity and observability—as significantly affecting nurses' intentions to using mobile EMR. They also mentioned that seniority influenced nurses' intentions significantly.

4.3.6 The Unified Theory of Acceptance and Use of Technology

In 2012, Venkatesh, Thong and Xu re-examined and updated the UTAUT and included extra constructs. The new model is known as the modified (or extended) UTAUT (UTAUT2). UTAUT2 was explicitly modified to examine consumer acceptance and use of IT. Four further factors were added. While experience was included as an internal variable, hedonic motivation, habit and price value were added as external variables. Figure 4.3 illustrates the modified model.

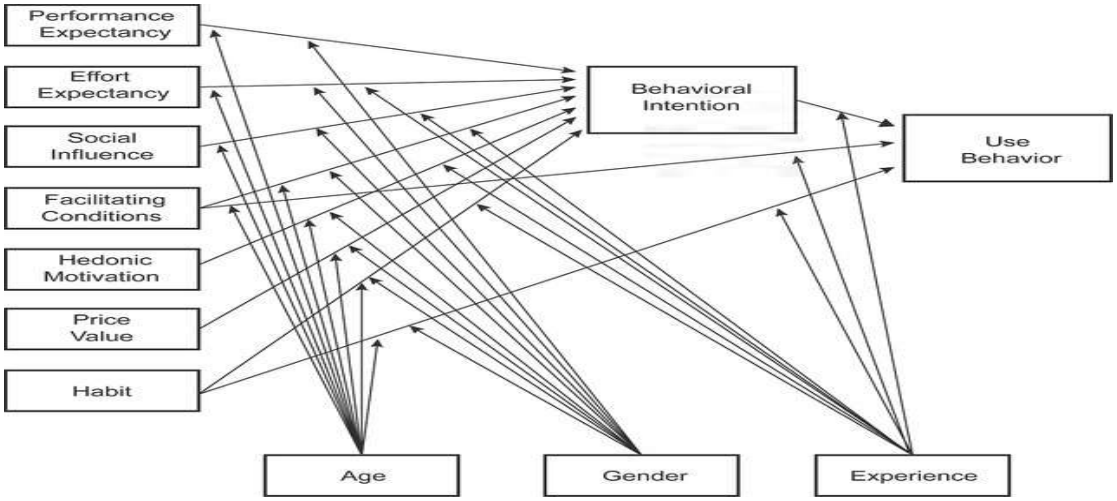

Figure 4.3: Modified Unified Theory of Acceptance and Use of Technology Model by Venkatesh, Thong and Xu (2012)

The aspect of voluntary behaviour in using digital technology, which was in the original UTAUT, was dropped as an internal moderating factor. This was because consumers in a non-organisational setting had no authoritative obligation to use digital technology and hence its use became voluntary.

The various concepts of UTAUT2 were characterised by Venkatesh, Thong and Xu (2012) as follows:

- Performance expectancy alludes to the degree to which using a technology will be valuable to consumers while undertaking specific activities.
- Effort expectancy is the degree to which the technology is easy for end users to use.
- Social influence refers to how much consumers trust that key people, such as friends and family, believe they should use a particular technology.
- Facilitating conditions identifies the opinions of buyers regarding the help and resources accessible to perform a certain behaviour.
- Hedonic motivation is characterised as the pleasure one obtains from using a certain kind of technology. Hedonic motivation plays a significant role in the acceptance of technology.

- Price value refers to the consumer's psychological resolution between the money-related aspects of using technology and the perceived advantages of using the technology.
- Habit alludes to the degree to which individuals perform specific behaviour naturally through learning.

4.3.7 Motivational Model

Davis, Bagozzi and Warsshaw (1992) developed the motivational model (MM) based on psychological aspects. The MM is significant in psychology as it is considered an explanation for behaviour. It has also been implemented to understand the acceptance and use of technology (Venkatesh & Speier, 1999). According to Davis et al. (1992), behaviour is a significant aspect of both extrinsic and intrinsic motivation. Intrinsic motivation is the perception that people are willing to do something for the sake of the activity. Further, intrinsic motivation is usually an activity undertaken for personal interest, and behaviour is its own reward (Davis et al., 1992). On the other hand, extrinsic motivation is an activity performed to gain a reward; for example, to improve one's work performance for a promotion.

Moon and Kim (2001) stated that apparent playfulness and enjoyment are intrinsic sources of motivation, while perceived usefulness is considered an extrinsic source of motivation. This has also been examined in other studies: in the context of technology acceptance, intention and actual usage are affected by both motives. Davis et al. (1992) argued that apparent enjoyment is determined by the ease of use the user experiences. However, the authors also observed that apparent enjoyment and usefulness are determined by the quality of the result and ease of use. Intrinsic motivation is considered a vital motivator that has strong effects on learning, adopting and developing individual

skills and capabilities. If a person has an opportunity to adapt their behaviour freely, then intrinsic motivation will be a vital source of that behaviour (Ryan & Deci, 2020).

The MM has been described as varying behavioural intentions in only variance 28% (Igbaria, Parasuraman & Baroudi, 1996), which is considered a low variance level. Therefore, Alkhwaldi and Kamala (2017) argue that MM should include new factors that can explain variance in behaviour. Moreover, Davis et al. (1992) state that the MM has fewer constructs that negatively affect its prediction power. Venkatesh and Speier (1999, p. 3) criticised the model, arguing that it does not discuss all the fundamental factors that influence intrinsic and extrinsic motivations for MM in relation to technology use.

4.3.8 Task-Technology Fit

The task-technology fit (TTF) model by Goodhue and Thompson (1995) has been widely studied in information systems, including HISs (Ali, Romero, Morrison, Hafeez & Ancker, 2018; Laugesen & Hassanein, 2017). TTF studies the technology and task characteristics as they fit the requirements of a task to enhance user performance (Goodhue & Thompson, 1995). TTF asserts that users do not rely solely on their beliefs and attitudes for the choice of technology; TFF can identify the factors of technology acceptance.

The TTF model includes two constructs: task and technology characteristics, which influence use and task performance (Goodhue & Thompson, 1995). TTF shows that if a technology has the characteristics that fit the requirements, then satisfactory performance will be achieved (Tam & Oliveira, 2016). Oliveira, Faria, Thomas and Popovič (2014) state that TTF users cannot be assumed to embrace a technology if it is unsuitable for daily tasks.

As Figure 4.4 shows, task and technical characteristics affect TTF, affecting system use and also user performance.

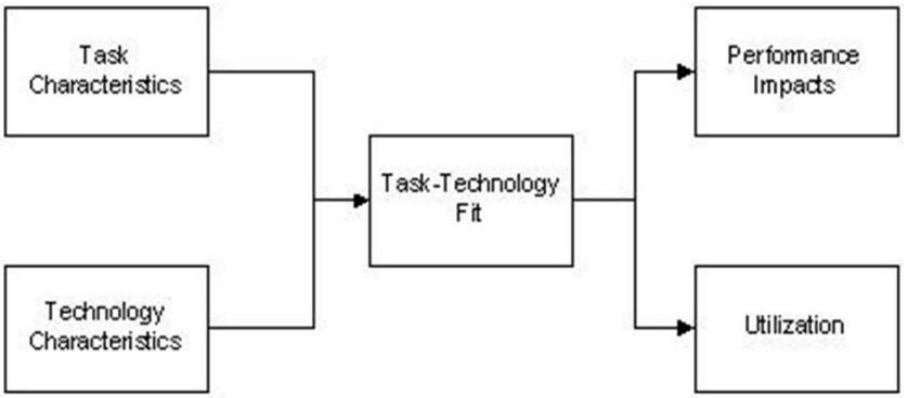

Figure 4.4: Task-Technology Fit (Goodhue & Thompson, 1995)

TTF evaluates a technology by examining the relevance between task and technology characteristics. TTF suggests that technology can improve the performance of users when the system is commensurate with their duties, and can assist them to perform their tasks properly (Goodhue & Thompson, 1995).

TTF implies that technology will have a positive influence on performance when its functionality is suited to task requirements (Goodhue & Thompson, 1995). Therefore, it is important to consider TTF when adopting or developing new technologies, to ensure that they suit the task, or the user needs.

TTF is defined as 'the degree to which a technology assists an individual in performing his or her portfolio of tasks' (Goodhue & Thompson, 1995, p. 216). Technology characteristics are the qualities users incorporate when performing certain tasks; these include the device, software and accuracy of system outputs. Utilisation is the technology recruitment behaviour towards performing the needed tasks. Performance effect refers to

the efficiency and high quality of the results achieved by a user (Goodhue & Thompson, 1995).

4.3.9 Unified Theory of Acceptance and Use of Technology as the Assessment Framework

The assessment framework for this research is based on the UTAUT model (Venkatesh et al., 2003). Figure 4.5 illustrates the model used in this study.

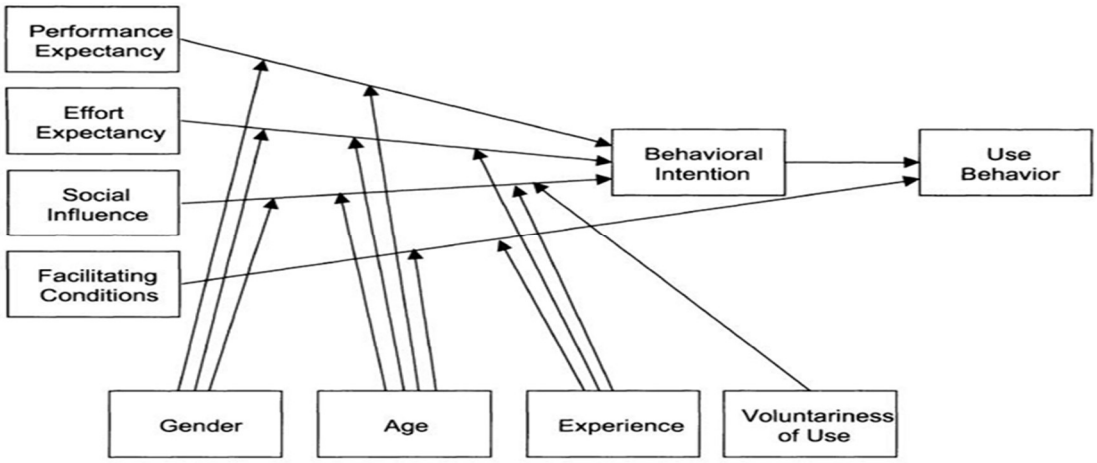

Figure 4.5. Unified Theory of Acceptance and Use of Technology by Venkatesh et al (2003)

As mentioned earlier, this research intends to use the UTAUT model to investigate CDSS acceptance among GPs and to examine the determinants that influence practitioners' acceptance of CDSS. The relevant literature suggests that the UTAUT model is based on eight different models:

1. the theory of reasoned action
2. the technology acceptance model
3. the theory of planned behaviour
4. a model combining the technology acceptance model
5. the motivational model

6. the model of PC utilisation
7. the innovation diffusion theory
8. and social cognitive theory.

The UTAUT model contains four variable factors: gender, age, experience and voluntariness of use. It also includes four principal determinants: performance expectancy, effort expectancy, social influence and facilitating conditions (Venkatesh et al., 2003, pp. 447–453). These factors are summarised as follows:

- Performance expectancy: the degree to which a belief is developed (by users of a system) according to which the information system will provide assistance to users in obtaining necessary gains from performing a job.
- Effort expectancy: the degree to which it becomes easy for users to use an information system.
- Social influence: the degree to which a perception is developed by individuals that the system should be used because it has been recommended by others. This has been predicted by the model that, within the system of information, posits that user behaviour is affected by behavioural intention.

According to Venkatesh et al. (2003), these determinants (social influence, performance expectancy and effort expectancy) have an immediate effect on users' behavioural intentions, while facilitating condition has an immediate effect on user behaviour. Venkatesh et al. (2003) asserted that these four major constructs are influenced by the following four variables:

- Gender: the degree to which being a male or female influences the use of a new system.
- Experience: the extent of use within a given period with experience being gained in the process.
- Age: the extent to which an individual's age influences the use of a new system.
- Voluntariness: the extent to which the system is used in a voluntary manner.

According to Venkatesh et al. (2003), the user's gender influences three constructs (social influence, effort expectancy and performance expectancy), while the age of a user affects all four constructs. Experience will influence effort expectancy, facilitating conditions and social influence. However, voluntariness will only influence the social influence construct. Finally, facilitating conditions never influence an intention to use CDSS in UTAUT, but they are linked to user behaviour.

4.4 Justifying Application of the Unified Theory of Acceptance and Use of Technology Model

UTAUT has been developed through investigating eight acceptance theories and models and considering the most significant determinants that influence technological acceptance.

The UTAUT model has been useful in several disciplines that focus on assessing the possible success of a new technology; it assists in understanding the drivers of acceptance (Gunawan, Sinaga & Purnomo, 2019). The flexibility and comprehensiveness of the UTAUT are part of its usefulness as a hybrid theory that combines the most ideal features of the eight earlier models. The advanced nature of UTAUT's explanatory power is considered more desirable when compared with other theories and models (Dulle & Minishi-Majanja, 2011; Venkatesh et al., 2003). The UTAUT model provides more explanation and clarification of the factors that influence the use of information systems than do other theories (Cobelli, 2020). It can examine more data through the variety of factors it includes (Yueh, Huang & Chang, 2015).

Good descriptions provided by qualitative research are ideal for exploring UTAUT's main constructs (Gruzd, Staves & Wilk, 2012). The use of qualitative interviewing that includes open-ended questions allows users to express themselves fully without

hindrance and may lead to the discovery of more issues (Devaraj et al., 2014). Further, the UTAUT model has been adopted in numerous studies that have investigated the acceptance and use of technology in developing countries (Alaboudi et al., 2016; Bawack & Kala Kamdjoug, 2018; Hoque & Sorwar, 2017; Mansoori, Sarabdeen & Tchantchane, 2018). In this research, the interview questions posed to GPs relate to the key factors of the UTAUT model to assess the effect of CDSS acceptance

UTAUT's illustrative power in clarifying in variance was 70% of intended use is significantly higher (Venkatesh et al., 2003) than other models, which have clarified only 40% (McGrath, Waehama, Korthaus & Fong, 2014). Marto, Gonçalves, Martins & Bessa (2019) considered that UTAUT is very helpful as it grants insights when applied to many different cultures. The UTAUT model has been applied to different studies of technology acceptance in healthcare services (Kim, Lee, Hwang & Yoo, 2016; Kohnke, Cole & Bush, 2014; Shibl et al., 2013).

Ameri, Khajouei, Ameri and Jahani (2020) note that UTAUT is one of the most extensive and robust technology acceptance models. UTAUT has been applied in many areas dealing with the acceptability of IT, and its validity has been proven by several studies in different fields, such as education (Hager & Sawsen, 2018), business (Khalilzadeh, Ozturk & Bilgihan, 2017; Samar, Mazuri Abd, Feras & AbdulHafaz, 2018) and e-government (Yavwa & Twinomurinzi, 2018). The UTAUT is used in several different sciences (Aldhaban, 2012). Khechine, Lakhal and Ndjambou (2016) argue that UTAUT is a comprehensive framework that can be applied to investigate the acceptance of new technology in various areas. UTAUT has been modified for many different studies, in order to discover other factors that may affect the user's acceptance of the information technology.

Nieboer, van Hoof, van Hout, Aarts and Wouters (2014) used a UTAUT model based on a qualitative phenomenological approach, with semi-structured and open-ended interviews, to investigate the views and values of professionals in the healthcare industry concerning successful technology implementation. The UTAUT has been applied in many qualitative studies that use semi-structured interviews. Several examples are listed below:

- The study conducted by (Pather & Abiodun, 2017) investigated the factors influencing the adoption of cloud computing in the business domain. In this study, four influential people from four different small projects were interviewed.
- Mahzan and Lymer (2014) examined the implementation of computer-assisted audit instruments by conducting interviews with ten decision-makers, focusing on the adoption of a computer-assisted audit.
- The study by Rempel and Mellinger (2015) investigated why scholars prefer bibliographic management methods and what causes them to continue with this approach. The researchers collected qualitative data from scholars who use a bibliographic management method. This study used UTAUT to provide a better understanding of these scholars' bibliographic management.
- Cranen et al. (2012) investigated patients' attitudes concerning prospective telerehabilitation and the determinants that aided or hindered patient intentions to use such services. The researchers interviewed 25 patients with chronic pain, where patients' attitudes were first classified according to the UTAUT (Cranen et al., 2012).
- The study conducted by Mejia and Torres (2018) investigated the implementation and normalisation process of asynchronous video interviews in the hospitality

business with UTAUT. They used semi-structured interviews with hiring managers from three different hospitality companies.

- UTAUT was used to recognise the facilitators and obstacles to the implementation of robotic-assisted surgical procedures; semi-structured individual interviews were carried out with 21 surgeons (Benmessaoud, Kharrazi & MacDorman, 2011).
- Another study sought to determine if, why and how researchers used social networking for connecting with other people and knowledge dissemination. Fifty-one semi-structured interviews with researchers in IS were analysed by using UTAUT to explain researchers' use of the social network (Gruzd et al., 2012).
- Hennington, Janz, Amis and Nichols (2009) adopted a qualitative method of data collection to investigate nurses' experiences in using the Universal Health Services Hospital EMR System in the US. Twenty-three nurses were interviewed, in addition to four nursing directors. The determinants of the UTAUT model were used to develop a theoretical framework for their study. Moreover, they assessed the effect of UTAUT structures and discovered key influencing factors outside the UTAUT model by conducting interviews.
- Rhodes (2016) presented a qualitative study based on the UTAUT model. The aim of this study was to evaluate current HIS standards to determine whether they were adequate to guide the evolution of national and international interoperability standards. The author interviewed 20 HIS professionals chosen from a professional healthcare administration organisation, and defined nine particular determinants that influenced healthcare centre actions. These were 'leadership, patient focus, planning, communication, alignment with lifecycle models, training

and user input, change management and recognition of the power of technology'. (Rhodes, 2016, p. iii)

Nunes, Limpo and Castro (2019) examined the roles of age and gender in the use and acceptance of m-health applications by employing the UTAUT model to investigate the main factors. The study showed that this model was a useful framework with which to investigate the behavioural intent to use technologies in this area.

The current study investigated each construct of the UTAUT model in depth, and discovered more factors related to the effect of CDSS acceptance by GPs in Saudi Arabia. Thus, this research adopts a more exploratory qualitative approach to provide a comprehensive understanding of CDSS acceptance in developing countries. Qualitative research enables the discovery of rich information, and as a result can provide the opportunity for new issues to be identified as well as clarifying issues already identified in the UTAUT model. This qualitative approach enables the 'how' and 'why' research issues to be answered (Cleland, 2017). Thus, to acquire information from participants on new issues regarding the factors that influence the acceptance of CDSS, semi-structured, in-depth interviews are appropriate at this stage.

4.4.1 Justification of the Integrated TTF Model with UTAUT as a Conceptual Framework for The Study

Through the study and revision of different acceptance models, this research proposes to integrate TTF with UTAUT. This seems to be the most relevant conceptual framework to make a reliable model capable of identifying the factors that influence CDSS as well as identifying the factors that affect the new technology in the field of HIS. Both models are distinguished by significant clarification and interpretation of information technologies acceptance, and the combination of the two provides a significant improvement over each

single model (Lai, 2017). Mosweu and Bwalya (2018) argue that the UTAUT model needs to be extended by using another model in order to gain a deeper understanding of the factors that influence technology adoption. Furthermore, according to Alazab, Alhyari, Awajan, and Abdallah (2021), the combination of the two models helps to have more knowledge of the task characteristics and gives more accurate results in regard to the willingness to adopt technology.

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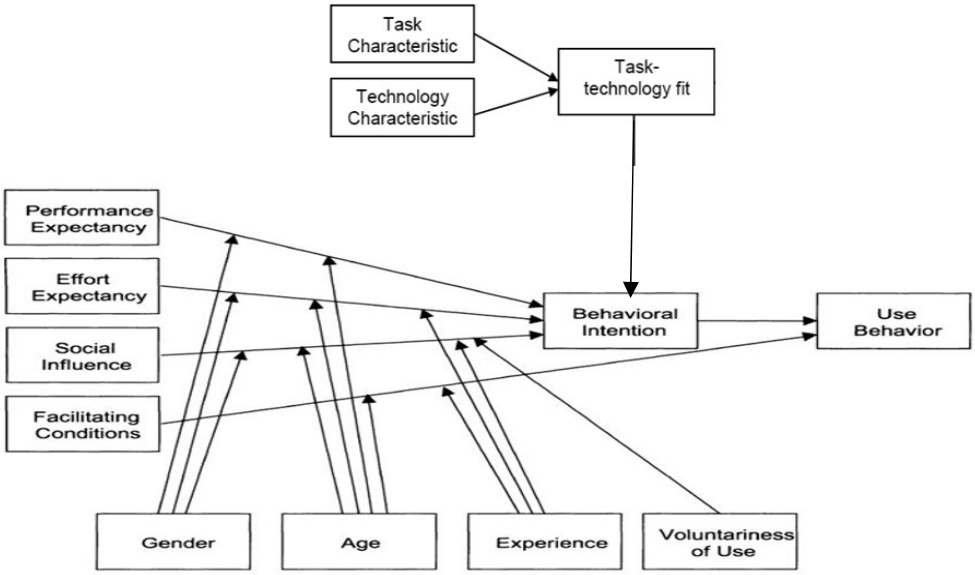

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Figure 4.6. Conceptual Model of Integration of UTAUT and TTF

Several studies that have integrated TTF with TAM (McLean, 2018; Narman, Holm, Hook, Honeth & Johnson, 2012; Wu & Chen, 2017; Yen, Wu, Cheng & Huang, 2010). Usoro, Shoyelu and Kuofie (2010) state that both TAM and TTF provide highly explanatory frameworks, but that the combination both outweighed the individual models. In addition, different studies have integrated TTF with UTAUT to study technology acceptance (Afshan & Sharif, 2016; Park et al., 2015; Zhou, Lu & Wang, 2010). Further, Khairat, Marc, Crosby and Al Sanousi (2018) provide a critical review of

CDSS studies. They indicate that combining the models can develop and enhance user acceptance to promote and assist the successful adoption of CDSS. The authors state that if a user does not accept the system, this may threaten the healthcare and wellbeing of patients.

The integrated UTAUT-TTF model provides important contributions to the field of technology acceptance modelling. First, UTAUT has been developed as a result of investigating and studying eight acceptance theories and models and takes account of the most significant determinants that influence technological acceptance. However, those studies do not include TTF, which considers task performance.

UTAUT is thus adequate for determining user attitudes to acceptance technology, but it does not sufficiently explain its TTF (Zhou et al., 2010). Zhou et al. (2010) outline the adoption of mobile banking services in China and found that the TTF-UTAUT model led to better results than using a single model. Each model has different advantages: UTAUT focuses on the study of the trends and behaviour of the user and pays little attention to the task that was already focused on TTF, or the degree of fitness of the technology regarding the task (Oliveira et al., 2014).

The advanced nature of UTAUT's explanatory power is considered more advantageous than other theories and models (Dulle & Minishi-Majanja, 2011; Venkatesh et al., 2003). The UTAUT model is one of the most effective theories in explaining the factors that influence the acceptance of technologies (Cobelli, 2020). Its diversity of factors contributes to extensive data examination (Im et al., 2011). Its illustrative power in clarifying 70% of intention to use is significantly higher (Venkatesh et al., 2003) than any other model, which have clarified only 40% (McGrath et al., 2014).

Another justification for the combination is that TTF is based on the premise that individuals will not directly use a technology if it does not suit their requirements and enhance their performance (Wang et al, 2020). Therefore, TTF has been added to UTAUT to study the determinants of TTF and identify more factors that influence the uptake of CDSS. Nunes et al. (2019) mentioned the importance of considering the user's characteristics as a necessary factor to gain a better understanding of behavioural intent in developing m-health.

Voluntariness of use was excluded owing to the system not yet being adopted, as the study focuses on the perspectives and intentions of physicians in relation to CDSS use. Moreover, if primary health centres and hospitals adopt the system, it will be compulsory and therefore the voluntariness of use factor is not relevant. In addition, several studies that have applied the UTAUT model have also not included the voluntariness of use factor, as the systems in question are considered compulsory (English, Ankem & English, 2017; Liebenberg, Benade & Ellis, 2018). Further, Trimmer, Cellucci, Wiggins and Woodhouse (2009) also note that any research that applies the UTAUT model to an EMR acceptance and adoption study does not need to include voluntariness of use because it is not a real variable, given that use will be mandatory if adopted.

The research investigated each construct of the UTAUT and TTF model in depth and discovered new factors that may relate to the effect of CDSS acceptance by GPs in Saudi Arabia. Thus, this research adopts a more exploratory qualitative approach to provide a comprehensive understanding of CDSS acceptance in Saudi Arabia.

4.5 Extension of the Model

For better understanding of the problems related to user acceptance in the industry of healthcare, TTF must be incorporated into evaluation frameworks, with the factor of user

acceptance. TTF is a significant addition for understanding the needs of user acceptance. This factor as seen in organisations, technologies and users could determine the factors that affect user acceptance (Mohamadali & Garibaldi, 2012). For understanding user acceptance in healthcare technology, we must comprehend not only the facts that affect acceptance but how these factors are fit. Even though various researchers have explained the matter of 'fit', this has been insufficient, because its significance within the organisation must be explored in detail, combining the technology with the user, to understand the issues concerned with the implementation of healthcare technology. There is a strong need to understand the empirical support for the factor of fit when determining the acceptance of healthcare technologies by users (Mohamadali & Garibaldi, 2012). Researchers must examine the factors that affect user acceptance regarding evaluation of user acceptance, along with the factor of fit in relation to the technology and users (Mohamadali & Garibaldi, 2012).

Alqahtani et al. (2017) have identified the obstacles that prevent the adoption of EHR in the Kingdom of Saudi Arabia. The researchers highlight the need to develop a new model for the adoption and acceptance of EHR, where the results will contribute to developing an appropriate framework. EHR contains comprehensive factors that support the work of both policymakers and workers in the field of health informatics, and researchers in the academic field and physicians. UTAUT is considered a general model and by itself is not enough to investigate the unique features of doctors, so it is important to develop and improve it to identify more factors that can explain the behaviour of doctors in the use of health technologies such as CDSS (Sambasivan et al., 2012).

Ritter (2019) has identified factors that influence the adoption of AI in the healthcare sector based on the UTAUT model, also including other factors such as trust, perceived

risk, anxiety and attitude. Ritter feels that the UTAUT model is insufficient to investigate the factors that affect the intent of using AI in health. He recommends that further studies be undertaken to contribute to the discovery of new factors. Further, Sevani and Marpaung (2018) state that recognition and understanding of factors of HIS acceptance are essential for successful implementation of IT. They argue that to implement IT in developing countries, UTAUT should be extended. That would then provide an appropriate model to implement HIS. Moreover, Rhodes (2016) has extended his study of the UTAUT model in EHR system development to discover and define the contributory determinants that influence the adoption of an EHR system. He interviewed 20 HIS professionals chosen from a healthcare administration organisation.

The UTAUT model has been widely used in the acceptance of IT. Nevertheless, in the domain of HIS it is considered simplistic as it focuses on limiting factors (Shachak et al., 2019). It is crucial to develop a model that combines more comprehensive factors that can contribute to a better understanding of the issues associated with the implementation of HIS. Providing a more extensive model to assess and investigate the characteristics of successful CCDS adoption and implementation would support professionals in the development, implementation and evaluation of CCDS (Delvaux et al., 2017).

Even though a number of models and frameworks regarding technology acceptance exist, UTAUT and TAM are two significant concepts used in the acceptance of health technology research (Li, Talaei-Khoei, Seale, Ray & Macintyre, 2013). Although UTAUT is the most detailed model in acceptance theory of IT, revision and modification of the model are required to accommodate different questions of research (Boes, Borde & Egger, 2015). Consequently, the modifications and extension of the actual model are

important for integrating variables that reflect the unique characteristics (Huan, Li, Aydeniz & Wyatt, 2015).

Al-Hadban, Hashim and Mohd (2016) evaluated the elements that assist in HIS adoption by healthcare staff in developing nations, specifically in Iraq. They mention the importance of adding further factors into the model of UTAUT to fulfil the needs of the study. The authors indicate that further research can provide detailed analyses with the use of qualitative approaches and develop an in-depth comprehension of the issues, adding other factors that might assist in HIS acceptance (Al-Hadban et al., 2016). Further extension of UTAUT is required to facilitate a better understanding of the dynamic and complex nature of health care, and how acceptance of certain solutions, despite their general appearance and acceptance, can be beneficial (Nguyen et al., 2016).

4.6 Chapter Summary

This chapter has presented an overview of what constitutes technological acceptance and the significance of studying it. In addition, this chapter has reviewed the existing literature on nine different theories of acceptance of technology. Finally, this chapter presented a justification for the integrated TTF-UTAUT model as a conceptual framework, and outlined the importance of extending the model.

This chapter has considered the importance and necessity of conducting studies related to the acceptance of IT. Through previous literary reviews, studies show that accepting technology by users will help organisations achieve a strategic advantage, reduce costs, improve performance and successfully implement IT. In the case of HIS, these systems can significantly influence patient care. Therefore, studying the use and acceptance by physicians is essential to obtain a better understanding of the GPs' perspectives and desires regarding the technology intended for acceptance, to consider their requirements

and desires at the design and implementation stage of the health system. Investigating the acceptance of healthcare experts will contribute significantly to the exploration and accumulation of knowledge that can improve healthcare services. The lack of acceptance of target users for HIS is one of the main reasons for the failure of IT implementation.

This chapter has also reviewed the existing literature on theories of acceptance of technology, which embrace the TAM, TRA, the UTAUT, the TPB, the SCT, the DIT, the UTAUT2, the MM and TTF.

The assessment framework for this research is based on UTAUT (Venkatesh et al., 2003). The UTAUT model includes four principal determinants: performance expectancy, effort expectancy, social influence and facilitating conditions. Three determinants (social influence, performance expectancy and effort expectancy) have an immediate effect on user behavioural intentions, while facilitating conditions have an immediate effect on user behaviour. The UTAUT model is one used in many recent studies in accepting IS in many different fields. One of the main reasons why UTAUT is so popular is that it was originally developed and built on the basis of eight theories and models of acceptance technologies. It takes into account the most important determinants that affect technological acceptance. UTAUT's explanatory power is more effective than other theories and models. The contributions of this model have notably led to the better comprehension of the factors that affect technology use. The UTAUT model is valuable because it can examine a large data set on a global scale. UTAUT has been modified in many different studies, yet the need for increasing the knowledge of views and intentions of individuals still requires the basic model.

This study investigated each factor of the UTAUT model in depth and explored other determinants related to the influence of CDSS acceptance by GPs in Saudi Arabia. Thus,

this study uses a more exploratory qualitative approach to obtain a comprehensive understanding of CDSS acceptance in developing countries. Applying a qualitative research method enables the discovery of rich information which, as a result, can provide an opportunity for new factors to be identified and added to the UTAUT model. Therefore, semi-structured in-depth interviews are appropriate for this study.

Through the study and revision of different acceptance models, this research integrates the model of TTF with UTAUT. This combination is the most relevant conceptual framework that makes a reliable model capable of identifying the factors that influence CDSS. Several studies have integrated TTF with TAM, as well as TTF with UTAUT, and have been highly explanatory. The results of that combination have outweighed individual models. Another reason for the integration of both models is that although UTAUT was adequate for determining user attitudes to acceptance of IT, it did not sufficiently explain its task for technology fit. Therefore, TTF has been added to UTAUT to study the determinants of TTF and to identify more factors that influence the acceptance of CDSS.

The studies indicate that the UTAUT model by itself is insufficient to investigate the factors that affect the intent to use HIS. Therefore, it is essential to determine and explore the factors that affect the acceptance of HIS to provide information and knowledge to stakeholders. This will promote the successful implementation of HIS and identify more opportunities to develop and improve HIS, which in turn may provide technical solutions that contribute to providing high-quality health care, especially for developing countries.

Chapter 5: Research Methodology

This chapter describes the methodological approaches in the study. A discussion of the different research methods available and a justification for the chosen method (qualitative semi-structured interviews) is presented as a part of the research process. This chapter concludes by mentioning the most important points in the ethical considerations, as well as occupational health and safety risk aspects regarding this research.

5.1 Methodology

5.1.1 Research Paradigm

Researchers make important decisions when selecting the most appropriate methodology for their studies. Basically, they tend to choose from three types of research methods: quantitative, qualitative and mixed methods. Each method is usually embedded in a different research perspective, such as positivism, interpretivism and pragmatism. According to Gray (2014), positivists believe that ideas should be put to the test of empirical experience to be validated. This will be accomplished through scientific study to accumulate data as it progresses or emerges. Positivists also believe that both natural and social worlds act within a strict set of requirements, which can be found through empirical examination.

Interpretivism, however, is the opposite of positivism. Associated with constructivism, interpretivism holds that because natural and social realities are different, different tests are required to validate theory. Here, the social sciences transact with the behaviour of the individual, such as symbolic interactionism, phenomenology, realism, hermeneutics and natural enquiry. Interpretivism also believes that meanings are not fixed or permanent but change according to background and experience.

Finally, pragmatism asserts that an ideology is real or true if it produces practical outcomes for society. This is why pragmatists focus on how a proposition fits a purpose and is capable of creating action. While undertaking research, pragmatists may combine or mix research designs (Gray, 2014).

To further differentiate the three research perspectives, Table 5.1 details the strengths and weaknesses of each.

Table 5.1. Three Research Philosophies

Research Paradigm	Strengths	Weaknesses
Positivism	- Theory can be generalised to a greater or lesser degree, even when replicated in diverse populations and sub-populations - Allows predictions - Validity is extensive (Johnson & Onwuegbuzie, 2004)	- The knowledge produced can be too general or abstract - Difficulty in detaching from hypotheses - Not suitable in human phenomena that test human behaviour (Johnson & Onwuegbuzie, 2004)
Interpretivism/ Constructivism	- Coherent and logical structure; orientation towards generating practice-relevant findings; attention to commitment and disciplinary biases (Hunt, 2009)	- Limited resources to perform or conduct measures; challenges in using lesser-known methodology; uncertainty in interpreting data (Hunt, 2009)
Pragmatism	- Can use both text and visuals to investigate a study to add meaning; provides more meaningful answers to research questions; can provide stronger evidence (Johnson & Christensen, 2012)	- Can be difficult to carry out; researchers must learn multiple methods and approaches (Johnson & Christensen, 2012)

5.1.2 Appropriate Paradigm to Use: Interpretivism

Because of the nature and aims of this research, the interpretivism paradigm was selected. The main query of this research involves the investigation of CDSS acceptance in Saudi Arabian health organisations, through GPs' experiences and intentions. According to Burton and Bartlett (2005), the interpretivist paradigm views society as not having a fixed approach, as the social world is created through interactions among individuals. Standards and values still exist, but they are considered essential components of social life. They are also used and altered by people as they interpret and respond to issues affecting them. The interpretivist approach demonstrates how participants or actors in social situations make choices and decisions, within the process of interactions. The interpretivist does not see or believe that objective reality exists outside the actor's explanations, but rather these are seen as varying versions of cases.

In using interpretivism, it is essential to consider its strengths and weaknesses. As discussed by Ponterotto (2005), one of the distinguishing features of interpretivism (or constructivism) is the supremacy of interaction between the researcher and the identified participants of the research. This is the only measure or interaction where a deeper sense and understanding can be revealed. Researchers can work together to create or construct findings, based on their respective dialogues and interpretations. The constructivist approach tends to rely on the viewpoints of the participants in the study. This model is consistent with this research plan in terms of using a qualitative approach through semi-structured interviews (Neuman, 2014).

Taking these details into account, Table 5.2 adds to the list of the strengths and weaknesses of interpretivism.

Table 5.2. Strengths and Weaknesses of Interpretivism

Interpretivism-	
Strengths	**Weaknesses**
-Allows the researcher to gain insiders' perspectives, especially upon trying to understand the subjects from within	- The subjective nature can question its reliability, especially as they are mostly people's thoughts and feelings
- Allows concepts to be identified and explained	- Findings are less likely to be generalisable to other settings
- Enables researchers to investigate explanations, then inferring them in measurements	- Time and resources required to gather information can be considerable
- Describes and expounds the relationships among research stakeholders	

Source: Gratton and Jones (2010, p. 28)

5.2 Research Methodologies

Research requires the use of an appropriate research method that best represents and supports the study design, data collection and analysis. Three broad research approaches are available: quantitative, qualitative and mixed methods. It is essential to understand the different research methodologies, their advantages, negative aspects and challenges to determine the most appropriate methodology for the current research. As Creswell (2014) discusses, researchers must think about the philosophical worldview assumptions that could affect the study design, specific approach or procedures of the study. The choice of proper research method is significant as it also helps researchers to collect information that is most suited to the research.

5.2.1 Quantitative Methods

Quantitative research tests objective theories through an examination of relationships among variables; variables can be measured by identified instruments and numbered data can be statistically analysed (Creswell, 2014). Researchers who use this kind of enquiry

have assumptions and theories that are tested deductively. They also build protection against prejudice, manage alternative interpretations and can generalise and duplicate the outcomes (Creswell, 2014).

The quantitative method presents statistical proofs through large sample reliability (Goertzen, 2017), using questionnaires, laboratory investigations and mathematical techniques, including statistical modelling (Straub, Gefen & Boudreau, 2005). Because of the large samples used, results from quantitative research can normally be generalised to populations(Creswell, 2014). This method demands fewer resources at the data collection stage than do qualitative study techniques (Mingers, 2001).

Limitations of the quantitative approach include the difficulty of controlling the study sample (as compared with qualitative approaches) (Myers & Newman, 2007) and the inability to discover detailed knowledge about certain phenomena and the social context (Mingers, 2001).

5.2.2 Mixed Methods

Mixed methods research is an approach that involves the collection of both quantitative and qualitative data, with the two types of data being integrated through various designs including, philosophical hypotheses and theoretical models. This method assumes that a combination of quantitative and qualitative approaches provides a more complete or comprehensive understanding of a research problem (Creswell, 2014)

Neuman (2014) notes that the mixed methods approach contributes to validation and reliability of the results and overcomes the limitations of each research method when used individually. Use of a mixed approach is increasingly acknowledged as achieving better outcomes for the issues under investigation (Mayoh & Onwuegbuzie, 2015). It

contributes significantly to the research, reaching greater depths and reducing the effects of quantitative and descriptive research results in case only one of them is used in the research method (Almeida, 2018).

5.2.3 Qualitative Research

Qualitative research methods seek to explore and understand the meanings of the person or people assigned to a social issue or matter. The research method includes merging enquiries and processes. Data are usually obtained from the participants' settings. Qualitative data are analysed inductively; that is, this means that the issues are considered, researched, and in-depth in order to build and develop the theory. Moreover, the researcher makes their own interpretations from the data gathered (Creswell, 2014).

Qualitative methods are suitable for an in-depth comprehension of phenomena (Liamputtong, 2020) and offer rich information, using quotations from participants that assist with the study outcomes (Sharan Merriam, 2014). When qualitative data are analysed, it usually leads to a deeper understanding of the research problem and allows the researcher to obtain more abundant and powerful information in comparison to quantitative data approaches (Anderson, 2010). Moreover, Duane et al. (2016) state that the qualitative approach is the most well known and is used in real life.

Structured semi-structured interviews are one of the commonly used approaches in qualitative research because of their flexibility in collecting data and the possibility of their adaptation in many uses (Kallio, Pietilä, Johnson & Kangasniemi, 2016). Semi-structured interview questions are pre-determined, relate to the core research interest and are administered to the identified sample of respondents (Kallio et al. 2016). The semi-structured interview offers freedom and time to the participant in the study through open questions, imparting confidence to the interviewer. This contributes to obtaining more

reliable data through in-depth discussion and debate with the participant (McIntosh & Morse, 2015). According to Yin (2014), the semi-structured interview must examine or interview enough participants to reflect the richness of the perceptions and obtain comprehensive comparisons. Researchers should also possess appropriate interviewing skills, together with the skills necessary to analyse the data effectively. Confidentiality must be observed while conducting the research. The researcher must make careful plans to avoid using prescriptive or misleading questions. In addition, semi-structured interviews can be time-consuming and require many resources (McGrath, Palmgren & Liljedahl, 2019). According to De Satgé and Holloway (2002), a semi-structured interview is a guided conversation about a research topic, where insights are acquired through discussions and visual analyses. What distinguishes a semi-structured interview is its adaptability and flexibility. Even if the semi-structured interview is categorised as an informal conversation, it is important to take the following points into consideration when this approach. The interviews must be:

- well-structured, well-defined and planned ahead of time
- directed by clear goals and with a checklist of relevant research issues and problems
- interactive, wherein those interviewed can ask questions of the researcher/interviewer (De Satgé & Holloway, 2002).

Each of these research methods possesses certain strengths and weaknesses that should be considered. The strengths and weaknesses of each research method are summarised in Table 5.4, with details acquired from Johnson and Onwuegbuzie (2004).

Table 5.4. Weaknesses and Strengths of Three Research Methods

Research Method	Strengths	Weaknesses
Quantitative	Can test and validate pre-constructed theories. Tests pre-constructed hypotheses before data are collected. Can generalise research findings. Research can construct situations that can eliminate confounding influences of several variables.	Researcher categories used may not reflect understanding of the local constituencies. Theories may not reflect local understanding Researcher may miss some phenomena.
Qualitative	Data are based on individual viewpoints and specific categories of the participants. Beneficial for examining and studying small numbers of the research population. Can describe phenomena in rich detail. Can determine how constructs are interpreted Responsive to local situations.	Results can be easily influenced by biases. Difficult to make quantitative predictions. Takes more time to collect data. Have lower credibility compared with quantitative research.
Mixed methods	Words and numbers can be used to add further meaning. Embodies strengths of both quantitative and qualitative research.	More time-consuming. More expensive.

5.3 Justification for Choosing the Qualitative Method

This study relies on the qualitative method to collect data through conducting semi-structured interviews. In this study, the questions and enquiries of a semi-structured interview pattern were pre-formulated, and the answers from the participants were based on open-ended questions. The answers extend through the control and management of the

interview by the interviewer. Therefore, the questions were expanded by enquiries and discussions to instigate more examination and comprehensive answers.

The study adopted the semi-structured interview to obtain detailed information on the factors influencing the acceptance of CDSS for healthcare in Saudi Arabia. In this study, 54 GPs who are currently working in various healthcare establishments or working at local hospitals in Saudi Arabia participated. Qualitative research focuses on 'exploring and understanding the meaning individuals or groups ascribe to a social or human problem' (Creswell, 2014, p. 4). A qualitative approach provides rich and abundant data that contributes a greater knowledge of the issue or a problem of the study (Johnson & Christensen, 2012). Thus, using qualitative research allows for a deep exploration and understanding of participants' individual perspectives. With the use of semi-structured interviews, participants freely provide their viewpoints. This approach sufficiently satisfies the objectives of this research.

An interview is a social study approach whose primary purpose is describing expertise, perceptions, opinions and beliefs of a specific pattern from the target population (Carey, 2017). This interview format allows the interviewer to further explore the relevant points and can lead to unexpected answers. Further, it gives the interviewer a chance to stop the interviews when sufficient data saturation has been reached (Flick, 2018). Kallio et al. (2016)) notes that semi-structured interviews are a good way to obtain people's attitudes and perceptions about reality. Moreover, they contribute to negotiating and discussing a particular topic (O'Keeffe, Buytaert, Mijic, Brozović, & Sinha, 2016). The use of qualitative research facilitates the identification of more information and as a result it leads to the identification of new issues and as well as simplifying issues identified previously.

The use of qualitative research methods, specifically semi-structured interviews with 54 GPs, was deemed the most appropriate method for collecting data owing to the need to explore the perceptions and expectations of the sample population regarding their acceptance of CDSS. Further, using the qualitative approach in this study has allowed the researcher to gain a greater understanding of the participants that may otherwise have been difficult to identify through a quantitative approach. Quantitative methods, which use numerical or statistical surveys, would be inappropriate because this study requires descriptive results and the aim is to discover participant intentions and attitudes to build and develop a theory capable of explaining the factors that affect GP acceptance.

Interview questions were prepared and designed from the key factors of UTAUT and TTF and through new factors discovered in the first stage of the interviews. Through the use of the semi-structured interviews, the GPs presented their views more naturally. This method also enabled the researcher to investigate the attitudes and beliefs of the GPs. The interview data made possible the easy identification and exploration of more constructs and extension of the proposed model to identify the factors that influence the intention and use of CDSS. This may help to gain a better understanding of the challenges and opportunities to use CDSS, as well as offering useful knowledge to providers, stakeholders and developers in the context of health care.

The qualitative approach provides justification to the answering of 'how' and 'why' research issues (Cleland, 2017). The application of qualitative research is significant for this study because it has enabled comprehension of the views of each individual and has also identified additional factors concerning the acceptance of new technology.

Several studies in HIS have investigated factors that influence the use of IS through data collection, based on qualitative research that uses semi-structured interviews (De Leeuw, Woltjer & Kool, 2020; Stapley et al., 2018).

This research seeks to construct and develop the theory through using qualitative research by conducting in-depth structured semi-structured interviews with GPs. Qualitative research is appropriate for conducting this study to explore the new factors that influence the acceptance of CDSS. Also, the main factors were identified and explored throughout the first stage, when conducting the interviews, through the prior theory that integrated TTF and the UTAUT. Research that aims to build theory is generally inductive. However, in this study, a mixture of inductive and deductive approaches is used, with greater reliance on the former, in building the theory. Deductions were made by identifying factors from the combined UTAUT/TTF model. Many studies have indicated both models' effectiveness in identifying factors that affect technology, and these factors were confirmed by convergent interviews during the first stage of the interviews. Mixing and combining inductive and deductive approaches to conducting research is preferable to studying phenomena in a case study (Fletcher, MacPhee & Dickson, 2015).

Saunders, Lewis and Thornhill (2012) describe both inductive and deductive methods as two primary reasoning approaches. The purpose of a deductive method is to test current theories by relying on causality, whereas an inductive method involves developing and creating a new theory and interpretation of a phenomenon through the evidence gathered. Further, Babbie (2015) argues that the inductive approach begins with empirical remarks and notes to discover the associated factors, but that deduction starts with an expected design hypothesis or model that is examined using the gathered and analysed data.

In inductive analysis, the research themes are directly extracted from the data obtained (Kibiswa, 2019). The inductive approach affords a number of procedures that contribute to making the qualitative analysis method easy to use, providing the formation of reliable and valid results (Langhan, Riera, Kurtz, Schaeffer & Asnes, 2015). In the inductive approach, the researcher investigates and seeks new insights, confirming them and obtaining more relevant information until data saturation, and then the theory is built accordingly (Liu, 2016).

Patton (2014) states that inductive analysis contributes to discovering and identifying patterns and themes from available data. Regarding the most appropriate approach to the present study, Elo and Kyngäs (2008) argue that this will depend on the research goal and the main question of the study. They suggest using an inductive approach to studies looking at phenomena with limited previous study or when there is a need to discover specific issues. In addition, they recommend using the deductive approach in cases of testing specific explanations for a particular theme. Moreover, Zeithaml et al. (2020) suggest that the inductive method is used to build theories or models that exist around a particular phenomenon. Langhan et al. (2015) also notes that the inductive approach contributes to developing a model or theory regarding the main construction of experiences that are obvious in the data. Elo and Kyngäs (2008) emphasise that if there is little or no knowledge about a particular phenomenon or issue, it is better to apply an inductive approach. This study seeks to build and develop a model, so the inductive approach is the main strategy used to discover more factors (Snieder & Larner, 2009). Further, with an inductive approach, the researcher continually explores and reviews the available data to develop and identify themes and phenomena that cannot be explored in advance (Sim, Saunders, Waterfield & Kingstone, 2018).

According to Thomas (2006), the inductive approach has three main purposes: (1) summarising the raw data in a brief textual form; (2) linking the study objectives with the research results from the preliminary data; and (3) establishing a framework for the main issues that are clear in the explored data**.** Further, Miles and Huberman (1994) indicate that the inductive approach has three comprehensive tasks in qualitative analysis: to reduce and display data; to represent and form a conclusion; and to check. The inductive approach selected for this research will contribute to a greater understanding of the issues and confirm the correct interpretations of the intended phenomenon (Sandström, Willman, Svensson & Borglin, 2015). Researchers conduct and adopt the inductive method mainly to resolve theoretical thinking and build a theory that depends essentially on the qualitative research approach (Khan, 2014).

The deductive approach is considered and classified as general to specific and aims to test theories and models (Wilson, 2014)**.** In other words, when using the deductive approach, themes are identified at the beginning and then studied to prove or disprove the theory (Sim et al., 2018). The deductive approach begins with a concept or theoretical model and uses the data that will validate results more (Joslin & Müller, 2016).The deductive approach is associated with data analyses that have been developed to examine whether the data are consistent with previous theories and hypotheses classified or created by the researcher (Bergdahl, Ternestedt, Berterö & Andershed, 2019). According to Zeithaml et al. (2020), deductive analysis is effective when relying on prior theories to study a particular issue or phenomenon. The deductive approach is based on prior knowledge (Sandström et al., 2015).

Although it is common to use the deductive approach when collecting data through quantitative research (Mansour, Rana & Al-Maatouk, 2020), several studies have also

adopted a deductive approach for qualitative research (Mittal et al., 2013; Robertson, Mullan & Todd, 2014; Young & Munksgaard, 2018). Locke and Latham (2020) support the deductive approach in studies that rely on qualitative research to provide insights and new factors that can contribute to building a theory.

Inductive and deductive approaches may be merged when exploring specific issues. This gives the opportunity to find unforeseen issues or factors by studying the participants' experiences with specific phenomena or when investigating a specific issue (Gale et al., 2013). Mixing both inductive and deductive approaches contributes to the development of theories (Axelsson & Goldkuhl, 2010). According to Campbell, Quincy, Osserman and Pedersen (2013), the combination of inductive and deductive approaches may contribute to obtaining more benefits than using only one of the approaches.

Several studies have applied inductive and deductive approaches in qualitative research methods (Klemets & Evjemo, 2017; Koskan, Hilfinger Messias, Friedman, Brandt & Walsemann, 2013). Mittal et al. (2013) used both approaches: the themes were first identified and reviewed based on the inductive approach, then the deductive approach was used based on the participants' reactions through looking at and researching patterns of agreement.

By combining both the inductive and deductive approaches, this current study has the advantages of both methods for enhancing scientific value and obtaining more knowledge (Saunders et al., 2012). In addition, making use of models and hypotheses is supported theoretically, where two main models were applied in this research in addition to the factors that were discovered through in-depth interviews. Further, mixing the inductive and deductive approaches contributes to the review of the original framework through the researcher's discoveries of related topics and issues after data analysis (Edwards et al.,

2015). Creswell and Plano Clark (2011) also note that merging both approaches supports a study's results by building base knowledge claims on pragmatic grounds. In addition, Laborde, Dosseville, Wolf, Martin and You (2016) have undertaken qualitative research through semi-structured interviews, where they analysed the content using both inductive and deductive use. The authors indicate that the merging the two approaches contributed to gaining more knowledge and discovering more factors that helped clarify the results more.

5.4 Ethical Considerations

In undertaking research, several ethical principles and practices have to be considered. It is vital to understand the potential ethical issues relating to the research so they can be eliminated or reduced.

This research has considered ethical issues and integrity. Consideration of ethical issues are a necessary part of any study because failing to do so can cause undesirable, negative effects on participants (Kimmel, 1988), which may also negatively affect the results of that study. The value of adhering to ethics is reflected in the significance of achieving and maintaining integrity. Codes of ethics in research are highly regarded as they sustain the value of integrity (Macrina, 2014). This project protects the participants from risks that are inherent in that participation, and thus ensures their safety (Tasman, Kay & Ursano, 2013). All such ethical principles and practices shape the overall quality of the research, specifically focusing on the validity, soundness and reliability of the information gathered and analysed.

While conducting this research, attention was given to ensure that the research abided by the ethics of research and to obtain the necessary permissions from the parties involved to avoid harm. Ethical issues are related to dealing with, or the behaviour of, others

(Cooper & Schindler, 2008). Therefore, this researcher obtained ethical approval from Victoria University (Melbourne) Human Research Ethics Committee to ensure the integrity and existence of any ethical issues or considerations affecting the research (Ref: HRE18-008) (see 8.7.6 Appendix). An informed consent form was obtained from each interviewee; this is an agreement between a researcher and participants in which the full and informed approval of each participant is obtained before taking part in the experiment and in which the knowledge of the consequences of participation in the study and its terms and effects are clearly explained (Oliver, 2010). Further, The Bio-Research Ethics course and test under the supervision of the Saudi Ministry of Health was also obtained and completed (see 8.7.4 Appendix D and 8.7.3 Appendix C). In addition, a letter of approval to conduct the research was obtained from the Saudi Ministry of Health (see 8.7.5 Appendix E).

Another important ethical principle integral to this research is confidentiality (Miller, 2012). The confidentiality of information given by the interviewee or participant must be maintained (King & Horrocks, 2010). The recordings of the interviews are stored on both a protected file on my laptop and on a flash drive. In this study, the interviewees are not named, participant information is anonymous to preserve their confidentiality and privacy.

The anonymity of participants is increasingly necessary when information is sensitive (Gillham, 2005). In this study, the anonymity of participants has been maintained through the removal of names and by replacing them with numbers or letters to describe them, without the reader being able to identify any participant. Other ethical considerations have been taken into account; namely, the right to privacy of the participant and not asking questions of a personal nature (Sarantakos, 2008).

5.5 Occupational Health and Safety Risks

This study has very low hazards related to conducting the research and collecting the data. Occupational health concerns may relate to safety during collecting the data in travelling to other cities to conduct interviews and working on computers.

5.6 Chapter Summary

This chapter has reviewed several research paradigms, with interpretivism presented as the appropriate paradigm for this study. The three research methods—qualitative, quantitative and mixed methods—were reviewed and compared, and the qualitative method was chosen.

The research paradigm for this study is based on interpretivism because of the nature and aims of this research. The interpretive paradigm understands the phenomena as expressed by users through their own experiences. Interpretivism focuses on interactions between the researcher and the identified participants of the study, and leads to a deeper sense of understanding as a result.

This study relied on the qualitative method to collect data by conducting semi-structured interviews. The study used the semi-structured interview to collect detailed information on the determinants that affect acceptance of a CDSS in Saudi healthcare. In this study, 54 GPs from different primary healthcare centres and hospitals in Saudi Arabia participated in the interviews. A qualitative approach provides rich and abundant data that contributes to a greater knowledge of the issue or a problem of the study. Thus, using qualitative research allows for a deep exploration and understanding of participants' individual perspectives. With the use of semi-structured interviews, participants are freer

to express their viewpoints. This approach sufficiently satisfies the objectives of this research.

Using a semi-structured interview technique allows the interviewer to follow up and further explore relevant points and this can lead to unexpected answers. This technique also allows follow-up enquiries for more information and gives the interviewer a chance to stop interviews when sufficient data saturation has been reached. The use of qualitative research facilitates the identification of more information. As a result, it leads to the identification of new issues as well as simplifying issues identified previously. Therefore, the use of the qualitative research method, specifically semi-structured, is deemed the most appropriate method for collecting data because of the need to explore the perceptions and expectations of participants regarding the acceptance of CDSS.

Using the qualitative approach in this study allowed the researcher to gain a greater understanding of the participants that may otherwise have been difficult to identify through a quantitative approach, which uses numerical or statistical surveys. The latter approach would be inappropriate because this study requires descriptive results. The aim was to discover participants' intentions and attitudes. Interview questions were based on issues related to the main factors of both the UTAUT and TTF models. In addition, new questions related to the factors discovered through the general questions were created.

At the end of this chapter, the researcher noted the most significant points of ethical consideration, as well as occupational health and safety risks.

Chapter 6: Data Collection and Analysis

6.1 Introduction

This chapter begins with a description of the interview process, followed by the interviewing technique and the justification for using a convergent interview technique. Moreover, this chapter details both the data analysis and the procedures preceding that analysis. A discussion follows on thematic analysis and data analysis, using the six stages mentioned in Braun and Clarke (2006).

6.2 Stages of Interviews

Data collection here was conducted across three-phase interviews. This technique was adopted to discover the relevant factors by adopting a convergent interview approach during the first stage. In the second stage, data and information were collected and the factors identified in the first stage (convergent interviews) were investigated, based on the case study method used to collect qualitative data. Many studies have relied on the combination of these two methods to provide more detailed and cognitive results (Joseph & Chad, 2017; Loh, 2012; E. Loh, 2015)

In Stage 1, 12 exploratory interviews with GPs were conducted using a convergent interviewing technique, to gather insights into and their reasons for the factors related to using CDSS. The Stage 1 findings have been used to clarify and confirm the appropriateness of the UTAUT and TTF, as well as to identify if other factors also influenced the acceptance of CDSS. Conducting interviews with several participants is useful as they may discuss issues within their knowledge, perspectives and experiences (Lewis-Pierre, Kovacich & Amankwaa, 2017).

The qualitative process of convergent interviewing includes lengthy interviews (Driedger et al., 2006; Rao & Perry, 2003). The interviewer interpreted the data and polished the interview questions after every interview to connect and identify similar issues. The questions to be included in future interviews were generated using the findings of prior interviews, to review, confirm and clarify the data collected (Dick, 1990). The interviewer stopped the interviews when no more data could emerge; convergence with the subsequent interviews proved or disproved the responses, and discrepancies were explicated (Cochrane, Dick, King, Hills & Kavanagh, 2017).

In Stage 2 of this research, 42 GPs interviewed. The questions here related to the issues and factors mentioned in the Stage 1 interviews to confirm and investigate them, and obtain more ideas, perspectives and experiences. This stage consisting of more in-depth interviews following the case study approach. It investigated the factors discovered in the first phase and investigated in greater detail the factors of the UTAUT and TTF models. Using a case study approach during this stage contributed toward a complete understanding and richly detailed data regarding the factors that influence the acceptance of CDSS by GPS. It contributed to confirming the extent of the research results. A case study approach is appropriate and effective when the issue of the research is not evident (Yin, 2014).

Stage 3 involved a review of the newly proposed framework to increase the accuracy of the final framework. This was discussed with three GPs, to gauge the extent of their agreement and views about it. This stage, along with Stage 2, strengthened the result validity and helped to gain a more comprehensive understanding of the final framework by end users of the CDSS. The participants of this stage were among those 12 GPs who were interviewed in Stage 1. Several other studies have conducted reviews and

evaluations of proposed frameworks through interviews. Herm et al. (2020) indicate that reviewing a framework through interviews improves the framework's validity. Maunder, Walton, Williams, Ferguson and Beck (2018) developed a framework for assessing the e-health readiness of dietitians. The authors conducted the study in three stages: a literature review, identification of topics related to the study, and interviews with 10 healthcare experts, to verify and confirm the validity.

6.2.1 Convergent Interviewing

Stage 1 is essentially based on a convergent interviewing technique to identify and explore the factors influencing acceptance of CDSS in the Saudi health sector.

Convergent interviewing is a valuable procedure in exploratory research where the objective is to gather, analyse, explain and understand qualitative data regarding an individual's preferences, perspectives, experiences, and feelings or to recognise significant concerns (Dick, 1990). Early interviews contribute to the questions becoming more structured in subsequent interviews. This means that the questions are also considered during successive interviews to make the questions more ordered and filtered (Dick, 1990). In the convergent interviewing technique and its subsequent interviews, participants are asked to comment on issues raised in previous interviews (Driedger, Cooper & Moghadas, 2014). By using this repetitious method, the validity and credibility of the study can be established (Evans & Maley, 2021). In the convergent interview technique, the theme is recognised and identified more easily and accurately (Rao, Kumar, Gaur and Verma, 2017).

Jepsen and Rodwell (2008) report that this technique may illustrate the tough and indecisive circumstances that may affect participant involvement of the participants and give them more confidence. The convergent interview is considered a credible,

dependable and accurate method of data collection (Jepsen & Rodwell, 2008). If used as an interview method, this technique is time-friendly and reasonable (Jepsen & Rodwell, 2008); it is distinguished by the structured method and disorganised content (Sankaran & Dick, 2015). In using this interview technique, the interviewer talks less during the conversation and allows the respondent to become more involved in the conversation. The interviewer can use the content of the speech to manage and control the interview (van Biljon, du Toit, Masango & Casteleijn, 2017). Convergent interviews generally proceed comparatively swiftly and have a built-in finishing point (Thynne & Rodwell, 2018).

The technique comprises a sequence of long, extensive interviews that create unstructured content, while using a structured process for the interviews (Rao, Perry & Hine, 2007). The standard for qualitative data is not the size of the sample, but instead it is the data saturation (Dick, 1990). Dick proposed that at least 12 interviews should be undertaken to assure data saturation from the different viewpoints provided when data converge. Many researchers have found that this can happen earlier (Low, 2019). When the assessment of the interview displays strong compatible arrangement of harmony and disparity in the previous two interviews, a final convergent interview can occur (Rao et al., 2007). The planning of convergent interviews includes multiple actions and determinations that consider sample selection and size, time and place of interview, and decisions about exploratory questions for special data collection (Dick, 1990).

In this interview technique, the initial interview is regarded as a tentative explanation of the data (Dick, 1990).

This technique is an in-depth interview procedure which starting in a structured action and unstructured content (Dick, 2016). The justification to use a convergent interview is

that it is beneficial in investigating in studies that lack or have only a limited theoretical base (Dick, 1990). The essence of the method is its adaptability, in that it permits the researcher to develop questions, processes or even answers across consecutive interviews. In addition, this technique helps to identify the issues more precisely (Dick, 1990).

6.2.1.1 The justification for using the convergent interview technique

This convergent interviewing technique is rationalised for this research (Rao & Perry, 2003). First, it intersects on similar issues expeditiously. Second, the convergent interview can evaluate when a researcher should stop conducting the data collection. Finally, the convergent interviewing approach contribute to increasing the reliability of the research. The convergent technique was very helpful in the initial stage of this research, as it permitted the researcher to identify the necessary issues quickly and establish questions for the next stage (Rao & Perry, 2003). Further, inspection after successive interviews reduced the risk of bias present in traditional interviewing techniques. Convergent interviews are an exploratory method that greatly assists studies and research in obtaining rich comprehensive data (McClymont, Gow & Perry, 2014).

Convergent interviewing helped this researcher to explore the available data, data that will be used to elucidate the problems central to this research. Rao and Perry (2003) state that the backbone of the convergent technique is its escalating character that permits a theory to transpire from succeeding replications of the research method. As this technique is designed as a detailed qualitative method, it is applicable to the initial stages of the research, particularly when this involves GPs as respondents.

Rao and Perry (2003) present three basic advantages of convergent interviewing. First, as a process it swiftly highlights basic issues in an area of fledging research. Second, as a

systematic process, it evaluates and analyses data after each interview. Third, the process identifies the final product of the research.

Both Rao and Perry (2003) and Dick (1990) elucidate that the main benefit of convergent interviewing is its potential to promote and improve the interview content; it may also help to identify further factors and broad issues. Thynne and Rodwell (2018) report that convergent interviewing can be successfully used in research fields that lack established models and framework foundations. Comparatively, convergent interviews are easy to use, are built well, and fit many circumstances (Thynne & Rodwell, 2018). Convergent interviewing is a helpful and valuable technique for both practical and theoretical research (Jepsen & Rodwell, 2008).

The convergent interview is particularly appropriate in health care (Van Biljon et al. 2017), and has been used widely in the field. Van Biljon et al. (2017) used it in a clinical therapy study of patient reviews about the lifework convalescence available in public hospitals. Their study found that therapists favoured using the convergent technique to draw out patient views regarding available services.

The adoption of this technique contributed to discovering new factors through in-depth, successive interviews. The approach of close interviews contributed to building and improving the questions after each interview, which resulted in obtaining rich information and a broader understanding. New interviews were stopped when saturation of data and information was reached. This method contributed significantly to developing the proposed model, which was validated during the second and third stages.

6.2.2 Limitations of Convergent Interviewing

Woodward (1996) has noted some drawbacks to the converging interviewing technique:

- The convergent interviewing contributes to building theories, however, to obtain the best use is through conjunction frameworks or conceptual models from previous literature or research.
- Convergent interviewing is time-consuming in the sense that it needs polished questions, it needs to examine intercepting ideas, and also needs a number of consecutive interviews with different individuals.
- The technique depends upon how the researcher gathers meaningful information by using skills and expertise during the data collection. The use of prior theory along with the ideas, skills and expertise of the researcher during the process makes it easy to authenticate data and information, as well as guaranteeing reliable data collection and analysis. Converging interviewing is regarded as a follow-up method or methodology that has some limitations. However, the advantages and benefits outweigh these constraints.

Woodward (1996) proposes that, to contribute to important probe research, researchers should have prior knowledge of the study topic to enhance their exploratory research. In addition, the author has expressed concerns that this technique is not efficacious enough to produce outcomes that can be generalised. Therefore, this researcher added another stage to confirm and investigate the output and the results of the first stage, interviewing 42 GPs to confirm the factors mentioned in the convergent interviews and gain a broader understanding and more comprehensive perspectives from study participants.

When using this approach, it is important to link it with later interviews (McClymont et al., 2014). In this research, data collection methods were increased across two additional stages to reduce bias and increase result reliability and accuracy.

6.2.3 Case Study Research

A case study approach was employed in the second stage of data collection. Forty-two GPs were interviewed to clarify the factors that influence the acceptance of CDSS by

GPs. Applying a case study approach in the interviews contributed to obtaining a wide range of opinions and ideas regarding the GPs' acceptance of CDSS.

The case study approach is widely applied in many different fields of research, including medicine, education and economics, owing to its distinctiveness and contribution to obtaining valuable results (Altan, Ozturk & Turkoglu, 2018; Fàbregues & Fetters, 2019; Shareia, 2016). The case study approach is defined as an empirical enquiry that reviews and studies a phenomenon or issue in a real-life setting, and studies it in depth (Yin, 2014). Applying the case study approach to collecting data contributes to focusing on the study and identifying the issues (Johnson & Christensen, 2012). Moreover, Gioia, Corley and Hamilton (2013) note that this approach provides opportunities for gaining insights into emerging concepts.

Loh (2012) notes that, because of the presence of many perspectives, case studies are used in research in the medical field to obtain a broader understanding and to enhance the possibility of further confirmation. The use of case study research as a second stage, together with convergent interviews in the first phase, increases the probability of confirmation of the research results and the validity of the inferred theory (Yin, 2014). According to Yin (2014), the case study method contributes to the investigation of a phenomenon by using multiple sources to obtain more evidence. In this present study, 42 physicians were interviewed during the second phase to improve data quality (Patton, 2014; Yin, 2014) and build a suitable model based on rich information and data.

Relying on interviews based on a multi-case technique also contributes to a study that is more exploratory in nature (Yin, 2014). Applying a qualitative approach, and drawing on case studies to identify factors also promotes a more comprehensive understanding of phenomena and issues in the targeted research (Agarwal et al. 2020). The purpose of a

case study approach is to obtain more explanations and to learn more about an issue by asking 'how' and 'why' questions, rather than attempting to examine or test a model (Alam, 2020). The use of multiple case study techniques in a study provides a more rigorous and accurate approach to data collection, because it triangulates the data sources (Yin, 2014).

In case studies, the optimum number of participants depends on when the saturation point in collected data is reached (Fusch & Ness, 2015). Gallo, Murphy, Braga, Farrokhyar and Thoma (2018) had claimed that the appropriate number of interviewees depends on the amount of information that can be discovered and obtained. Many studies suggest that there is no established rule regarding the number of cases appropriate for qualitative research (Patton, 2014). The qualitative approach helps to generalise cases in relation to the identifier group, instead of focusing on statistical generalisation; its goal is to obtain further knowledge and a detailed understanding (Yin, 2014).

Loh (2015) used two specific methods of data collection. The first method relied on five interviews using convergent interviewing. In the second stage, the case study approach was used to interviewed 15 participants. This second stage aimed to confirm the results and obtain more details and knowledge, as well as to confirm or disprove the theory. Loh (2015) claimed that following these two methods in research contributes to the development of a new model based on the prior theory and the data collected, depending on the two phases (i.e. convergent interviewing and case study interviews). Consequently, this research has adopted the same approach. Case studies contribute to further knowledge and investigation of complex issues that are difficult to obtain from statistical surveys (Yin, 2014).

Pathiranage, Jayatilake and Abeysekera (2020), the case study is empirical research into an attitude or issue, and it contributes to gain rich data and knowledge that helps with understanding about a situation. The use of exploratory interviewing is appropriate to build a theory based on the inductive approach (Bott & Tourish, 2016). Exploratory research contributes to an in-depth understanding of the issues relating to a subject and can be used when little knowledge about a study exists (Zikmund, D'Alessandro, Winzar, Lowe, & Babin, 2016) . According to Maxwell (2010), exploratory case studies are conducted in order to understand a specific phenomenon and the views of the participants in the study on an issue that needs more details. The exploratory qualitative case study assists in producing a conceptual framework for the case of the research study (Melewar, Foroudi , Dinnie & Nguyen, 2018). Furthermore, Yin (2014) states that exploratory case study is appropriate when there is insufficient theoretical guidance in order to reach the research investigation. Therefore, adopting a case study approach to collect data is the preferred study technique to develop theory generation (Yin, 2014). Using this methodology can greatly contribute to an in-depth understanding of the factors that influence a specific phenomenon or issue (Yin, 2014). Thus, through conducting in-depth interviews with the participants in the research, the application of the exploratory qualitative case study approach greatly contributed to providing rich information regarding the factors that affect the willingness to accept the CDSS. This demonstrated the importance of building and developing a model capable of answering the research questions.

Other studies also assert that the case study approach supports and achieves validity and reliability in research (Yin, 2014). Dependence on a multi-case study during the second stage contributes to confirming or refuting the construction of the model development

(Loh, 2012). The research literature provides further confirmation of and enhances the developed theory (Bott & Tourish, 2016).

Creswell and Creswell (2016) suggests the number of participants in the interviews should be between 20 and 30, while Morse (2015) suggests the number of participants can be between 30 and 50 participants to gain a broader understanding and rich information and build theories. Dworkin (2012) and Marshall, Cardon, Poddar and Fontenot (2013) state that a sufficient number of participants in a case study should be between 15 and 20 interviewees. Loh (2012) argues that there is no set or ideal number of participants for the case study approach.

The single case study contributes to the investigation and in-depth study of a particular phenomenon (Yin 2017). This method is an ideal option for developing and building theory (Yin, 2009). In addition to its effectiveness in obtaining rich and useful data (Hyett, Kenny, & Dickson-Swift, 2014), it also helps to gain a better understanding of the issue (Ortiz, Ren, Li & Zhang 2019). According to Eisenhardt, Kathleen and Melissa (2007) the single case study helps in the generation and construction of complex theories due to the acquisition of detailed data while the multi-case study approach focuses on comparing the results between the case studies and their common features. The single case study was the most appropriate approach for this research because it enabled to focus on uncovering the factors that affect the willingness of GPs in Saudi Arabia to accept the CDSS.

The methodology of convergent interviewing is not considered self-sufficient, but it is enough to conduct research and obtain strong results. Therefore, the additional case study methodology contributes to providing more secure results. The convergent interviewing approach in the first phase of this research allowed the formation of issues and questions for the case study methodology of the second stage.

6.3 Sampling Strategy

A total of 54 GPs participated in this study. They are currently working in different hospitals and healthcare centres in the two major cities of Riyadh and Qassim. Riyadh is the capital of Saudi Arabia, and has the greatest number of residents in one community, with a population of 8,660,885 people; Qassim has 1,488,285 people (General Authority for Statistics, 2019). More emphasis has been placed on primary health centres, as physicians are often employed by GPs and usually have less access to developed medical devices and systems than do hospitals.

The study applied both purposive and snowball sampling techniques to select participants. The purposive sampling methodology is designed specifically for collecting in-depth experiences in qualitative research (Etikan, Musa and Alkassim, 2016). The participants are predefined, with the aim of identifying participants who can offer information relevant to the research question. The main features for analysis include personal characteristics and participants' depth of understanding regarding the central themes to be studied (Ritchie, Lewis, McNaughton Nicholls & Ormston, 2014). Sharma (2017) define purposive sampling as a technique used mainly in qualitative studies to select participants by evaluating their specific purpose within the research question. These makes the approach suitable for applying into our research. In addition, specific participants are drawn from the target population, to obtain appropriate information that supports and fits to the aim of the research and assists to obtain valuable and usual results.

This methodology is rapid, because only candidates who meet the specified interests are selected (Polit & Beck, 2010). Polit and Beck (2010) describe purposive sampling as a non-probability technique that selects participants based on personal attributes and allows researchers to identify those participants most likely to provide informative information

(i.e. experts within the field of study). The participants chosen for this study include healthcare practitioners operating in reputable medical centres; hence, they are qualified to provide rich data.

The purposive sampling technique was proposed by Neuman (2014) for use in cases involving participants who were either difficult to reach, or that included experts in specialised populations from specified fields. The participants in this study are GPs; the nature of their work requires them to operate under strict timelines and they have very limited availability. Further, the purposive sampling technique has been used because it was difficult to choose participants through other means, so emails were sent to some physicians or they were approached directly. The aim of the interviews was to collect information about the participants' understanding of their perspectives on CDSS acceptance and use. Purposive sampling is considered appropriate for this study because all participants were in Saudi Arabia working at different hospitals, clinics, primary healthcare centres across different cities.

The snowball sampling technique was also used to select participants: the directors of the primary healthcare centre, physicians' supervisors and others in hospitals were invited to nominate GPs who might participate. Similarly, some GPs were asked to nominate co-workers who might participate. The snowball sampling approach was also used to contact GPs who may not have otherwise been selected from the purposive sample. Consequently, the snowball approach was applied to increase the number of participating GPs. The snowball sampling strategy helps researchers to approach a specific number of people to become involved in a study, thereby helping the researcher to communicate with and recommend further suitable persons (Voicu & Babonea, 2011). The snowball method was used in different Saudi healthcare studies to select participants. According to

Ghaljaie, Naderifar and Goli (2017), the snowball method is commonly used in studies that include specific specialists who then identify other specialists or experts. Fortune, Reid and Miller (2013) note that each individual who agrees to be interviewed is invited to suggest other participants, until the study has enough s. Applying the snowball sampling method contributes to reducing the time and effort of participant selection (Geddes, Parker & Scott, 2018).

The purposive and snowball samples in identifying participants for interviews are the common approaches (Fortune et al., 2013). Therefore, their selection results in more reliable and confident responses: several studies have adopted these two approaches when using qualitative methods to collect data. Both purposive and snowball sampling approaches are the most rapid and active ways in which to acquire targeted specialists and other experts, based on the selection of participants and on additional suggestions from HIS experts (Duan, 2018).

The diversity in methods of how participants were selected for this study has contributed to reducing bias and reliance on one method. The use of two different methods in selecting interviewees has resulted in identifying and reaching suitable GPs quickly, which is vital as GPs usually have minimal time to participate in interviews, because of the pressures of their work. These participants provided rich data and valuable information.

6.4 Participant Details

Fifty-four GPs from different hospitals and primary healthcare centres in Saudi Arabia participated in the research. Through their participation, I obtained a better understanding of the intention to use and accept CDSS in their medical practices. Each interview in the first stage (involving 12 GPs) lasted approximately 30 to 50 minutes. In the second stage, 42 GPs were interviewed, and this number contributed significantly to providing valuable

information that provided further knowledge of the factors that affect the acceptance of CDSS. The ages of the GPs interviewed ranged from 26 to 65, while the gender mix was 25 women and 30 men.

All interviews took place within the GPs' clinics, after obtaining permission from the hospital administrations, primary healthcare centres, with each GPs nominating an appropriate time. All the locations in Riyadh and Qassim are under the supervision of the Ministry of Health.

Table 6.1. Stage 1 Participant Details

Number	Participants code (Stage 1)	Gender	City	Experiences	Age
1	SA1	F	Riyadh	30+ Years	50= <
2	SA2	M	Riyadh	20–29 Years	41–50
3	SA3	F	Riyadh	20–29 Years	41–50
4	SA4	M	Qassim	10–19 Years	31–40
5	SA5	M	Riyadh	0–5 Years	25–30
6	SA6	M	Riyadh	6–9 Years	31–40
7	SA7	F	Qassim	10–19 Years	41–50
8	SA8	F	Riyadh	10–19 Years	31–40
9	SA9	M	Riyadh	10–19 Years	31–40
10	SA10	M	Qassim	30+ Years	51= <
11	SA11	F	Riyadh	6–9 Years	31–40
12	SA12	M	Riyadh	0–5 Years	25–30

Table 6.2. Participants Demographic Statistics (Stage 1)

Gender	Number	%
F	5	41.7%
M	7	58.3%
Total	12	100.0%
Cities	Number	%
Riyadh	9	75%

Qassim	3	25%
Total	12	100%
Experiences	Number	%
0–5 Years	2	16.7%
6–9 Years	2	16.7%
10–19 Years	3	25.0%
20–29 Years	3	25.0%
30 + Years	2	16.7%
Total	12	100.0%
Ages	Number	%
25–30	2	16.7%
31–40	5	41.7%
41–50	3	25.0%
51 = <	2	16.7%
Total	12	100.0%

Table 6.3 Participants' Details (Stage 2)

Number	Name Code	Gender	City	Experiences	Age
1	SB1	F	Riyadh	20–29 Years	41–50
2	SB2	M	Riyadh	30+ Years	51= <
3	SB3	M	Riyadh	20–29 Years	51= <
4	SB4	F	Riyadh	6–9 Years	31–40
5	SB5	M	Riyadh	6–9 Years	41–50
6	SB6	F	QASSIM	10–19 Years	41–50
7	SB7	F	Riyadh	6–9 Years	31–40
8	SB8	M	Riyadh	0–5 Years	25–30
9	SB9	M	Riyadh	6–9 Years	31–40
10	SB10	M	Riyadh	6–9 Years	31–40
11	SB11	F	Riyadh	0–5 Years	25–30
12	SB12	F	Riyadh	0–5 Years	25–30
13	SB13	M	Riyadh	6–9 Years	31–40
14	SB14	F	QASSIM	10–19 Years	31–40

Number	Name Code	Gender	City	Experiences	Age
15	SB15	M	Riyadh	10–19 Years	31–40
16	SB16	F	Riyadh	0–5 Years	25–30
17	SB17	F	QASSIM	10–19 Years	41–50
18	SB18	F	Riyadh	10–19 Years	31–40
19	SB19	F	QASSIM	10–19 Years	31–40
20	SB20	M	QASSIM	10–19 Years	31–40
21	SB21	M	QASSIM	30 + Years	51 = <
22	SB22	M	QASSIM	10–19 Years	41–50
23	SB23	M	QASSIM	6–9 Years	25–30
24	SB24	M	QASSIM	20–29 Years	41–50
25	SB25	F	QASSIM	30 + Years	51 = <
26	SB26	M	QASSIM	10–19 Years	41–50
27	SB27	M	QASSIM	30 + Years	51= <
28	SB28	M	QASSIM	20–29 Years	41–50
29	SB29	F	Riyadh	0–5 Years	25–30
30	SB30	M	Riyadh	6–9 Years	31–40
31	SB31	F	Riyadh	10–19 Years	31–40
32	SB32	M	Riyadh	20–29 Years	51= <
33	SB33	F	Riyadh	20–29 Years	41–50
34	SB34	F	Riyadh	6–9 Years	31–40
35	SB35	M	Riyadh	0–5 Years	25–30
36	SB36	M	Riyadh	0–5 Years	25–30
37	SB37	F	Riyadh	30+ Years	51= <
38	SB38	F	QASSIM	20–29 Years	41–50
39	SB39	F	Riyadh	10–19 Years	41–50
40	SB40	M	Riyadh	20–29 Years	51– <
41	SB41	M	Riyadh	6–9 Years	31–40
42	SB42	F	Riyadh	0–5 Years	25–30

Table 6.4. Participants' Details (Stage 2)

Gender	Number	%
F	20	47.6%
M	22	52.4%

Gender	Number	%
Total	42	100.0%
Cities	Number	%
Riyadh	28	66.7%
Qassim	14	33.3%
Total		100%
Experiences	number	%
0-5 Years	8	19.0%
6-9 Years	10	23.8%
10-19 Years	11	26.2%
20-29 Years	8	19.0%
30+ Years	5	11.9%
Total	42	100.0%
Age	number	%
25–30	9	21.4%
31–40	14	33.3%
41–50	11	26.2%
51=<	8	19.0%
Total	42	100.0%

6.5 Reliability and Validity

Validity and reliability are essential foundations for building scientific research. Therefore, the researcher should pay much attention to the procedures and methods of research to produce a reliable and consistent study. It is important to follow these recommended procedures to provide comprehensiveness and high-quality research (Amankwaa, 2016). Some researchers claim that the reliability and validity of some research tools are suitable for a qualitative research approach and that different methods and procedures must be followed to measure the efficiency of qualitative research (Pandey & Patnaik, 2014).

It is essential to focus on the validity and reliability of research in a general way to ascertain and verify the results and final contributions of the research. Validity in research indicates the validity of data and information collected by the researcher. Moreover, Maxwell (2013) indicates that the goal of conducting qualitative research is to understand the perspectives of participants in the study and to discover and investigate and not document a specific objective fact. Nevertheless, there are several methods that researchers have taken to manage any risks regarding research viability (Creswell & Creswell, 2016). In qualitative research, various concepts are usually used to assess the validity or reliability of the research, including credibility, trustworthiness, transferability and quality assessment (FitzPatrick, 2019). Roulston (2010) indicates that there are some differences and procedures in the manner and method of achieving these concepts in qualitative research.

There are some differences in the definitions of the two concepts of validity and reliability in social science research. Validity indicates the extent of accuracy in study outcomes; reliability refers to the degree of compatibility or reproducibility (Peeters & Harpe, 2020). Validity in qualitative studies refers to the appropriate and suitability of the processes, that the procedures used are valid and justified; this includes choosing appropriate methodology, selecting samples, choosing a suitable method of analysis, and correcting the results (Leung, 2015). Furthermore, Leung (2015) notes that reliability in qualitative research refers to repetition of processes and outcomes with high accuracy, while this considered challenging and contrary to intuition in the qualitative approach. According to Grossoehme (2014), reliability in qualitative research depends heavily on consistency. A margin of variability is allowed in the results of qualitative research, but there should be similarity in the data. However, there may be a difference in the richness and ambience of the collected data (Leung, 2015).

Yin (2014) suggests that, to confirm the validity of data analysis, appropriate analytical methods must be identified, and data collation must be undertaken. I have adhered strictly to recognised approaches in the method of data collection and analysis to ensure a high level of validity of my research. The data analysis section contains a detailed discussion of the procedures followed. This research applies thematic analysis to examine the qualitative data, following the six-step phases recommended by Braun and Clarke (2006). These phases help to analyse data collection; they are: (1) familiarising data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report. Further, the data analysis was conducted in NVivo 12 software, which made the investigation and analysis much easier to organise and classify.

Henry (2015) argues that one method to promote research credibility is to show the sensitivity of the context toward the research. Prior to interviewing and collecting data, a literature review of similar and related studies is provided. Here, this investigated the goal and problems of the research. This contributed to increasing knowledge and obtaining useful information that helped to achieve a better understanding of the research and related topics. It also led to a greater general understanding of the interview method, as well as of the data collected. In addition, the results were validated and confirmed from the conclusions reached in previous, relevant studies.

Tracy (2010) argues that to obtain accuracy in data, it is crucial to consider selecting an appropriate sample so that the research can achieve the study's goal. Using purposive sampling that represents the participants who meet the required characteristics of the study helps to achieve external validity (Silverman, 2020). This research has used both purposive and snowball sampling techniques to choose its participants. Purposive

sampling was used because it was difficult to select the research participants by other means, while snowball sampling was also used, with where the directors of healthcare centres and the physicians' supervisors in hospitals were invited to nominate GPs for possible participation. Both techniques enabled a targeted choice of participants that represented rather than a random selection. This research is focused on GPs: they have the knowledge and medical experiences that may encourage the presentation of valuable information. All physicians participating in the study work in primary health care and hospitals under the supervision of the Saudi Ministry of Health. As Smith (2011) notes, data analysis should be comprehensive and determine the frequency of themes in the context of the information and data gathered, while also highlighting some excerpts from the interviewee responses and their contexts. Through analysing the data, the main and sub-themes were identified in each transcript (each interview has one transcript). Further, an in-depth discussion of the factors and the inference from previous studies relevant to the purpose of the research. In addition, quotations from the participants are presented in order to clarify and understand the attitudes and viewpoints of GPs.

Henry (2015) notes that transparency and coherence should also factor in effective research. Here, this study includes comprehensive details of the data analysis process, the selection of research participants, how interviews were conducted, the rights of participants, the method of preserving data and the records collected; tables summarise physician details and information. The justification of the techniques and methods of data analysis in this research, taken from previous studies, is also provided. These details contribute to increasing the level of consistency and transparency in this study. It also enables the reader to learn more about the processes and methods of conducting and building the research.

it is very important that the researcher needs to be careful and accurate in collecting and collating the data in order to reduce errors and to promote impartiality, and ensure that the value of the results reflects the real perspectives of interviewees so the researcher remains neutral. In this research, the questions asked in a manner that did not affect or confuse participants. In addition, many primary and follow-up questions were asked to ensure greater consistency and validity, contributing to more dependable and reliable results. Further, asking investigatory and probing questions contributes significantly to promoting reliability and validity in the study (McKinnon, 1988). The participants were presented with questions that encouraged explanation and interpretation, thereby providing rich data and information.

Many methods and tools used have been highlighted in previous studies in relation to validity and reliability, and their use is recommended here (Yin, 2014). One common method in qualitative research is that of triangulation and the frequent review of data analysis (Yin, 2014). Flick (2018) also highlights that triangulation is used in more than one approach of data collection to study a specific case. Further, Fusch, Fusch and Ness (2018) state that triangulation refers to the use of more than one method of data collection and is useful in analysing data, contributing to enhancing research result validity and obtaining more knowledge. Triangulation refers to the frequency of data collection so a deeper understanding and perception of cases is gained to remove biases and verify information (Mayer, 2015). Triangulation aims to overcome the problems facing a researcher with regard to bias and credibility, and to support the research method in diverse ways that contribute to achieving greater validity (Dick, 1999). In this research, three stages were followed. In the first stage, 12 GPs were interviewed to determine the main factors in the model, and TTF factors were added to the main UTAUT model. Here, a convergent interview approach was used to identify and explore the factors influencing

acceptance of CDSS. In the second stage, 42 physicians were interviewed to explore their perspectives and perceptions of the specific factors. In the third phase, three physicians who participated in the first phase were interviewed again to further verify and confirm the final model. The use of more than one stage of data collection has contributed to greater credibility in data collection and in verification of its validity.

In this research, 54 interviews were used to confirm and verify the information obtained, as well as provide more information and clarification about the discovered factors. After recording the interviews, they were then transcribed, reviewed and read again in the analysis phase, with recorded notes. This contributed significantly to increasing data validity As a preliminary step to the interview process, participants were spoken to and informed of their rights to remove any fear or ambiguity regarding this research. All enquiries and questions were answered regarding the research topic and its purpose. This helped give participants more confidence during the interviews and increased the information, knowledge and perspectives gained.

Silverman (2020) has noted that it is essential to provide data in table form to reveal more information about interviews. Bakker et al (2020) also states that coding during data analysis is a necessary procedure that provides the researcher with insights and ideas regarding data meanings. This contributes considerably to enhancing the reliability of qualitative research (Franklin, Cody, & Ballan, 2010). The coding of the factors and the citations of participants about the NVivo program contributed to facilitating and arranging the data and speeding up the discovery and referring to the specific encodings. This program helped to arrange the data and analyse the data, which led to greater reliability and accuracy of the results and to saving the data.

Data were collected through a semi-structured and in-person interview method. This method assisted with understanding the meanings and expressions and to recognise facial expressions and body language during the interview. This helped to obtain a broader and deeper understanding of the participants' perspectives and the data collected.

In qualitative research, generalisation is not regarded as a source of concern. Johnson (1997) notes that 'generalizability is not the major purpose of qualitative research' (p. 289). Nevertheless, researchers indicate that some methods and procedures may contribute to generalising the results of qualitative research. This research aims to develop and build a model that identifies the factors that affect GP acceptance of CDSS, instead of a statistical generalisation. Several interviews were relied upon to obtain an analytical generalisation. Moreover, Gack (2018) notes that gathering several different perspectives from many participants on one topic reinforces better understanding and generalization of the targeted problem. Further, the results of this study have been compared with the previous literature to increase result validity.

Souza, Alexandre and Guirardello (2017) defines reliability as the degree to which measures are error free, achieving more consistent and accurate results. Further, O'Connor & Joffe (2020) suggests that reliability can be achieved by observing the search process and ensuring that previous procedures and methods have been used correct. The concept of reliability in quantitative research differs significantly from the concept in qualitative research (Merriam & Tisdell, 2015). Several strategies can increase the reliability of qualitative research. Bakker (2018) have found that a focus on transcripts was one of the main procedures to achieve reliability. NVivo software tools provide significant support in arranging, coordinating and classifying information and include several advantages for the researcher, providing easier techniques of data analysis and

increasing the level of validity (Miles, Huberman & Saldaña, 2014). NVivo 12 was used in the data analysis of this study, which has facilitated the process of data analysis, discovery and the identification of themes in a flexible manner. I transcribed all interviews into Arabic and then into English, reading them more than once, including taking notes and using NVivo 12 to facilitate data analysis and increase the reliability of the study's results. In another strategy to improve reliability in research. Here, I reviewed previous research relating to the acceptance of HIS and technology systems in other fields to demonstrate the effect of the factors discovered as influencing CDSS acceptability by GPs. Bakker (2018) also suggest using recording devices to review participant responses and to improve reliability. I recorded all interviews, saved them on my computer and then transcribed them to facilitate the data analysis process. The audio recordings of interviews were used to verify certain sentences in context and to understand their views, as an addition to the tone of voice in the audio recording. The scientific tools and methods in this research were chosen from a number of published scientific articles that justify each method used, ensuring that this study is reliable.

It is crucial to adhere to the principles and philosophies of the qualitative approach in health research to enhance the level of credibility and reliability in a study (FitzPatrick, 2019). Cook (2012) notes that the breadth of health studies and the diversity of the qualitative research methods used in them have contributed to greater reliability. Cook notes that an in-depth understanding of the cognitive principles and appropriate methods for research contribute to the promotion of health. The use of advanced programs specialising in the analysis of qualitative research, such as NVivo, has contributed to increasing the degree of reliability and validity in qualitative health research (Hafeez-Baig, Gururajan & Chakraborty, 2016).

This thesis has considered and adhered to the criteria of validity and reliability in qualitative research. Many of the guidelines and procedures referred to in previous studies were followed. In all steps of this research, I have been keen to follow the methodologies recognised in scientific research. All research steps were justified and detailed to obtain a high-quality study that contributes to the development of medical systems and the improvement of health care.

6.6 Thematic Analysis

Because of the nature of this study, a qualitative research design has been used, with semi-structured interviews. This study also uses thematic analysis to examine the interview data. Thematic analysis classifies, distinguishes, analyses and summarises themes from the available data. It systematises and defines a data set from the details (Maguire & Delahunt, 2017). One of the advantages of using thematic analysis is that it is a flexible when identifying themes and thus provides a more accessible analysis (Nowell, Norris, White & Moules, 2017). In addition, thematic analysis allows researchers to generate unanticipated insights based on the themes produced. Moreover, Nowell et al. (2017) note that thematic analysis is a useful for summarising large sets of data through its well-structured approach in handling information.

Thematic analysis is more effective in identifying the main themes from the rich data obtained compared with content analysis (Vaismoradi, Turunen and Bondas, 2013). The main theme and sub-themes were discovered from the rich data obtained from in-depth interviews with GPs. This helped build and develop a model that identifies the factors that influence the acceptance of the CDSS by GPs. Thematic analysis contributes to the formation of theories through a set of procedures that generates factors (Guest, MacQueen, & Namey, 2012). Moreover, thematic analysis is an intensive method that

results in more understanding and clarification of the research issue than a set of texts (Brough, 2018). According to Marshall and Rossman (2014), following the thematic analysis significantly helps uncover alternative explanations for the phenomenon of the study, and build a more structured analysis.

This study has followed six phases to analyse the qualitative data: (1) familiarisation with the data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report.

The first step is familiarising data: the transcripts of the interviews were read and the main ideas underlined, and the records listened to more than once. Notes were taken to recognise the existing data and to better understand the interviews. At the second step (generating initial codes), a list of different words was encoded from the transcripts, which categorised the data into the themes. NVivo 12 software was used to formulate the different codes. The third step is searching for themes. This involves intensive work to classify and link the themes with the coding undertaken in the previous step. This help to make the themes more identifiable by highlighting relevant words within the possible main themes. The fourth step (i.e. reviewing themes) involves checking the themes and their codes, which is confirmed in the transcripts of the interviews (these themes and their codes had been established in the previous step). The researcher may then correct any mistakes and add more codes. The fifth step is defining and naming themes. This step promotes a comprehensive analysis of every theme and determines an illuminating or illustrative name for each theme. It also provides a clear explanation for each theme. The sixth step is producing the report. After completing the description of each theme to verify the validity of the analysis, a report is then made to facilitate understanding of the interviews and related issues.

6.7 Recording of Audio Interviews

This study's sample size was determined by considering the information needs and primary aim of the research. The interviews were recorded to increase data collection accuracy because it was possible to rewind the tapes and listen to unclear passages again. All participants agreed to an audio recording of their interviews. The recorded information was securely stored on my computer. All audio recordings and transcripts were saved onto secure files on both my laptop and an external storage devices. After transcription of the data, unique IDs were provided for interviewee information to ensure that anonymity was maintained while writing up the research.

The information collected from participants was crucial to understanding the acceptance of CDSS within the healthcare environment in Saudi Arabia, and also for other issues relating to implementation of the CDSS.

6.8 Transcriptions

The interviews recorded were saved onto my computer and mobile phone after obtaining permission from each participant. All interviews were conducted in Arabic because that is the participant's native language. Transcription was done first in Arabic and then the text was translated into English. The interviews began with a summary of the objectives and explanation of the research goal. In addition, I ensured that all participants were aware of and understood the CDSS, as well as knowing their rights regarding interview procedures, which include the confidentiality of their information and records. The use of interview recordings and transcriptions helped with effective data analysis. Listening to the recordings and reading the transcriptions multiple times contributed to discovering more information and ideas. It also allowed me to understand any issues and ideas that were not immediately clear.

Converting the audio recordings into both Arabic and English took a long time. However, a large amount of data and information were obtained that has contributed to increasing knowledge regarding the acceptance of CDSS and ways of improving health care through using HIS, via the interviewee perspectives and experiences. Further, 54 interviews were converted from audio to text. The presence of the transcripts and the records contributes to a greater understanding of the data provided by participants.

6.9 Data Analysis

Thematic analysis was used to analyse the data gathered from interviews with the aim of learning more about their experiences, perspectives and attitudes (Braun & Clarke, 2006). Thematic analysis has become widely employed in HIS studies (Christie et al., 2020; De Leeuw et al., 2020; Stapley et al., 2018). Initially, the data were investigated and reviewed in Arabic. The data analysis was undertaken manually using Word and Excel applications, to learn more about the data and identify the codes. Through this method, the main sub-themes were identified. These steps have contributed to a greater clarity regarding the themes.

The data were then mainly analysed using NVivo software, following the six-step phases of thematic analysis established by Braun and Clarke (2006). I used both processes: the initial analysis in Arabic, with reliance then placed on data analysis mainly in English, depending on the NVivo software. This contributed significantly to understanding the content and helped determine the main themes through a further review of the transcript contents.

All transcripts were collected in folders dedicated in the NVivo program for the purpose of objective analysis, to obtain a deep review of the content, understand the perceptions of participants and explore the factors that affect physician acceptance of the system.

Once the NVivo data has been manually formatted as data in various aspects, it is easy to organise and classify the data in an orderly and coordinated manner. It is also easier for the researcher to delve deeper into the data (Bazeley & Jackson, 2013). Further, NVivo allows a researcher to specify sentences, phrases and words in the content. NVivo also contains features that help to easily identify and arrange both the main and the sub-themes (Dollah, Abduh, & Rosmaladewi, 2017). NVivo has contributed further to this research by coordinating content, providing transparency, maintaining consistency and reaching informed results. NVivo 12 software was used to assist in analysing, organising and classifying the data of the qualitative interviews. In addition, it facilitates discovering and managing the coding and themes from the rich data that leads to major themes. NVivo is commonly used by qualitative researchers to analyse the data process with more transparency and clarity (Hutchison, Johnston & Breckon, 2010). NVivo provides graphs and charts that enable the researcher and reader to better understand the results (Zamawe, 2015).

This study has employed thematic analysis of the data from the interview transcriptions by following the six-step phases of Braun and Clarke (2006), as outlined previously. In the following sections, more detail of each phase is outlined.

6.9.1 Phase One: Data Familiarisation

Here, I listened to each interview recording and read each transcript to highlight the main ideas. The transcripts were read two or three times, and notes were made to better recognise the existing data and understand the interview. This stage contributed to the identification of more initial themes and ideas. The process of transcribing data from audio to text is an important process in analysing the data, as it can lead to greater knowledge of the data. Therefore, all interviews undertaken in the first and second stages

were recorded. Copies in both Arabic and English enabled me to become acquainted with the data at a deep level. All files were separately imported into the NVivo application to coordinate the data in a structured manner.

6.9.2 Phase Two: Generating Initial Codes

Identifying symbols is an important step for getting to become closely acquainted with the data. This is an interesting step for the researcher as it helps to focus on and search for ideas and phrases that contribute to finding issues that support the research goal. 'Coding' is defined by Saldana (2016) as a word or short sentence that can be identified and classified with a specific symbol. Sentences and phrases in each document related to the search question were found and coded in NVivo, where appropriate phrases were specified with codes for reference. Each code was linked into nodes to facilitate the process of building main and sub-themes. A list of different nodes was encoded from the written text, which categorised the data into specific classified themes. This phase contributed significantly to discovering new views and attitudes from the data, and was initiated by highlighting certain words in the transcripts to explore sub-codes relating to the principal codes. This process considered all interview transcripts in both Stages 1 and 2.

Stage 1 involved 12 interviews. The data from each interview were analysed before the next interview, to discover and review the factors that influenced the acceptance of the CDSS. I then discussed that data in the next interview. After all main factors had been identified, together with their influences, they were included as questions in Stage 2 (42 interviews). Here, the data were not analysed after each interview as had been the case in Stage 1, but were analysed after all interviews were completed.

6.9.3 Phase Three: Searching for Themes

After the initial arrangement and coding of data, the symbols were classified into possible themes, in addition to creating related sub-themes for the main themes. This involved intensive work to classify and link the themes with the coding of the previous step, so I integrated codes within possible themes. In addition, at this phase, similar codes were combined and unnecessary ones removed. One of the goals of this stage was to begin making connections between themes and sub-themes.

Some themes were named and identified in NVivo before the coding process because they were extracted from the theories adopted for this research (UTAUT & TTF). These embrace the following themes: performance expectancy, effort expectancy, social influence, facilitating conditions, technology characteristics, task characteristics and TTF.

A list of main factors was classified in NVivo 12. This started the process of thematic coding, which helps to organise data, to search the text more easily (Rowley, 2012) and to identify the themes and sub-themes that emerge. Coding arranges the data into themes, concepts and classifications to highlight related words or sentences with a code name and then to identify the themes and sub-themes that emerge. In this phase, the nodes associated with the codes were updated by linking them again with more appropriate themes, although the names of the themes had yet been finalised: these themes could then be updated in the following stages (Braun & Clarke, 2006).

6.9.4 Phase Four: Reviewing Themes

In this step, the themes and their codes (established in the previous step) were checked and confirmed through comparing them with the interview transcripts. The texts were reviewed to ensure all important codes were related to the research questions and were

linked to the main and sub-themes. It was necessary to ensure that the themes and sub-themes were closely aligned with the codes. Unsuitable themes and codes were removed after the review, to maintain the integrity of the themes and their relevance to the code.

6.9.5 Phase Five: Defining and Naming Themes

This step represents the final access to the main themes, their identification and their approval regarding their relevance to the codes (Braun & Clarke, 2006). This prompted a comprehensive analysis of every theme and determined an illuminating or descriptive name for each theme. It also provided clear explanations for each theme. Maguire and Delahunt (2017) indicates that themes, when named in the qualitative analysis, must have a clear, expressive conceptual meaning and a summary that reflects the extent of their relevance to phenomena being studied. The predefined themes, through acceptance of the UTAUT and TTF models, together with the sum of the main themes after analysing all interviews, became the 13 themes seen to influence acceptance of the CDSS.

6.9.6 Phase Six: Producing the Report

This is the final stage in the steps for thematic analysis as recommended by Braun and Clarke (2006). Completing a description of each theme verifies the validity of the analysis. A detailed explanation of each theme was undertaken, with the addition of essential quotes from participants to facilitate understanding of the themes. Braun and Clarke (2006) consider that writing the report is similar to writing a story and can persuade the reader of the investigation's reliability. Accordingly, this study has produced an analytical report that includes the essential aspects and influential factors mentioned in interviews.

At the end of the data analysis, the following main and sub-themes were included: performance expectancy, effort expectancy and facilitating conditions, TTF, technology

and task characteristics, accessibility, perceived patient satisfaction, informativeness, connectedness, communication and shared knowledge, privacy and security and perceived risk (functional performance risk and time risk). In the results section of this study, evidence from previous studies is used to demonstrate the influence of these factors on IT acceptance studies.

6.10 Limitations of the data collection and analysis

There are a number of limitations involved in adopting a qualitative approach for data collection and data analysis, however many strategies were adhered to, and the relevant literature reviewed in order to ensure the integrity of the data analysis and collection procedures.

One of the challenges encountered during data collection was the search for study participants who fitted the main objective of the research. Another challenge was the workload of the GPs. Therefore, two methodologies were followed in selecting participants: the purposive and snowball sampling techniques. This contributed to obtaining rich information. In addition, following the objective analysis methodology helped with analysing, arranging and summarizing big data from the in-depth interviews. Another important issue which arises in research, especially qualitative approach, is the issues of bias. A strict methodology has been followed in the process of selecting participants and analyzing data, as confirmed and mentioned above, with inferences from relevant studies which significantly contribute to the validity and credibility of data collection and analysis. In addition, participants were allowed sufficient time to speak and were also provided with the opportunity before and after the interviews to ask any questions related to the interview or the objectives of the research. They also had the

right to withdraw from the interview at any time. This helped many participants feel comfortable and consequently helped in obtaining rich and useful information.

6.11 Chapter Summary

This chapter has described the data analysis methods used in this study. It has also described the interview process and explained the appropriateness of applying a convergent interview technique. The thematic analysis was then explained: this has been used to analyse the data obtained from interviews.

Fifty-four physicians from different primary healthcare centres and four hospitals from Riyadh and Qassim in Saudi Arabia were interviewed. Data were collected through two interview stages. In Stage 1, ten exploratory interviews were conducted using a convergent interviewing technique, to gather insights and reasons for using (or refusing) CDSS. This stage also clarified and confirmed the appropriateness of UTAUT and TTF factors, and identified other factors that might influence the acceptance of CDSS. In Stage 2, 42 GPs were interviewed. The questions at this stage related to the issues and factors raised in the interviews of Stage 1, to confirm these issues and factors.

This study is primarily based on a convergent interviewing technique that identifies and explores factors influencing the acceptance of CDSS in the Saudi health sector. Convergent interviewing is a procedure used in exploratory research where the objective is to gather, explain and understand qualitative data regarding an individual's preferences, perspectives and experiences. The approach of convergent interviews is that they generally begin as unstructured, and then become more structured during subsequent interviews. The convergent interviewing technique in those later interviews requires participants to comment on issues they raised earlier. The convergent interview is considered a credible, dependable and accurate method of data collection: adopting the

repetitious approach leads to authenticity and credibility. The convergent technique was beneficial in the initial stage of this research. I could swiftly find the relevant issues and establish questions for the next stage. Adopting this method contributed to exploration of the data that was available and was then used to elucidate the crucial problems applicable to the research.

This study adopted both the purposive sampling and snowball sampling technique to select participants. The purposive sampling technique was used because it was difficult to select participants in the study by other means. E-mails were sent to some GPs, while others were spoken to directly, requesting their agreement to participate. Additionally, the snowball sampling technique was used to select participants by asking the primary healthcare centre directors, and physicians' supervisors in hospitals, to nominate GPs for possible participation.

This study used thematic analysis to investigate the interview data. Thematic analysis is a technique that classifies, distinguishes, analysis and summarises themes from available data. The thematic analysis helped to provide a flexible approach to identifying themes and thus contributed to a more accessible analysis. It is a useful method for summarising large sets of data. This study followed the six-step phases of Braun and Clarke (2006) to analyse the qualitative data: (1) familiarisation with the data; (2) generating initial codes; (3) searching for themes; (4) reviewing themes; (5) defining and naming themes; and (6) producing the report.

The interviews were recorded to increase data collection accuracy; the recordings could be listened to later to clarify misunderstandings. The recorded information was securely stored on a computer. Unique IDs were provided for interviewees to ensure that anonymity was maintained during the writing of the research. The data and information

collected from participants were crucial for the better understanding of CDSS acceptance within the Saudi healthcare environment. They were also highly relevant to other issues relating to the implementation of the CDSS. Further, a large amount of data was obtained that would also contribute to increasing knowledge regarding the acceptance of CDSS and HIS, and to that health care could be improved through using HIS and considering the perspectives and experiences of GPs in Saudi Arabia. In addition, data analysis incorporated identification and coding of significant themes.

Chapter 7: Discussion

7.1 Introduction

This chapter provides a detailed discussion on current health IS in Saudi Arabia, as explored through interviews with the physicians participating in the study. It also provides discussions and investigations on factors affecting the acceptance of CDSS by GPs from the participants' perspectives. This chapter contributes to providing a detailed explanation of each factor that affects a GP's acceptance of the CDSS, along with quotations from the participants about each factor.

7.2 Current Health Information Systems in Saudi Arabia

The Ministry of Health in Saudi Arabia is working hard owing to government pressure and the significant material support it receives annually to develop health services that include facilities, medical equipment and staff. Through attending the different hospitals and primary health centres for this study, I have noted that the ministry has worked to unify or standardise health programs among all primary health centres. It is doing this so that the process of managing patient files is facilitated and the dependency on paper files is reduced. However, it seems that health programs and applications may differ among hospitals: I conducted interviews with GPs in four different hospitals.

The interviewed GPs indicated that the hospitals outperformed the primary health centres because of their greater facilities and the consequent variety of available techniques, technical support and various medical capabilities. Of course, this is attributable to the capabilities of hospitals and the requirements they have owing to their work, and to the 24-hour presence of physicians.

Primary health centres in Saudi Arabia (in both Riyadh and Qassim) depend on two major software programs in performing their work. These relate to the programs that physicians use when meeting and caring for patients. The first program, Alam, contributes to managing patient files and documenting symptoms and health complaints. The second program, Wasfaty, helps GPs to prescribe treatment: the GPs communicate with pharmacies, providing a patient's treatment plan, along with the medications they need.

The ministry aims to provide an easy way to open electronic files for patients with a national registry number (Ministry of Health, 2020). EMR in Saudi Arabia, according to the Ministry of Health (2020), is a software initiative that aims to provide all primary healthcare patients with an electronic file. EMR will ensure it is easier to standardise patient file records electronically, as well as verify patient information entered into the HIS.

Wali et al. (2020) investigated patient satisfaction regarding the adoption of EMR with patients visiting five primary healthcare centres in Saudi Arabia. As part of the study, 377 questionnaires were distributed to patients, the results of which presented many factors pointing to satisfaction with EMR, including improved physician observations. Clinical counselling increased (82.3% participants), interpretation of examinations and medicines improved (85.8% participants), and more time was spent with patients during consultations (80.4% participants). Additionally, patients seemed more confident in talking with their physician at the time of diagnosis (84.0%). The authors mention that patients were more satisfied with the adoption of EMR in primary health care compared with PMR.

One of the applications also used in primary care centres is 'Mawid', which is an electronic service that enables customers to book appointments in primary healthcare

centres and to manage them by rescheduling or cancelling them. This is done through an electronic smartphone app, or on the Internet. Most the primary health centres require patients to register and book through this app so that only non-infectious patients attend. In addition, this service contributes to verifying the patient's identity by linking the reservation with the patient's national identification number (Jabour, 2020).

Another application adopted by the Ministry of Health for citizens is the application 'Seha'. This provides consulting services and medical follow ups through a mobile apps or a website where users can communicate with one of the ministry's certified physicians (Ministry of Health, 2020). This service is provided daily during working hours and in limited hours on weekends. The Ministry of Health aims to develop and improve healthcare services in remote areas while reducing medical errors and promoting the provision of electronic health services in accordance with international standards (Alshammari, 2019).

There has been a noticeable development in the use of apps and advanced programs in the method of dispensing medication for patients, as seen with 'Wasfaty'. This is an important measure for reaching the objectives of *Saudi Vision 2030*, which are to improve the provision and quality of healthcare services (Almansour et al., 2020). The document, Unified National Platform (2021), mentions that medicines are dispensed free of charge to citizens by 'Wasfaty' through pharmacies contracted to facilitate patient access to prescriptions at any time and from any place.

Wasfaty enables a patient to receive medicine from the nearest pharmacy contracted to the Wasfaty Service, through an electronic platform that links hospitals and primary health centres to those pharmacies. Additionally, the Ministry of Health reports that Wasfaty allows medications to be dispensed from different locations within Saudi Arabia

and the system is characterised by the avoidance of medical errors that can result from handwriting. It also provides the option to re-dispense medication to patients with chronic diseases. The ministry's website claims that the Wasfaty app has been approved in more than 772 health centres throughout Saudi Arabia, through which more than 2,757,562 electronic prescriptions have been exchanged (Wasfaty, 2020). Through the own design, the ministry seeks to achieve the following goals:

- to provide the highest standards and electronic systems to facilitate medication dispensing services,
- to expand cover to all health facilities in Saudi Arabia,
- to provide time and resources for government health agencies,
- to ensure the availability of medicines to beneficiaries, and
- to improve and develop medication guidelines (Ministry of Health, 2020).

Many GPs noted that the EMR program is quite recent; some GPs face challenges related to the user interface of the program, often because of the many blank fields that appear and which take much time to fill out. Consequently, some GPs do not undertake this process, and can click on 'next' to reduce patient waiting time. The EMR is intended to manage patient files and record information and diagnostics, while also providing many diagnostic options and information relating to the disease or the patient's condition. This may make it easier for GPs to choose a diagnostic icon instead of completing blank fields to write the diagnosis. One GP noted that this feature created a characteristic that contributed to the knowledge of some diseases according to geographical location, by revealing statistics:

> *".....the use of the EMRs application takes more time than necessary in entering the patient's diagnostic data. There are fields that cannot be neglected and their completion is mandatory. For example, he mentioned a case of a patient with a cold:*

he needed a treatment that may be as simple as a pendulum, but the EMRs program requires many unnecessary details such as a family medical history or the question: Is there a person in your family who has high blood pressure or diabetes? Such questions do not benefit the physician's decision regarding the appropriate medicine" (SA5)

The Wasfaty application, as GPs mentioned, was implemented in some hospitals and most primary health centres. This application works to speed up the delivery of a patient's prescription to the pharmacy. When the physician approves the prescription through the program, an official text message is received by the patient on a private mobile device registered on the official website of the Ministry of Health. This includes an application number. The message also reaches a number of pharmacies cooperating with the primary health centre to take the patient's medication. Some GPs stated that the Wasfaty program only sends prescriptions to the pharmacy for the patient, but does not record previously disbursed medications.

"In order to save the prescription information for the patient, I need to write it into the EMRs program because the Wasfaty program is only for dispensing the treatment and sending it to the pharmacy" (Sb5)

One problem is that GPs working in primary health centres may sometimes experience slow Internet speeds, a medical program may be suspended. Therefore, they suggest the need for updated computers and faster Internet connections, as well as updated applications to reduce or prevent suspensions and slow performance of the medical programs used:

"we have a problem, for example, in my prescription, we face difficulties if the program is suspended for an hour or two and times the text of an hour, and even if one minute is suspended, this takes time from the physician, and more importantly, it takes more time waiting by the patient" (SA10)

SA10 also noted:

"....there will be a problem if the program stops with you. For example, if Wasfaty stops, there will be a problem because it is the only channel to give the drug to the patient, but in general there is a very large acceptance by patients regarding the program of Wasfaty"

Many GPs saw the need to link and integrate the two applications (Wasfaty and EMRs) to facilitate the process of caring for and following up with patient information completely; these should include the patient's diagnostic information, as well as their medication. Most physicians indicated that the use of two different applications during a patient interview meant that more time was needed. In using the two applications, upon completing the entry of patient information and medication diagnoses into the EMR medical program, the physician must then re-enter information into the Wasfaty program and repeat the process. This can be wasteful:

"If a program is unified for all health activities related to the patient, this will lead to saving more time and effort. But the multiplicity of programs used to take care of the patient leads to a waste of time and effort" (SA2)

In addition:

"We have one program called EMRs and another named 'Wasfaty'. Each is separate. If the two were linked, the work would be done much better, because at present I am obliged to enter patient data in both applications. But when I enter all the data at once, it will be comfortable for me, of course" (SB19)

Numerous GPs added that they still use some paper-based medical transactions, such as for the results of blood and X-ray analyses, and medical certificates for patients. Some also mentioned follow-up information for monitoring pregnancies.

Some hospital physicians also complained about the frequent use of different programs and applications regarding the follow-up and care of patients. Some noted that they may use more than five different programs, with a patient's electronic file to write a diagnosis

and another application to view the X-ray and another to read the report and results of blood test and yet another to follow up on courses offering initiatives for physicians or one to narrate the results and images of a patient's ECG. This may consume more time and there is no combining of a patient's information electronically. In addition, each application has a different password and username, which may inconvenience the end user. As one participant stated:

> *"It is necessary to integrate all medical programs where there is more than one medical application used, such as the main application of the patient file, Flowchart, and a special application for radiology and ECG, another application for prescription and each one has a password and password*" (SB41)

Interviews with research participants revealed that the currently used programs need to be merged into a single program to facilitate the application and speed of completing medical tasks. Frequent entries of unnecessary information may hinder a GP's acceptance of the system used, as well as result in increased waiting times and less satisfaction for patients. However, the adoption of a new HIS to replace paper records may contribute to accessing patient information faster and more accurately. Among the negative aspects identified through GPs' interviews in both hospitals and primary health centres was the lack of a link between them in terms of the HIS used, which may lead to a loss of access to important medical information about patient health conditions.

7.3 Discussing and Investigating the Factors

All the main factors that influence the acceptance of CDSS are discussed here. These were clarified through interviews conducted with GPs in different medical centres in Saudi Arabia, where the main determinants of both the UTAUT and TTF models were discussed. Other factors were also disclosed through interviews by mentioning other physicians' statements, and evidence from previous relevant studies.

As mentioned in the previous chapter, the data collection process was undertaken in three stages. In Stage 1, 12 GPs were interviewed to identify and discover the factors that affected acceptance of CDSS. Semi-structured and in-depth interviews were undertaken to discover new issues and factors not included in the model proposed for this study. These interviews confirmed the effect of the factors in UTAUT and TTF on GP acceptance of the CDSS. The results of this study show that most factors affect acceptance by GPs. These include performance expectancy, effort expectancy, facilitating conditions, TTF, technology characteristics and task characteristics, but exclude social impact. The duration of the effect on these admissions by physicians has not been determined. New factors were also discovered, such as accessibility, perceived patient satisfaction, informativeness, connectedness with patients, communication and sharing knowledge, privacy and security and perceived risk (functional performance risk and time risk).

In the first stage of the interviews, I had specific questions that included UTAUT and TTF factors. In addition, participants could discuss the new factors that might affect physician acceptance, and I then investigated these further with the participants, highlighting the importance of each factor. At this stage, the data were analysed after each interview to identify new factors that affected the use of CDSS, and this then created new questions based on the new, unexplored factors. These further questions were then discussed with a participant in a succeeding interview.

In the first stage, the eleventh and twelfth interviews revealed no new factors that affected GP acceptance of CDSS. Therefore, further interviews were discontinued to conduct in the first stage. Cochrane et al. (2017) argue that convergent interviews can be suspended or stopped where no new information is obtained regarding the purpose of the study.

All interviews were conducted in health centres after obtaining permission from the centres' managers and physicians at convenient time. Also, help and support were given with conducting interviews in some centres, where patients were referred to another doctor if the GP needed this, provided that this did not lead to obstruction or delay of their medical tasks. This was a significant service provided by the health centre management, as well as the Ministry of Health, in giving me approval and support to collect data. This assistance from the ministry supported and encouraged my scientific research to develop and improve healthcare in the nation.

The Stage 1 interviews were conducted with seven male and five female GPs in Riyadh and Qassim. The ages and experiences of participants in this study were varied, and this is significant to obtain different information and perspectives according to these differences.

The actions taken during the first stage are important and crucial for data collection because the identification of factors and related issues was conducted at this stage. I analysed the data after each interview and determined the emerging factors to ensure that they were included in the next interview. This stage formed the main factors that influence the acceptance of CDSS and that were validated in Stage 2.

In the first stage, 12 GPs were interviewed using the convergent interviewing approach to identify and explore the factors that influence the acceptance of CDSS. Several different factors were identified by the first eight interviews. In Interviews 11 and 12 no new factors were discovered.

In Stage 2, 42 GPs were interviewed to confirm the correctness and effect of the factors discovered in the first interviews. At this stage, the physicians were asked about the role of the main factors in the UTAUT and TFF models regarding their acceptance of CDSS,

as well as discussing the new factors discovered in the first stage. Semi-structured interviews were conducted to obtain more information and discover if there were other, related issues affecting their acceptance of CDSS. In addition, I and discussed with participants the current systems used and the challenges and opportunities, as based on their experiences and viewpoints.

The interviews in Stage 2 provided results that helped confirm the validity of the factors explored in the first stage. However, the social influence factor in the UTAUT model is not considered a factor affecting the acceptance of CDSS by GPs, according to most interviewees. In addition, through the many interviews, information, ideas and illustrative issues regarding acceptance of the CDSS were obtained. The interview stages provided me with a better understanding of the current system used and the level of physicians' satisfaction. Many physicians mentioned some of the problems they face in the current system, which is considered fairly new in primary health centres. Further, many participants added some information about their experiences regarding the previous paper system and the current electronic system, and the differences between them in performing medical work.

In Stage 2, 22 male and 20 female GPs were interviewed. Seven physicians worked in hospitals, and 35 physicians worked in primary health centres in Riyadh and Qassim. It is clear that physicians in hospitals have more resources, capabilities and facilities than physicians in primary health centres, because of the multiplicity and availability of resources in hospitals and the existence of different departments. The most important of these is the IT department that provides many services and maintenance for the systems. They are more efficient because of their presence in the same medical building. In addition to these factors, there is a greater availability of more advanced diagnostic

devices and a proximity to specialist physicians and consultants, whose experience and knowledge is beneficial. Regarding technical team support at health centres, they are located in different buildings, and are usually contacted through a website or by phone to solve technical problems or answer end-user enquiries.

The multiplicity of interviews contributed to the second stage by ensuring that the factors identified in the first stage were accurate. Repeating questions that had the same answers proved the validity of the results and contributed to proving the correctness of the factors identified. Further, this repetition also provides abundant perspectives that contribute to providing information in building and developing a model, in addition to providing explanations for questions that require clearer answers from participants with different experiences, ages and genders.

In addition, using semi-structured interview methods contributed to ensuring that both participant and interviewer understood the information. If a participant did not understand the question, the question was repeated in another form or was explained further. Conversely, if the participant's answer is not clear or if the interviewer needs more explanation or information, a relevant enquiry will produce a better understanding of the response. Therefore, using in-depth interviews helped to obtain information and clarifications for many questions and also helped participants to voice many relevant issues.

In Stage 3, three GPs (SA1, SA2 and SA4) who participated in the first phase were interviewed to further review and verify the final model, Although the second stage greatly clarified the opinions and intentions of the participants toward accepting CDSS, this contributed to building the model and clarification of each factor. In stage three, all GPs agreed that all of the selected factors played a major role in their acceptance of CDSS.

The main reason for choosing these participants was that they were among the first five GPs interviewed in the first stage, and therefore, they were not aware of the factors discovered and identified in subsequent interviews. In addition, these participants possess a diversity of experience and enthusiasm, providing more data compared with other GPs in the same stage.

Table 7.1 shows the answers from the study participants regarding the factors affecting their acceptance of CDSS identified in the first stage. A sign '√' indicates that the participant agrees and supports with it, while 'X' indicates that the participant does not agree with, or denies the influence of this factor.

Table 7.1. Factors Discovered During Stage 1

Factors Influencing the Acceptance of CDSS																						
	Identified from the models UTAUT and TTF													Factors from the interviews								
	Performance expectancy				Effort expectancy	Social influence	Facilitating conditions			Technology characteristic			Task characteristics	Informativeness	Communication Share knowledge	Perceived Risk		Task-technology fit	Accessibility (Integration)	Patient Satisfied	privacy and security	Connectedness
GPs	**Treatment**	**Time**	**Alerts**	**Reduce Errors**			**Training**	**Technical Support**	**Updati**	**Accurat**	**Fast Internet**	**Quality Modern Computer**				**Time risk**	**Functional risk**					
SA1	X	√	√	√	√	X	√	√	-	-	√	-	√	√	-	√	-	√	-	-	-	-
SA2	x	√	√	x	√	X	√	√	-	√	√	-	√	√	-	√	√	√	-	-	-	-
SA3	x	√	√	√	√	√	√	√	-	√	√	-	√	√	-	√	√	√	-	-	-	-
SA4	√	√	√	√	√	X	√	√	√	√	√	√	√	√	-	√	√	√	√	-	-	-
SA5	√	√	√	√	√	X	√	√	√	√	√	√	√	√	-	√	√	√	√	-	-	√
SA6	√	√	√	√	√	X	√	√	√	√	√	√	√	√	-	√	√	√	√	√	-	√

SA7	√	X	√	√	√	X	√	√	√	√	√	√	√	√	-	√	√	√	√	√	-	√
SA8	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	-	√
SA9	√	x	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	X	-	√
SA10	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SA11	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	x	X	√	√	√	√	√
SA12	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	X

Table 7.2 Factors discussed in Stage 2

Factors Influencing the Acceptance of CDSS																							
			Identified from the models UTAUT and TTF											Factors from the interviews									
			Performance Expectancy		Effort Expectancy	Social Influence	Facilitating Conditions			Technology characteristic			Task characteristic	Informativeness	Communication Share	Perceived Risk		Task-technology	Accessibility (Integration)	perceived Patient satisfy	Privacy and security	Connectedness
	Treatment plan	**Time**	**Alerts**	Reduce Errors			**Training**	**Technical**	**Updati**	**Accurat**	**Fast Internet**	**Quality Modern Computer**				**Time risk**	**Functional risk**					
SB1	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
SB2	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√	√
SB3	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SB4	√	√	√	√	√	X	√	√	√	√	√	√	√	X	√	X	√	√	√	√	√	√

SB5	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SB6	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SB7	√	√	√	x	√	X	√	√	√	√	√	√	√	√	√	X	√	√	√	X	√	√
SB8	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√
SB9	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	x	√	√	√	√	√
SB10	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√	√	√
SB11	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√
SB12	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SB13	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√
SB14	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
SB15	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
SB16	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
SB17	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√
SB18	√	√	√	√	√	X	√	√	√	√	√	√	X	√	√	X	X	√	X	√	√	√
SB19	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
SB20	√	√	√	x	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√

SB21	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√
SB22	X	X	√	√	√	√	√	√	√	X	√	√	√	X	√	√	X	√	√	√	√	√
SB23	√	√	√	√	√	X	√	√	√	√	√	√	X	√	√	X	√	√	√	√	√	√
SB24	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√
SB25	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	X	√	√
SB26	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√
SB27	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SB28	√	√	√	√	√	X	√	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√
SB29	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
SB30	√	√	√	√	√	√	X	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√
SB31	X	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√
SB32	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	X	X	√	√	√	√	√
SB33	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√
SB34	√	√	√	√	√	X	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√
SB35	√	√	√	√	√	X	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√	√
SB36	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	X	√	√
SB37	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X
SB38	√	√	√	√	√	X	√	√	√	√	√	√	X	√	√	X	X	√	√	√	√	√
SB39	√	√	√	√	√	X	√	√	√	X	√	√	√	√	√	X	X	√	√	X	√	√
SB40	√	x	√	√	√	√	√	√	X	√	√	√	X	√	√	√	X	√	X	X	√	√

SB41	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	X	√	√	√	√	√	√
SB42	√	√	√	√	√	X	√	√	√	X	√	√	√	X	√	√	√	√	√	X	√	√

Table 7.3 shows the percentage of participants who agreed and disagreed with the factors that influence the acceptance of CDSS in the second stage. In this stage, much important information was collected about the GP perceptions and their support for the factors, to contribute to building the theory. The second stage was crucial in determining the percentages of support and agreement of the participants regarding the factors identified in the first stage.

Table 7.3 Percentage of Participants Who Agreed and Disagreed Regarding the Factors

Factors		Agree with factor	Disagree with factor
Performance Expectancy	Treatment plan	95.24%	4.76%
	Time	95.24%	4.76%
	Alerts	100%	0%
	Reduce Errors	92.86%	7.14%
Effort Expectancy		100%	0%
Social Influence		35.71%	64.29%
Facilitating Conditions	Training	97.62%	2.38%
	Technical Support	100%	0%
	System Updating	97.62%	2.38%
Technology Characteristics	Accurate	92.86%	7.14%
	Fast Internet Connection	100%	0%
	High-quality computers	100%	0%
Task Characteristics		88.09%	11.91%
Informativeness		90.48%	9.52%
Share Knowledge		97.62%	2.38%
Perceived Risks	Time Risk	69.05%	30.95%
	Functional Performance	69.05%	30.95%

Factors	Agree with factor	Disagree with factor
Task-technology Fit	100%	0.00%
Accessibility (Integration)	90.48%	9.52%
Perceived Patient Satisfaction	71.43%	28.57%
Privacy and Security	100%	0.00%
Connectedness	97.62%	2.38%

7.3.1 Performance Expectancy

The performance expectancy factor has been used in different models of acceptance technology, including UTAUT (Venkatesh et al., 2003), TAM (Davis, 1989) and UTAUT2 (Venkatesh et al., 2012). It was identified as an important and fundamental determinant of acceptance of technologies in HIS (Engin & Gürses, 2019; Ira & Alia, 2019; Wang, Liu & Liu, 2020). Performance expectancy is defined in this study as the degree to which a user believes that the application or system will provide certain benefits or advantages, and that adopting the CDSS will assist in the daily practice performance of patient treatment and care. In this study, performance expectancy is a major determinant of the effect on physician acceptance of CDSS: all interviewees acknowledged the importance of this factor in their acceptance and accreditation of using CDSS. Time, effective alerts, reduced errors and treatment plans were identified as the main elements underlying performance expectancy that contributed to admission processes. In Stage 2, 95.2% of the participants indicated that the efficiency of the treatment plan and its contribution to obtaining information in a timely manner each had a significant effect on accepting CDSS. All participants emphasised and agreed with the effect and importance of alerts in CDSS, supporting their acceptance. In addition, 92.8% of the participants agreed with and supported the effectiveness and effect of CDSS in reducing medical errors.

Most GPs indicated that the extent of the CDSS's contribution to saving time and obtaining information was vital:

> *"CDSS contribute to obtaining the information in real time, meaning that if you want to request a patient file from the hospital or even from another hospital it would be quick to get his or her information"* (SA6).

> *"Such programs greatly reduce and save time"* (SB13).

> *"The time factor in using CDSS makes the decision faster, but it may be in more complex medical cases that could take longer due to entering the required information from the program. But in addition to that, this program may help in communicating and discussing with colleagues and obtaining information faster"* (SB7).

Alerts are considered the most common and effective method for physician-system communications; however, they should be applied properly to minimise alert fatigue and reduce liabilities (Hinderer et al., 2017). Participants in this study noted the ability of alerts and warnings in the CDSS to provide recommendations and consider matters that may the physician may miss:

> *"... certainly, the human being is not infallible. Sometimes there is an error in terms of increasing the dose or when the patient is taking a particular drug and the physician gives him a different medicine because he has not read about it, so the system will help to discover that"* (SB4)

> *"CDSS can be used to write the diagnosis. For example, if I give a patient a specific medication or two medications, the program will provide some alerts if one medication is not right to take with the treatment. A physician may lose some focus due to a large number of patients, especially as some drugs need accuracy and attention, and the program contributes to discovering drugs that are incompatible with each other by providing alerts"* (SB11)

> *"The alerts feature warns you and shows you the guidelines, such as hypertension and allergy: they tell you if the patient has an allergy, and where exactly the allergens came from, if there is any medicine or something else to cause that"* (SB34)

An important sub-themes of performance expectancy that contributes to GP acceptance of the CDSS is its role, and their belief that it helps to avoid or reduce medical errors:

> *"CDSS help to reduce medical errors. For example, when it provides me with a warning that the patient has allergies or gives advice about that in order to draw it to the attention of the physician"* (SB42)

> *"Medical authorities seek to reduce these errors, and computing or using these applications is sure to help eliminate the human error factor… this application will reduce errors and help more to understand patients better. These two factors will greatly affect the lives of patients. I believe that if this project achieves these two goals, especially in reducing errors and helping physicians in understanding their patients, the result will be excellent"* (SA12)

The treatment plan is an important feature of the CDSS that also affects GP acceptance of a CDSS, as indicated by the majority of participants in this study:

> *"CDSS will help the physician to develop an accurate treatment plan, as it will contribute to avoiding. forgetting or lacking items in the treatment plan. In some cases that are without the use of such programs, because we are human we may forget some parts of the treatment plan"* (SB20)

> *"One of the benefits of using CDSS is the speed of this diagnosis. One of the things that we can benefit from is we rely on the diagnosis as a first step and then begin treatment, so it will help us in terms of diagnosis and in terms of the treatment plan that we will develop for the patient"* (SB9)

7.3.2 Effort Expectancy

This study confirms that effort expectancy is one of the main factors that contributes to the acceptance by GPs regarding CDSS use. This factor is present in a number of models that study acceptance of technology, such as UTAUT (Venkatesh et al., 2003) and TAM (Davis, 1989). There is clear evidence from several studies in different fields of IT that effort expectancy has a positive effect on the behavioural intention to use HIS applications (Engin & Gürses, 2019; Garavand, Samadbeik, Nadri, Rahimi & Asadi,

2020; Ira & Alia, 2019). In this study, effort expectancy is defined as the level of ease for using CDSS, and if a GP considers that using a CDSS will result in less effort because of its ease of use.

In this research, effort expectancy is a major factor regarding GP acceptance of a CDSS. In the interviews, all GPs indicated that the CDSS would be easy to use because of their technology backgrounds:

> *"I think the CDSS will be easy for me to use, and I also think it will be easier with the practice of the program over time"* (SB25)

> *"I think it will be easy to use because technological systems have become prevalent and also because education has now gone through many technological systems, but some of the elderly may have some problems with its use in the beginning, but after a while, they learn it—unlike the younger ones who learn faster"* (SB23)

The interviews in both the first and second stages highlighted the extent of participant consensus regarding the importance of ease of use, which is the second determinant of the UTAUT and the framework of the proposed study. Notably, the greater ease of use attributed to a CDSS, the greater the likelihood of its acceptance and use.

7.3.3 Social Influence

The social influence factor is the third construct of the UTAUT model, and most participants in the study indicated that it had no effect on accepting the CDSS. Social influence is defined in this study as the degree to which a user accepts or thinks that significant others will influence their use of IT (Venkatesh et al., 2003). This factor is an important determinant in various studies regarding the intention to use IT (Halili & Sulaiman, 2017; Knoblock-Hahn & Lerouge, 2014; Wang et al., 2020).

Most interviewees indicated that people who might influence their work had no impact on their decision to use CDSS. However, some GPs indicated that co-workers could play an influential role in their use of CDSS; 64.29% % of participants in the second stages indicated that social influence did not affect their acceptance of the CDSS, while 35.71% of the participants indicated that social influence was an influencing factor. As some note:

> *"I don't think co-workers and influential people influence my decision to use CDSS"* (SA9)

> *"My colleagues and influential people do not affect my decision to use CDSS; this is my decision according to my personal convictions"* (SB13)

It is noticeable that social influence is not considered important in accepting the CDSS for most GPs participating in the study; many claim that the final decision to accept the system was due to a personal decision and the extent of their conviction and satisfaction with the performance of the particular HIS.

7.3.4 Facilitating Conditions

Facilitating conditions is the fourth factor in the UTAUT model proposed for the framework of this research. This study confirmed the importance and role of facilitating conditions as a key factor in influencing GP acceptance and use of the CDSS. In the interviews, participants agreed on the importance of the following elements: training, technical support and updating IT systems. Several studies outline the importance and positive role of facilitating conditions in influencing HIS use (Garavand et al., 2020; Hossain, Quaresma & Rahman, 2019; Sallehudin et al., 2019). This research considers that facilitating conditions are the resources and instruments that support and assist GPs in the use of CDSS.

Most participants indicated that the role of facilitating conditions influenced their acceptance of CDSS. They expressed the importance of considering training, technical support and of updating IT to facilitate and support the use of CDSS. All participants indicated the important role of the availability of technical support and the influence that had on their acceptance the CDSS. Further, 97.62 % of participants in the second phase noted the importance and impact of training, and of continuous system updates in relation to their acceptance of CDSS.

Participants supported the role of training and its importance in understanding and presenting the CDSS, especially in the early stages of its implementation in order to use it properly:

> *"Training and setting up courses for users are important in the beginning, and the importance also lies in convincing the user that this system is good and through that, IT should be marketed"* (SB8)

> *"For me, training is very necessary. First: how can I open it, what should I do, how is it important to me, and the training as well? If I train, I will be more convinced and then the application will become familiar to me. To use CDSS with confidence, I think training is essential"* (SB17)

Facilitating conditions also supported another element. GPs highlighted the need for technical support that contributed to solutions to problems and enquiries related to the CDSS. They stated that this would be significant in helping them to use and accept CDSS:

> *"It is important to have technical support because I think there will be some problems when starting to use programs, so it is necessary that there be technical support or training for the users of the program"* (SB9)

> *"I think we must have existing technical support: IT technicians are supposed to be around or very close because or we may need them to modify any information or if there is any malfunction of the program or discontinue"*. (SB34)

"…any system such as these systems is subject to any error or problem and could stop functioning at any time. So, it is important that there be technical support for these in case anything happened to these" (SB29)

Another important element mentioned by participants is updating, and its role in supporting the acceptance and use of CDSS. The continuous updating of a medical application provides updated knowledge-based information. This is in addition to updating the system to repair faults and gaps that may be discovered during the implementation and use phase. Several participant statements support this:

"Updating the system is very important because the fields of medical knowledge are constantly developing, so the system needs constant updating" (SB14)

"Frankly, it is very important to update the system, because it is based on updating the information that we will use and rely on in our job and patient diagnosis. This will help us a lot. There must be a periodic update" (SB19)

"Updating the system is very important. I mean sometimes with time the user will discover some issues that need to be fixed or updated. For example, regarding the current system of HIS, I see things that need development" (SB30)

Most GPs participating in the study agreed with the extent of the relationship and the effect of facilitating conditions in supporting the process of using the CDSS. They indicated that training and updating the system, and the presence of a high-level and effective technical support team would encourage the acceptance and use of the CDSS. It is important to consider these elements in facilitating the conditions to and expedite acceptance among physicians.

7.3.5 Technology Characteristics

The technology characteristics factor is one of the main constructs in the TTF model, which was added to the proposed framework for this research. Interviews with GPs in

this study demonstrated the role of technology characteristics as an influencing factor in their intention to use the CDSS. This factor has been considered a significant construct in several studies regarding issues of IT acceptance (Salloum & Shaalan, 2018; Virdyananto, Dewi, Hidayanto & Hanief, 2016).

IT is considered both a tool and a system employed by users to complete tasks. Participants in this research noted the importance of technology characteristics in that these includes accuracy of data in the CDSS, fast Internet speeds and quality modern computers that contribute effectively the TTF and thus to the acceptance of the CDSS. Most GPs noted that the availability of such features in the CDSS helps them to save time and perform their tasks in a timely manner. This also helps the patient by reducing waiting times for diagnoses and consultations, and a reduction in those consultation times.

All participants in this study stated that a fast Internet connection contributes to more efficient work performances, obtaining information more effectively and dealing with software. Many noted that having fast Internet speeds would contribute to making medical work easier and faster:

> *"There must be a fast Internet because, as a physician, I need the Internet to search and read a lot. In addition to that, the medical system will be linked to the Internet, so the Internet connection must be fast"*. (SB5)

> *"Having fast Internet is very necessary in order to search for specific medical information as well as in order not affect the system by interruptions, the use of a fast Internet will facilitate work—for example when a patient comes and has forgotten the name of the drug he is using, so the patient describes the form and package of the drug. I look on the Internet to find it and then confirm with the patient that it is the same drug he (or she) is using"*. (SB38)

> *"I remember we previously had a problem with the Internet that was slow. After that, we did not work as required and our work was very affected. Then the technical support was contacted in the ministry and the situation was fixed. We also use the Internet as*

well in cases of follow-up guidelines, and I use it to learn, so I download the guidelines on my computer. I also use the Internet to view and track available training materials online, so I think when the Internet is faster, it will lead to doing the job better and faster". (SA7)

Among the elements of the necessary technical characteristics that participants referred to, the role of modern computers and their quality of speeding up and facilitating medical work, together with the extent of their contribution to developing the technology help with their compatibility and fitting in with their work. All participants in the research highlighted the role and importance of having high-quality computers and the impact of this on their acceptance of CDSS.

"The presence of modern and high-quality computers contributes to a better performance of medical work. Also, the better the computer the easier is the work, but sometimes it annoys me when I am using the keyboard and sometimes happened a slow or hanging response in the computer" (SA7)

"The presence of computers and modern programs is important as it contributes to performing medical work and helps to avoid suspension problems, as such technical problems that take the physician's time and more importantly the patient's time" (SA10)

Another critical element that the study participants mentioned as influencing their acceptance of CDSS is the significant and positive role of data accuracy. CDSS has the ability to improve efficiency and accuracy in diagnoses, including complex medical diagnoses that require complicated decisions (Belard et al., 2017). Regarding the significant positive role of data accuracy in physicians' acceptance of CDSS, with 92.86% of participants in the second stage asserting that accuracy would contribute significantly to their acceptance of the CDSS:

"I think using CDSS will contribute more to knowing the correct dosages which will be accurate" (SB41)

"I think the CDSS outputs will generally be accurate, but they will be more accurate when there are people who regularly review and update the program, in addition to having feedback and evaluation from the user" (SB29)

The physicians participating in the study noted the importance of considering the characteristics of the technology that would help and contribute to supporting the performance of their medical tasks. The characteristics discussed and supported by the GPs included the accuracy of data and its role in the CDSS, as it assists in speeding up their acceptance of the system, compared with paper records or more basic informational health systems. One important element is having a fast Internet connection so that the CDSS response is also fast and easy to use, and can quickly obtain information. In addition, an important element is the quality of computers, as the computer's speed and other advantages can support GPs in using health applications.

7.3.6 Task Characteristics

Task characteristics is another factor that has been added to the conceptual framework of this research, as it is main construct in TTF. Most participants indicated the extent of task characteristics' role and its positive impact on the intention to use CDSS. Most participants considered that the daily work has degrees of difficulty and complexity. In some cases, the patient's diagnosis requires more investigation and further tests. The task characteristics factor has been examined in several studies in relation to the acceptance of IT (Saputra, Wardani, Trialih & Hijriyati, 2018; Virdyananto et al., 2016).

Tasks are procedures performed to convert inputs into outputs and they include characteristics that promote greater reliance on specific features of a technology. Task characteristics is defined in this research as the degree of flexibility in the daily work of GPs, the complexity of medical cases, and whether these cases are considered routine.

Most GPs interviewed indicated that medical work was not considered easy, as there are many different cases that are not routine.

In Stage 2, 88.09% of participants confirmed that task characteristics were a factor affecting their acceptance of the CDSS. In addition, some indicated that \some similar diseases and cases exist, but the symptoms may differ, and the ages and general health of the patient should be considered. However, other participants indicated that the work was considered routine and often easy because of the similarity of cases. Through interviews and the analysis of results, it is clear that there is a role for the characteristics of a mission to positively affect the task of fitting technology to the particular purpose. Some comments from participants regarding this factor include:

> *"In general, our work, I cannot say about it easy work, but it is not considered that work is routine because every day we may discover something or a new thing, so the work is considered completely non-routine"* (SB17)
>
> "*The medical profession is difficult, because you have a great responsibility, especially as you deal with lives of people and you initially do not want to harm the patient, we are afraid to cause harm to the patient or delay in treatment"*. (SB35)

SB35 also noted that:

> *"Our work is not routine to a certain degree, but it is true that the cases are sometimes the same, but each patient has his own cases and his own story"*

Most physicians participating in the study indicated that their medical work was considered non-routine because of the different conditions of patients and the variety of their health symptoms. Therefore, the GPs, as an end user, needs a HIS that is appropriate and provides information and tools to facilitate making a final decision to treat each

patient. Therefore, there is a significant relationship and influence of task characteristics on physician acceptance of the CDSS in this research.

7.3.7 Task-Technology Fit

The task technology fit factor is one of the main TTF constructs added to the proposed model for this research. According to Goodhue and Thompson (1995), TTF is defined as 'the degree to which technology assists an individual in performing his or her portfolio or tasks' (p. 216). In this study, the TTF determinant refers to a belief that the CDSS matches the GPs' task needs and their capabilities (Jarupathirun & Zahedi, 2007). In other words, TTF determines which technologies benefit particular tasks, while the features present the tools that meet user requirements sufficiently. The GPs confirmed that the nature of medical work, and their daily medical practices, are closely aligned to and fit with the CDSS, which will help to provide better medical services and care. TTF has been used in many different studies in HIS (Chen, Yu & Chen, 2015; Mirabolghasemi, Iahad & Miskon, 2015).

The GPs in this study state that advanced medical programs would achieve their desired goals and that TTF would have a positive impact on their acceptance of the CDSS. All study participants confirmed the suitability and effectiveness of the CDSS in performing their medical tasks:

> *"I think there is very high compatibility and fit between such these programs and medical work, as I do not think that additional medical progress will occur without the presence of these programs that contribute and lead to medical progress"*. (SA12)

> *"The CDSS is one of the programs that we need, as it is a feature of the era. It helps obtain the information and saves visitors' data in an easy way and is considered appropriate and helps the physician with many useful things and provides many advantages*" (SB6)

Through discussions with GPs about TTF in the CDSS, it became apparent that the CDSS is considered appropriate and can contribute to improving work performance because of its features and tools that are fit and support medical work. Consequently, this factor is considered necessary and effective in GPs' acceptance of the system, because of the compatibility of the system's functions with the end-user's mission. GPs also asserted that this would have an effect on gaining positive results from the CDSS in providing care and medical decisions, for the patient's benefit.

7.3.8 Privacy and Security

The privacy and security factor has been added after discussions and interviews conducted in the first stage of the interviews, where GP SA10 mentioned this factor. It was adopted for the rest of the interviews, as well as in the next phase interviews to confirm its importance and the effect it had on GP acceptance of the CDSS. This study confirmed the importance and role of the privacy and security factor in GP acceptance of the CDSS: GPs stressed its necessity, as it is considered a basic requirement to maintain patient confidentiality and information security. Physicians are very confident in the safety of new health applications and the many features they provide. This factor was added to the main model after confirming its importance through all interviews in the second stage.

The factors of security and privacy have a significant influence on the adoption of mobile health systems (MHS) (Duan, 2018). Therefore, without a suitable safeguard for data in MHS, healthcare centres and hospitals will not adopt it. The application needs to have powerful security and privacy measures to be accepted by patients being (Duan, 2018). To make progress in the successful adoption of m-health, it is important to consider the

confidence of users in health care regarding data security and privacy (Steinhubl, Muse & Topol, 2015).

Security and privacy are two of the main factors that the study's participants mentioned as influencing the intention to use CDSS very significantly. The lack of privacy or safety in medical systems negatively affected their acceptance:

> *"One of the most important factors regarding the acceptance of CDSS is security and privacy. Privacy of the patient's information is sacred in medicine. The patient has the full right to hide information even from those closest to him, so this is his right. If there is any violation of the patient's confidentiality, I won't use the program. For me, this is the most important point"* (SA11)

> *"Security and privacy are considered necessary matters in the medical programs, as they are important in the patient's relationship with the physician. Therefore, it is necessary to make sure that the information is safe and confidential, and I think that such advanced medical programs are secure"* (SB15)

It is necessary consider the level of security and privacy in the HIS used, given the great interest of doctors in preserving the confidentiality of patient data. Raising the level of security and privacy of a system helps a CDSS be accepted by GPs. This can include only giving permission to access the system to people who are end users, such as the doctor. In addition, using passwords and confidential numbers to log in to a system after obtaining entry permits from the top management can help. If there are some violations in the system or a weak level of security and confidentiality, this will contribute to the lack of acceptance of the CDSS and thus GPs may fail to adopt and implement it.

7.3.9 Accessibility (Integration)

The accessibility factor is considered another significant positive influence on GP intention to use the CDSS. Through convergent interviewing in the first stage, the fourth participant, SA4, discussed the extent to which the accessibility factor affected their

acceptance of the CDSS. This factor was discussed in subsequent interviews, as well as in all interviews of the second stage. The participants indicated that just one access application was needed, instead of multiple applications. They submitted that integrating all health applications used in primary health centres or hospitals under one application would contribute to the speed of performing a task and reducing diagnostic times. Having one health application that included the patient's records, previous diagnoses, medication dispensed and tests would contribute to GP acceptance of and intent to use CDSS. Some participants indicated that they currently used more than one application of the HIS, and this was inconvenient because they were not linked.

The presence of many investment companies in implementing HIS has contributed to providing different medical applications that are difficult to integrate because of heterogeneity and different specifications (Payne et al. 2019). This leads to difficulty in the interconnection and sharing of information and data between hospitals. Al Aswad (2015) indicated that the laboratory system is often uses different EMRs across many Saudi hospitals, where there is no integration of laboratory systems with EMR owing to system complexity.

The participants agreed with the importance of integration between medical programs used. They pointed out that CDSS should be combined with all the health systems used to gain all their advantages. Using more than one medical application, such as a blood test system, a radiology system and a medication system, added to the time required and increased waiting and diagnosis times for patients. Having one advanced medical program such as CDSS that combined all of these systems would greatly promote its acceptance by physicians. In the second stage, 90.48 % of participants confirmed that the

integration factor (accessibility) was very important and would contribute to the acceptance of the CDSS. This is supported by some participant statements:

> *"Using a single system that includes all medical programs is much better than using many different applications. The integration will greatly affect our acceptance of CDSS. This will make the work easier and save time by using one program, not like the case now where we have a program for prescribing medications and another program for the patient's records"*. (SB24)

> *"I think integrating all programs into one system is very important because moving between one program and another wastes time, so integration will help to reduce the time"*. (SB23)

> *"All programs must be integrated into one program, so merging helps to accept CDSS. I think that once I enter the patient identification number, I should find a place for X-rays, laparoscopy and old medicines. I am also supposed to find a place through which I can dispense new medicines, and read the old notes made by the physicians in the clinics the patient has visited"* (SB4).

The accessibility factor is an important construct that should be considered when adopting HIS in medical organisations. Accessing a single, unified health application that includes all the services an end-user needs, such as the history of illness, dispensing of medicines, treatment plans and medical recommendations will contribute to HIS acceptance, facilitating entry making and saving time. The presence of many different medical applications may distract a GPs, and delay or affect the performance of the medical task.

7.3.10 Informativeness (Increased Knowledge)

The informativeness factor was found to be another factor affecting GP intention to use CDSS. In first stage convergent interviews, the first participant, SA1, mentioned the role of the CDSS in acquiring knowledge and its effect on acceptance of the system. This factor was included for all questions in subsequent interviews, as well as for all interviewees in the second stage. In this study, the informativeness factor indicates the

existence of a tool that contributes to the user's increased knowledge and learning from the tools provided by the CDSS, as well as increased knowledge from alerts, signals and medical directions, and from setting medication dosages. Participants indicated that this tool provided them with modern medical information, especially when linked to reliable medical sources or ones that may be designed specifically for them.

Informativeness is information that is provided and presented to the user from the system (Sun, Han & Feng, 2019) and contributes to obtaining valuable and useful information for the user (Dehghani, Niaki, Ramezani & Sali ,2016). Zhao and Wang (2020) have extended the UTATU model by adding additional factors, including informativeness, which contributes to enhancing the model to understand the features of social networks.

GPs pointed to the role of the CDSS in increasing their knowledge in the medical field and medications. Many mentioned that using the CDSS would help them learn through the recommendations and advice provided by the program when diagnosing a patient's condition. In addition to identifying the most appropriate medication for a disease, as well as identifying interactions with other medications. In the second stage, 90.48 % of the participants stated that the informativeness factor would contribute significantly to acceptance of the CDSS. Some statements from participants highlight this:

> *"I think it's a good way to use CDSS in order to get the information you need. This helps to deal with the patients' situations that we encounter it daily. The physician should ask many questions in order to understand the pathological case and look into the details in order to not ignore a specific or serious disease. For example, two days ago I had a patient and I asked him many questions about his family record and symptoms of the disease. After that it became clear that he had a suspected colon cancer. He was examined after that and it was confirmed that he had that disease. Therefore, it is important that there is a system in which a bank of questions is available that helps the physician diagnose and then works to guide you. When many questions*

are asked, for sure will you obtain useful information that will contribute to patient safety" (SB11)

SB11 also noted that:

"I think that such programs will help me to use them as my reference, such as if I ask the system any questions about a specific situation or disease through this program, I will be able to obtain information that helps me to make the appropriate decision and learn from it".

"I think CDSS will help me to learn and increase my knowledge. For example, I take advantage of times when patients do not come, to enter the program and search for things related to the patient that I've examined, and review the treatment that she has taken, about which I forgot. Also, I update my information from information contained in the program. This is very useful". (SB29)

Several participants in the research mentioned that the CDSS was considered a source from which to increase their knowledge, one that could provide reminders of medical information related to their medical task. Having alerts and reminders in the CDSS is a great opportunity for the physician to learn more and reduce medical errors. The increase in disease cases and the difference of symptoms has led to the need for an intelligent medical system that contributes to providing more effective and better quality health care.

7.3.11 Communication and Shared Knowledge

The seventh participant in the first stage, SA7, mentioned CDSS's role in communicating with doctors and sharing knowledge, and the positive effect of this on accepting the system. After that, the effectiveness of this factor was discussed in all interviews, as well as for all interviewees in the second stage. Participants noted the importance and influence of communication and shared knowledge in their intention to use CDSS. They indicated that the presence of this tool would contribute to their communication with other physicians, especially during medical consultations, instead of contacting them over the

phone and waiting for a response. The physicians indicated that it might be possible to communicate in the system by writing in a chat function or through a video or voice call.

Sharing knowledge and communication between physicians contributes to enhancing the quality of patient care (Radaelli, Lettieri, & Masella, 2015). The term 'knowledge sharing' is defined as 'referring to the communication of knowledge within a group of people' (Sarminah, 2018, p. 429). The requirement for effective sharing of knowledge in healthcare is increasing because of the complexity and kinds of knowledge in medical research and clinical treatments, which have led to difficulties in relation to information and providing quality healthcare (Tsai & Hung, 2016).

The CDSS is an effective tool for physicians for managing medical knowledge and presenting health information (Improta et al, 2020). Medical knowledge management is important for the successful implementation of the CDSS (Lyman et al, 2010) and therefore it is essential that it is regularly updated (Khalifa & Alswailem, 2015). According to von Michalik, Kwiatkowska, & Kielan (2013), the CDSS is one of the main and important tools that support knowledge management in the health care field. Furthermore, the CDSS is an effective tool for providing necessary and correct information which is easily accessible (Zhang, Duan, & Zhao, 2015). Moreover, it enables information and knowledge to be shared among physicians in various locations and facilitates making medical decisions (Tawfik & Anya, 2015). However, as Esmaeilzadeh et al (2015) point out, a positive attitude pf healthcare professionals on regards knowledge sharing greatly increases the willingness to adopt the CDSS.

Communication and knowledge sharing are among the important factors that participants said positively affected their acceptance of CDSS. Many physicians indicated that they needed a tool that connected them with their colleagues or with physicians who

specialised in different medical fields to consult and ensure that their decisions were correct. Participants indicated that in some cases, there was difficulty in communicating with specialists, but the presence of such advanced systems would facilitate faster and smoother communications. Of the second-stage participants, 97.62% said that communication and knowledge sharing would contribute to their acceptance of CDSS. Some statements support this overwhelming response:

> *"Having a tool to communicate with physicians in CDSS is very important. For example, when I want to communicate with a consultant, I find it very difficult to do that, but thanks to this application, we can be linked with hospitals and thereby the ease of consulting on such matters"*. (SB19)

> "*As for the professional division of a medical student to a general practitioner, to a deputy specialist, to a progressive specialist, according to knowledge and according to the grade, so communication with them is a very important matter and should not be interrupted at all. In some cases, getting feedback is important from specialists regarding some cases of patients. The specialists are better informed than us, so it is assumed that we communicate with the specialist and can get his opinion and provide appropriate treatment"*. (SB26)

Communication and knowledge sharing gives the physician more reassurance to correctly diagnose a condition in cases where they lack the relevant specialisation; for example in cardiology, kidney conditions and internal medicine. Taking this factor into account will contribute to HIS acceptance by GPs, because it gives them an opportunity to communicate in an organised and easier manner through the CDSS, instead of relying on traditional means such as the phone or waiting to meet with a specialist physician.

7.3.12 Perceived Patient Satisfaction

Perceived patient satisfaction is another factor that affects GP intention to use CDSS. In convergent interviewing in the first stage, the sixth participant, SA6, mentioned the importance of patient satisfaction regarding the HIS used, as this affects GP acceptance

of the system. This factor was discussed in the subsequent interviews, as well as in all interviews in the second stage to determine the extent of its effect on participants. GPs participating in this study considered that the patient's views on the systems used were important, as when the medical systems become more advanced, this will in turn lead to the provision of more medical care services. When the patient becomes more satisfied with the system used, this will cause physicians to become more confident. The presence of a high-quality and efficient CDSS contributes to a better feeling for the patient and this naturally contributes to acceptance of the HIS by the physician. Abdekhoda, Ahmadi, Gohari and Noruzi (2015) have noted that the physician-patient relationship has a significant influence on physicians' attitudes toward accepting HIS. Shibl et al. (2013) indicated that GPs considered patients' confidence worthwhile in the use of a CDSS.

In the second stage, 71.43% of participants indicated the importance and of patient satisfaction on their acceptance of the CDSS, while 28.57 % indicated that this factor would not affect their acceptance. The GPs indicated the importance of the patient's presence and their confidence in the physician's use of CDSS when using the system to make a medical decision. Most GPs believed using an advanced medical system contributed to greater patient satisfaction and confidence in the physician. In addition, some physicians believed that using the system improves relationships with patients, especially since many patients know and understand how modern systems can obtain more accurate information. Despite that, there was some fear or hesitation from a few physicians about using CDSS and taking advantage of its capabilities and benefits, because of their patients' own views of the physician. Patient confidence in physicians may decrease if they depend on medical applications in decision-making:

> *"I think the patient will be more satisfied and confident when using CDSS, because originally it will help more in making decisions: when you make the right decision, for*

sure, the patient will be satisfied, and this program exists in order to help in making the decision and avoiding mistakes". (SB35)

"I think that the patient will be satisfied and will trust more if he knows that I am using CDSS because CDSS helps to reduce errors, and this leads to improving my relationship with the patient" (SA11)

"Nowadays, patients are accustomed to using electronic services such as traffic services, passports and other services, so there will be trust by the patient in such advanced medical programs. I think patients who are educated or even non-educated have more confidence these days when the physician uses advanced medical systems. For example when using CDSS, I say to the patient, 'You did a test two weeks ago and its result is such and such'. Also, two or three years ago you did a blood test and its result is as follows. So the patient knows that the medical program is registered with a lot of important and useful information, and it will add to the patient's confidence quickly and significantly". (SB27)

Patient satisfaction with the medical systems used contributes to the acceptance of GPs. This can happen through the patient's observation of the tools or services that the CDSS may provide to ensure more effective medical and personal decisions. Providing better services and health care through the features provided by the HIS will increase patient satisfaction with and loyalty toward GPs, thus increasing doctors' acceptance of the CDSS.

7.3.13 Connectedness with Patients

The connectedness with patients factor was discovered through the fifth interview with SA5. SA5 indicated the role and importance of this factor in the physician's acceptance of the CDSS. The participants in this study noted the importance of CDSS interactions with patients in terms of communicating through text messages or emails. The participants stated that the presence of information for patients about medical information contributed to GP intention to use the CDSS. Some GPs added that a text message could be sent to the patients reminding them of medications or periodic reviews, in addition to

alerting them to diet and nutritional programs that would contribute to their treatment and care.

It is necessary to provide a means of communication with patients to increase their awareness of the healthcare services provided, and this is best done through the patient's online portal (Hoogenbosch et al., 2018). Turan and Palvia (2014) studied and reviewed significant IT concerns in the Turkish healthcare sector. They found that sharing health information with patients was an IT issue. The CCDS provides many features that contribute to better health care, including the involvement and empowerment of patients in a greater understanding of their health conditions and the treatment provided through health information portals accessible to the patient (Shirazian et al., 2014).

The GPs generally agreed that the ability to communicate with patients in the CDSS through sending useful information positively affected their greater acceptance of the CDSS. Some indicated that this feature, where the physician controls the content of the message and the timing of transmission, may strengthen a good relationship between patients and GPs, as well as increase their trust and confidence in physicians who use CDSS. Some GPs indicated that text messages may be the most appropriate tool of communication because most patients have mobile phones. Through this research, 97.62% of the participants in the second phase indicated the influence of connectedness with patients on their acceptance of CDSS:

> *"The presence of certain tools to send educational messages, awareness and education to the patient is an important feature. We assume that the patient has a specific disease and I want to give him a specific description: it is possible to send a prescription or the treatment plan to a patient's email and via SMS. I think that this feature is excellent, especially if the patient needs to be alerted from time to time… I think communication with the patient is important because the patient has the right to be educated and know*

more about his or her illness. Receiving documented messages are useful to them and this contributes to acceptance of the CDSS". (SB41)

"I think the factor of communicating with the patient for education and awareness is a very important factor that contributes more to acceptance of the system. The factor of communicating with patients is very important. For example, diabetics are supposed to keep in contact with their physician in order to take appropriate treatment. If I send awareness messages or a reminder of an appointment or something, I am putting the patient at the top of my interests. This tool is a very beautiful thing that helps and supports the patient to heal". (SB26)

"I think sending reminders, educational messages to the patient is a factor that contributes to reflect positively on my acceptance and even on the patient's acceptance regarding the system. Communication by sending educative messages to patients so that they benefit from them is evidence of the interest of the physician and the primary health centre. The awareness and reminder messages for patients will contribute significantly to reducing the cost. Prevention contributes to preserving many of the country's resources" (SB25)

Finding a communication tool with patients through the CDSS contributes to acceptance among GPs, as this may strengthen a relationship between the patient and the physician. In addition, a communication tool can improve patient health care and provide useful health information, and awareness and appointments can also contribute to obtaining better medical care.

7.3.14 Perceived Risk

The perceived risk factor was discovered during the first and second interviews, where SA1 mentioned the role of time risk in influencing CDSS acceptance, while the functional risk effect was discovered through an interview with SA2. This factor was then added to questions in all subsequent interviews to examine the role and influence of this factor in GP acceptance of CDSS. Several participants in the present study indicated the effect of perceived risk on their intention to use CDSS. GPs considered that perceived risks must

be considered and dealt with appropriately so that the CDSS was problem free, challenges may otherwise hinder acceptance and use of the CDSS. Participants noted several important determinants under the perceived risks factor. The first is the time spent in using CDSS during the diagnosis and interview of a patient, owing to the introduction of much data (both necessary and unnecessary) that prolongs the consultation, as well as increasing the waiting time of other patients. A second determinant is the suspension or disconnection of the CDSS, which may refer to or delay the process of completing the required patient data, and thus affect the physician's acceptance and use of CDSS.

Ayanso et al (2015) indicated that perceived risk was one of the major factors influencing the acceptance of personally controlled EHR. The authors mentioned that it was necessary to improve these systems to reduce and prevent challenges and risks to provide a better healthcare service through the implementation of a successful HIS. In addition, Andrews, Gajanayake and Sahama (2014) investigated how people perceived having a personally controlled EHR. They indicated that the perceived value and the perceived risks factors were the two most important variables that influenced acceptance of that system. Further, Jiming (2016) sought the determinants of the use of HIS by reviewing previous studies, and concluded that perceived risk was a major determinant.

Some GPs were concerned that the use of such advanced medical programs may increase time spent because of the failure to merge them with the main program being used, or that they may need to fill in fields to record a diagnosis and obtain support for making a medical decision. Some GPs indicated these reasons may adversely affect their relationship with a patient. Most of the study participants indicated (during the second phase in this research) the influence of perceived risk on their acceptance of CDSS. Here, 69.05% said that time risk and systemic function, which includes system suspension or

slowdown, would affect acceptance of the CDSS, while 30.95% indicated that these would not influence their acceptance. Some participant statements clarify these positions:

> *"The use of many medical programs will create a problem, unfortunately. We are currently using various medical applications such as the electronic health record program and the drug programs and if yet another program is used that helps with a diagnosis, together these mean more work for the medical practice and this will lead to more time being spent"* (SB9)

Also, some GPs felt that writing might also cause more time spent on the CDSS:

> *"I think sometimes such programs take a lot of time. I mean, for example, in order to benefit from applications such as this, you should add all the requested data like diagnosis, medical history, and the tests I have done. Therefore, because you're adding complete data to each patient, this process takes a lot of time"*. (SB11)

SB11 added that she would use CDSS if she discovered that it was beneficial to the patient, even if it is time-consuming:

> *"For me, the most important thing I have is the patients: if I know this will help them in diagnosis and health care, I will use it even if it takes a lot of time. I am sure I will use it"*

Other physicians considered that when CDSS was first implemented, it may take more time to use:

> *"I think this system is important, but it may consume a lot of time because it is new, but with practice and the passage of time it will be faster because it is supposed to be easy to use… CDSS should be brief in order to be faster and save time"*. (SA1)

On the other hand, participants discussed their fear that some suspension or temporary interruption of the CDSS may occur during use, because of the poor quality of the CDSS design or poor Internet connectivity. They also claimed that this problem would impedes their work performance, which may negatively affect patient health care. Therefore, they stressed the importance of designing an effective and high-quality CDSS that includes

technical support. This needs give easy access to highly experienced and efficient experts. The breakdown or failure of HIS has mentioned in many different studies regarding the acceptance of IT in general and HIS in particular. Participants support this position:

> *"We need a strong infrastructure and fast Internet, which means that there may be a problem either in the Internet bandwidth or in the servers. This causes a problem in suspension or breakdown of CDSS due to the crowding out patients… The problem may arise because a large number of users on a web-based system, especially at peak time, the system is at its lowest level, meaning that there is a problem with either the bandwidth or the servers. Then it resumes working after the rush hour"*. (SA9)

SA9 also continued to say that if the application was based on the Internet it could become a significant problem:

> *"It is the biggest problem if is it web-based. Why is it based on the Internet? … The application should be stored on the device or the private server in the health centre, and the data can be transferred later without dealing directly in the application that is web-based"*

SB32 was concerned about suspending or stopping the application, especially in early implementation phase, stating:

> *"There may be some malfunctions in the application in the beginning, but with continuous updating, it will be good. If the application breaks down, there will be a problem because it is the only channel for recording and retrieving patient data"*

This GPs also suggested providing technician support to overcome any obstacles in CDSS:

> *"The presence of competent and experienced technicians who are devoted to every seven or eight primary health centres contribute to overcoming obstacles and technical problems"*

Another participant stated that:

"One of the challenges that may affect the workflow is the system stoppage, which is usually due to the interruption of the Internet, as is the case in the current system at times. This causes a long wait for the patient and postpones medical prescriptions until the system works again". (SB2)

SB8 commented on dealing with programming companies that have long experience in the market and have great potential:

"Frankly, some software companies that produce and design medical software should be avoided. There are companies that provide inappropriate designs and their [service] level is very weak. The more powerful the company and the more experience it has on the market, the better and more professional its software and products"

Time is one of the most important things in a GP's task performance, especially in general medicine, where many patients may be waiting to see a GP. Therefore, the CDSS design should consider the time taken for each task, and should not require unnecessary empty fields to be filled by a GPs. Moreover, it is vital to take into account any technical problems in the system that may significantly hinder task performance and thus negatively affect the GP's acceptance of the CDSS.

7.4 Moderating Variables

The conceptual model proposed in this research studied the impact of three moderating variables (gender, age and experience) on the factors which influence the acceptance by GPs of the CDSS. The results of this study indicate that none of these moderating variables were found to have an effect. Several other studies, however, have indicated the effect of these variables on users' acceptance of technological systems.

Earlier research has noted the possible influence of gender as a moderator on technology acceptance (Venkatesh et al., 2003; Chauhan, Jaiswal & Kar, 2018; Tran, Zhao, Diop & Song, 2019). Furthermore, Some studies also consider the effect of age on technology

acceptance (Morris, Venkatesh & Ackerman, 2005; Venkatesh et al., 2003; Tran, Zhao, Diop & Song, 2019; Chang, Liu, Huang & Hsieh, 2019). Other research also confirms the influence that experience has on moderating technology acceptance (Venkatesh et al. 2003; Chauhan & Jaiswal 2016; Moryson & Moeser, 2016).

In this study, as previously mentioned, there is no proof that these variables affect physician acceptance of the CDSS. Several other studies have also found that age does not affect IT acceptance (Giri, Apriliani & Sofia, 2019; Gusman & Ariyanti, 2019; Madigan, Louw, Wilbrink, Schieben & Merat, 2017). There is also confirmation from some that gender does not affect the acceptance of IT (Giri et al., 2019; Gusman & Ariyanti, 2019; Madigan et al., 2017). Additionally, some researchers assert that experience does not affect technology acceptance (Alasmari & Zhang, 2019; Baz, Cephe & Balçikanli, 2019; Momani & Abualkishik, 2014).

Research conducted by Robinson et al. (2020) which employed the UTAUT model has shown that age is not considered an influence on willingness to use technology. Another study by Tennant et al. (2015) explored the impact of sociodemographics and social determinants on Web 2.0 usage to access health information. The results of this study indicated that age did not have an impact. Furthermore, in a study by Shibl et al. (2013) on the factors that affect the acceptance of decision support systems, the authors showed that gender, age, and experience had no effect on any of the UTAUT factors as well as the other factors identified in their study. In other research Van der Ham et al (2020) investigated the acceptance of digital cognitive rehabilitation amongst healthcare providers with the results indicating that both age and gender did not influence degrees of acceptance. Furthermore, Ujala, Hörhammer, Kaipio and Heponiemi (2018) studied the health professionals' prospects regarding the impact of using the patient portal system.

The results of the study indacated that age and gender were not considered to influence use. Moreover, Lubua and Pretorius (2018) state that both gender and experience do not impact on factors which determine the sustainable use of the HIS.

7.5 Appropriate CDSS Design for End Users

Among the important notions discussed by the study participants was the significance and necessity of designing the CDSS according to the desires and needs of the end user (the physicians). Many GPs indicated that for a HIS to be successful and acceptable, designers should first communicate with GPs who will use this system, to provide tools and services on the application's interfaces that serve the end user. Semi-structured, in-depth interviews with physicians is one of the best methods for exploring clinicians' perspectives, desires and needs regarding designing a CDSS centred on the end user.

Communicating with many doctors, especially those with much experience, about the development of health systems, will contributes to learning about what will help GPs to provide better health services and care. In addition, the participation of physicians from different specialties in the design of the medical system may assist in providing essential information to the end users. This is evidenced in participant comments:

> *"It is very important for CDSS providers to meet the physicians in all disciplines in order to learn of their requirements and the things that benefit them to facilitate the healthcare work"* (SB41)

Communicating with GPs before designing the system creates an opportunity for designers and developers of health informatics programs to learn more about the conditions facing physicians. This will lead to a more acceptable HIS among end users. In-depth interviews with GPs before designing a program will also provide a clearer picture for software developers regarding the challenges end-user physicians face in their

medical tasks. Software developers usually do not have experience in medical work, so communication with doctors will provide them with rich and useful information. As one participant stated:

> *"It is necessary for the developers of such programs to communicate continuously with the end users of the system to know our requirements. If system developers want more benefit and information, they can communicate with patients to find the benefits of and challenges to the doctor when using such and such in this system"*. (SB11)

The continuous development and updating of the medical application is vital to ensure the effective performance of its medical tasks as required. Communicating with the medical staff for feedback and providing follow-up technical support team to solve any system problems will enhance the GP's acceptance, in addition to contributing to the successful implementation of the CDSS. This is supported by the study participants, one of whom stated that developers should:

> *"….continuously communicate with the medical staff to find out any deficiencies in the system used, which means if there are any unavailable things in the system that the doctor recommends to develop and fit the system to the medical work. This is additional to correcting unsuitable and inappropriate issues in the system"*. (SB10).

Acceptance of a HIS may not occur because of the failure to consider the requirements and needs of GPs. The GPs is the system end user, so conducting in-depth interviews with them will contribute to identifying the features, tools and data they require. Designing according to end-user needs will contribute significantly to saving the cost, time and effort in designing a health program and will create a health application that meets GP' needs.

7.6 The outcomes from discussions

This chapter discusses in depth each factor which affects the willingness of GPs to accept the CDSS in Saudi Arabia. This contributes to answering the main question of this thesis.

The results of these discussions and the inferences from related studies indicate that the current status of medical systems is constantly evolving. Many participants in this research indicated the importance and necessity of adopting CDSS and pointed out the challenges and opportunities that they may face in using this application. Through in-depth interviews and thematic analysis, the discussions in this chapter helped to identify and understand the 13 factors affecting the acceptance of CDSS.

The 54 interviews conducted through three stages were enough to obtain rich information that helped reach convincing answers and understand the current status of the medical system used in Saudi Arabia. The primary healthcare centers in Saudi Arabia rely heavily on the use of two applications: the first is the electronic file to manage patient data, and the second is an electronic application for the management and dispensing of medication to the patient. Despite the positive performance of the two systems in general, the use of two applications during the patient's visit is considered annoying to the doctor. Most indicated that this may take a longer time due to the need to enter the necessary data while the patient is waiting. Therefore, the participants emphasized the necessity of integrating HIS applications.

Main research question		
What are the factors influencing the acceptance of CDSS in Saudi Arabia?	**Factors**	**Subfactors**
	Performance Expectancy	Time
		Alert
		Reduce errors
		Treatment plan
	Effort Expectancy	
	Facilitating Conditions	Training
		Technical support
		System updating
	Task-Technology Fit	
	Technology Characteristics	Accuracy
		Internet connection speed
		Quality computers
	Task characteristics	
	Accessibility (Integration)	

	Perceived patient satisfaction	
	Informativeness (Increased knowledge)	
	Connectedness (with patients)	
	Communication and Shared Knowledge	
	Privacy and Security	
	Perceived Risks	Functional performance risk
		Time risk

Through the discussions and data analysis, it was found that there are no moderate variables that impact on the factors that affect the GPs' acceptance of the CDSS. The variables that were adopted in the conceptual model of this study were inferred from previous studies and included gender, age and experience,.

The above discussions with evidences from relevant studies helped to shed light on the role of the factors that were discovered in the success of the CDSS adoption. The views and the experiences of doctors as end-users are necessary for the development and design of medical systems in order to avoid any future problems that hinder the acceptance of the HIS.

The main objective in this study was to build and develop the theory, and not to test the theory. Accordingly, the qualitative approach was adopted rather than the quantitative approach which relies on statistical indications in order to test theories. Another limitation is for the thematic analysis is to present themes of deep understanding (Hawkins, 2018). Therefore, in order to avoid presenting themes that lack clarity, the themes were derived from relevant literature in the area of factors affecting technology acceptance. Another limitation in thematic analysis is the possibility of missing some important texts and data.

This was avoided by re-reading and reviewing the texts more than once in order to confirm and discover the themes.

There are several limitations and challenges that were encountered in this thesis as a result of the adoption of a qualitative research method and data collection and data analysis. These challenges were addressed by following strict methodologies and strategies with inference from the literature in order to ensure the validity and credibility of the study procedures. More details are provided in chapter six and eight regarding the challenges that were faced while conducting this research and how these were dealt with.

7.7 Chapter Summary

This chapter has discussed the factors that influence acceptance of CDSS. At the outset, the current state of HIS used in Saudi Arabia was discussed. It is clear that there has been a remarkable development in the systems used in HIS over recent years, but paper records continue to be used in some primary healthcare centres.

Through semi-structured interviews with 54 GPs, this research has contributed to obtaining rich information regarding the current use of HIS and the factors that affect GP acceptance of the CDSS.

In this study, 54 GPs were interviewed, across three stages. In the first stage, 12 GPs were interviewed to determine the main factors in the model, as TTF factors were added to UTAUT. Dick (1990) considers that 12 interviewees are enough to identify factors: when no new factors are disclosed in successive interviews, the interviewer can cease this stage. This is what happened: in the ninth and tenth interviews, no new factors were mentioned. In Stage 2, 42 GPs were interviewed to investigate and discuss the factors mentioned in Stage 1 and to ascertain the extent of their agreement and perceptions. In Stage 3, three

participants from the first stage were chosen to increase verification and investigation of the proposed model and its effectiveness, and the factors that were discovered in explaining GP acceptance of the CDSS.

Most of the health centres where GPs were interviewed largely depend on two software applications provided by the Saudi Ministry of Health. The first is the application of a patient's electronic file. This helps GPs in recording all the patient's data, and information regarding diagnoses and historical and current health conditions. The second application used, 'Wasfaty', helps doctors to dispense medicines. This application allows a patient to obtain their medication from the nearest pharmacy contracted with the 'My Prescription' service, through an electronic platform that connects hospitals and primary health centres with those pharmacies. This application also helps to clarify medical prescription details, as it helps to avoid any typographical errors.

In addition, the chapter discussed the factors affecting GP acceptance of CDSS. Many quotations from participants are included, clarifying their views on CDSS acceptance.

The following 13 factors influence acceptance of CDSS: (1) performance expectancy (including timeliness, alert, reduction of errors, treatment plan); (2) effort expectancy; (3) facilitating conditions (including training, technical support, the provision of updates and workflow); (4) task-technology fit; (5) technology characteristics (including accuracy, the Internet and modern computers); (6) task characteristics; (7) accessibility (integration); (8) perceived patient satisfaction; (9) informativeness (increased knowledge); (10) connectedness (with patients); (11) communication and shared knowledge; (12) privacy and security, and (13) perceived risks.

Chapter 8: Findings and Conclusion

This chapter presents the findings with a conclusion of the research. All the factors that affect the acceptance of the CDSS are presented and investigated with reference to relevant previous studies. This investigation has contributed to clarifying and learning more about the factors affecting the acceptance of CDSS, which has contributed to building the final model for the research. This chapter also includes answers to the secondary questions of this research. In addition, the importance of effective CDSS design is explained, based on the GPs' recommendations and their opinions as end users: they are in the best position to know their requirements of the system. The final proposals regard the factors that influence the acceptance of CDSS by GPs in Saudi Arabia and incorporate recommendations that will contribute to the implementation and adoption of a successful CDSS. Further, the research limitations, future research and conclusion are presented. Finally, at the end of this thesis, all references and appendixes are presented.

8.1 Findings of Factors Influencing the Acceptance of the Clinical Decision Support System

This study has made a significant contribution to the exploration and investigation of the factors that influence the acceptance of the CDSS among GPs in Saudi Arabia. In the previous chapter, the factors discovered from the interviews were discussed in depth with the GPs participating in this study, after analysing the data.

The main research question of this study is: what are the factors influencing the acceptance of the CDSS in Saudi Arabia?

This question was answered through semi-structured in-depth interviews with 54 GPs in three stages. This contributed to clarifying, investigating and discovering 13 influencing

factors. This led to the construction of a new model that clarifies the factors that influence the acceptance of the CDSS in Saudi Arabia These factors include both UTAUT and TTF determinants. However, the potential factor of social influence was excluded from the UTAUT model in this study because most participants considered it either ineffective or irrelevant. The adoption of a three-stage interview strategy contributed to discovering and identifying the factors that influence GP acceptance of CDSS. The convergent interviewing approach was used in the first stage (interviews with 12 GPs) to identify and determine the initial factors. In the second stage, 42 GPs were interviewed to obtain an understanding and clarification of the factors identified in the first stage. The second stage contributed to emphasising the factors that affect GPs' acceptance and increasing the understanding and clarification of these factors, and contributing to building the final model. In the third stage, three physicians were interviewed from the first stage to increase verification and knowledge of the participants' compatibility regarding the final model.

The following 13 determinants affect acceptance: (1) performance expectancy (including timeliness, alert, reduction of errors and treatment plan); (2) effort expectancy; (3) facilitating conditions (including training, technical support and the provision of updates); (4) task-technology fit; (5) technology characteristics (including accuracy, the Internet and quality modern computers); (6) task characteristics; (7) accessibility to CDSS (integration); (8) perceived patient satisfaction; (9) informativeness (increased knowledge); (10) connectedness (with patients); (11) communication and shared knowledge; (12) privacy and security; and (13) perceived risks.

Figure 8.1 shows the final model for this research, which includes all the factors that were discovered and verified from previous relevant studies.

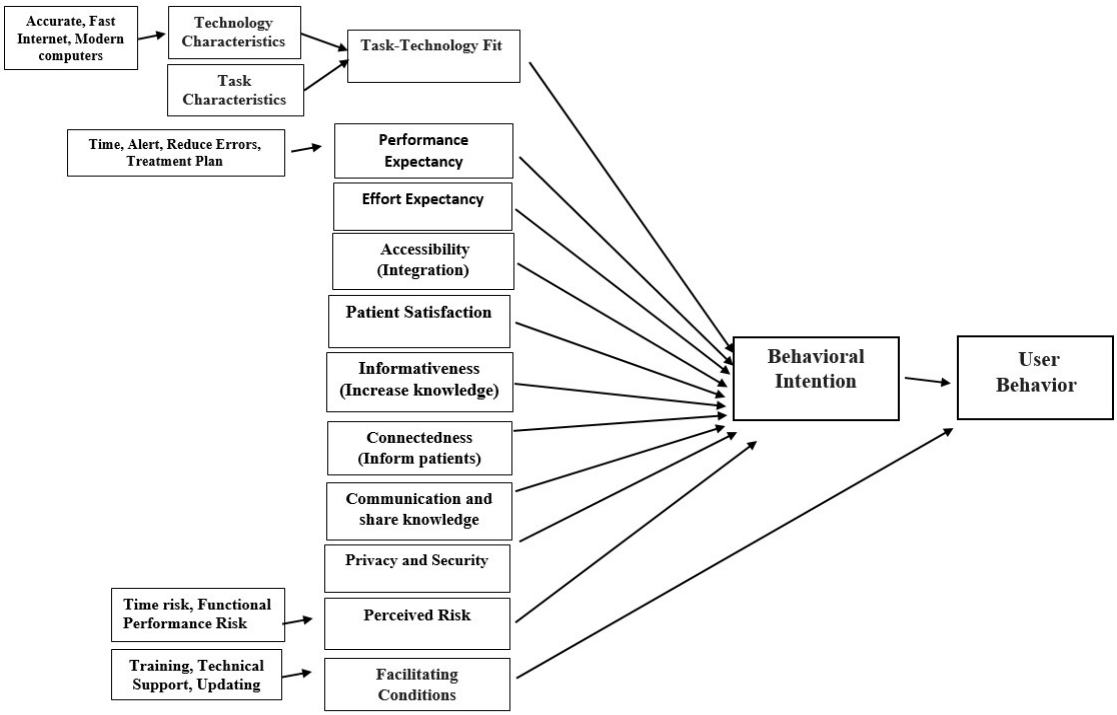

Figure 8.1. Final Model Developed in the Research

Of these 13 determinants, three (performance expectancy, effort expectancy and facilitating conditions) correspond to those found in the UTAUT model, while three others (task-technology fit, technology characteristics and task characteristics) used the TTF model. However, contrary to the UTAUT framework, the participants in this study considered social influence to have little or no effect. In this study, seven determinants not in the UTAUT or TTF (see Figure 8.1) were discovered: accessibility, perceived patient satisfaction, informativeness, connectedness with patients, communication and shared knowledge, privacy and security, and perceived risks.

The following sections outline all the factors that have been discovered and identified as the main factors affecting GP acceptance of the CDSS in Saudi Arabia, as well as the references to previous relevant studies.

8.1.1 Performance Expectancy

Most participants in this study confirmed the significance of the performance expectancy factor that influences GP intention to use CDSS. They supported the performance benefits of the CDSS in terms of reduced errors, treatment plans and effective alerts. They indicated that these factors contribute greatly to their acceptance of the CDSS. Several studies have noted the positive influence of the performance expectancy factor on HIS acceptance (Petersen, Luckan & Pather, 2020; Shiferaw & Mehari, 2019; Zhang et al., 2019).

Regarding medical errors, according to Aldekhail (2014), CDSS prevents many and thus contributes to providing better healthcare services for patients. Further, Catho et al (2020) found that CDSS helps to reduce the diagnostic and investigation time for patients. CDSS is also designed to provide alerts when certain medication orders contain possible high-risk medication interactions (Mulder-Wildemors, Heringa, Floor-Schreudering, Jansen & Bouvy, 2020). In addition, Baypinar, Kingma, van der Hoeven and Becker (2017) found that a CDSS improved physician performance.

Aggelidis and Chatzoglou (2009) studied the factors that determine HIS acceptance for hospital staff in Greece. The results of their study suggest that performance expectancy influenced the behavioural intention to use HIS for hospital staff significantly. Moreover, Hennington et al. (2009) studied nurses' experiences of using an EMR system in the US. Twenty-three nurses were interviewed, in addition to four nurses' directors. The study results indicate that performance expectancy is strongly influential on EMR use. Also, Holtz and Krein (2011) examined how nurses perceive EMR applications in a hospital. They employed the UTAUT model to understand the factors that influence nurses. Participant responses showed that performance expectancy was an important factor in

adopting the EMR. In addition, Sallehudin et al. (2019) studied the acceptance factors for the Military Lifetime Health Record in Malaysia based on the developed model of both TAM and UTAUT. They showed that performance expectancy positively influenced the medical clinicians' intentions to use that particular system.

In a study by Bennani and Oumlil (2013) to determine the factors that positively affect nurses' acceptance of IT in Morocco, the UTAUT model was used to identify the factors that influenced them. The study was conducted in public and private healthcare institutions. The findings showed that performance expectancy was a very strong factor in the Moroccan nurses' acceptance of using IT. In addition, Sambasivan et al. (2012) concluded that performance expectancy was an important influence in using CDSS. Further, Phichitchaisopa and Naenna (2013) found that performance expectancy had a significant influence on the intention to use the HIS.

Esmaeilzadeh et al. (2015) showed that performance expectancy had a significant impact on physicians' intention to use CDSS in 12 public and private hospitals in Malaysia. Jahanbakhsh et al. (2018) also found that performance expectancy had a positive effect on the acceptance of HIS in primary health centres in Iran. Moreover, Schomakers, Lidynia and Ziefle (2018) examined the determinants affecting the acceptance of m-health applications by adopting the UTAUT model. They mentioned that performance expectancy affected the use of m-health smartphone apps. Yet another study examined the acceptance and use of IT to determine the factors that affect the intention to use health information through social media. The outcomes of that study showed that performance expectancy influenced adoption behaviour (Boontarig, Papasratorn & Chutimaskul, 2016).

Rahmner et al. (2012) stated that physicians need to find knowledge databases that contribute to dispensing medication, understand the doses and side effects and obtain the necessary alerts. Regarding medical errors, Rahimi, Moghaddasi, Rafsanjani, Bahoush and Kazemi (2019) noted that CPOE, which is associated with the CDSS, greatly contributes to reducing pharmacological errors in chemotherapy treatments and actively contributes to providing adequate dosages for the patient. In addition, the CDSS provides tools that help provide an appropriate treatment plan that will support the provision of better, efficient and quality health care to the patient (Razmak & Aouni, 2015). Moreover, the CDSS helps in providing data and information related to real-time medical decision-making (Simões et al., 2018). This means that it contributes to reducing the time required to obtain medical information.

8.1.2 Effort Expectancy

This research proves that effort expectancy is one of the main factors that contribute to GP acceptance of the CDSS. This factor is considered the second determinant of the UTAUT model. Most GPs in this study indicated that CDSS would be easy to use. Several studies have shown the positive influence of effort expectancy on HIS acceptance (Apolinário-Hagen, Menzel, Hennemann & Salewski, 2018; Shiferaw & Mehari, 2019; Zhang et al., 2019)

The focus of planners and managers should be shifted toward ensuring that hospitals have IT that is user-friendly, as contributes greatly to physicians' acceptance of health systems (Chen & Hsiao, 2012). The perception of users regarding the effectiveness and the ease of use of a system are the main determinants in providing an incentive to embrace technology that will be effective in applying health information management (Abdekhoda, Ahmadi, Dehnad & Hosseini, 2014). The CDSS delivers information in a

simple way and it can clarify information or provide alerts based on the submission of images and reports that contribute to decision-making (Musen, Middleton & Greenes, 2020). Shibl et al. (2013) indicated that ease of use of the CDSS is significant but not essential for decision-making support. Dunnebeil, Sunyaev, Blohm Leimeister, and Krcmar (2012) also argued that several e-health technologies, including the CDSS, have an influence on the practice intentions of medical practitioners. Esmaeilzadeh et al. (2014) highlighted the value of ease of use in determining physicians' intentions to adopt the CDSS. Ifinedo (2012) conducted a study in Canada and found that health professionals' acceptance and intentions to use IT were strongly affected by effort expectancy, which supports the findings herein.

Shiferaw and Mehari (2019) pointed out that effort expectancy greatly influences the intention of doctors to use the EMR system. Again, Aggelidis and Chatzoglou (2009) investigated the factors that influenced HIS acceptance by hospital staff in Greece. The findings indicated that effort expectancy significantly affected the behavioural intention by hospital staff to use HIS. Further, Hoque and Sorwar (2017) declared that effort expectancy has a strong effect on user acceptance of the picture archiving and communication system used by the radiology department employees. Also, Aldosari (2012) studied the acceptance of use PACS by employees in the Radiology Unit at King Abdulaziz Medical City in Saudi Arabia. The author indicated that perceived ease of use was the most important factor in accepting PACS. Further, a study by Hosizah, Kuntoro, and Basuki N (2016) in primary health centres in East Java Province, Indonesia, was conducted to evaluate the intention and use of IT. The authors indicated that effort expectancy was a very important factor that affects IT users' intentions.

Phichitchaisopa and Naenna (2013) employed the UTAUT mode in their study that investigated the determinants that affected HIS use. The study's participants were physicians, nurses and hospital staff in Thailand. The outcomes of the study noted that effort expectancy had considerable influence on the behavioural intention to use HIS. In addition, Jahanbakhsh et al. (2018) stated that effort expectancy influenced the acceptance of HIS in primary health centres in Iran, where participants in the research were all users of HIS in health centres.

8.1.3 Facilitating Conditions

This study defined and considered the facilitating conditions that GPs believed were resources and instruments that support and assist the use of CDSS. The research confirmed the significance and role of facilitating conditions as a principal factor in influencing GP acceptance and use of the CDSS in Saudi Arabia. This is the fourth determinant in the UTAUT model. Through in-depth interviews, the GPs agreed on the importance of the following elements: training, technical support and updating the CDSS. Several studies have asserted the positive influence of the facilitating conditions factor on HIS acceptance (Apolinário-Hagen et al., 2018; Petersen et al., 2020; Shiferaw & Mehari, 2019; Zhang et al., 2019).

Ifinedo (2012) reported that organisations should consider facilitating conditions as a significant factor in IT acceptance. A CDSS could be harmful if users are not fully trained on how to use the system, if the information presented is incomplete, or if the CDSS is not well assimilated within existing workflows (Castillo & Kelemen, 2013). English et al. (2017) used a modified version of the UTAUT framework to assess the contentment and achievement regarding the use of a CDSS by pharmacists in relation to prescription

identification and surveillances. They showed that the facilitation of conditions outlined by the CDSS had a direct consequence on the practice of pharmacists.

Antwi et al. (2017) examined the factors that influence Medical ICT acceptance by hospital staff in Ghanaian Tertiary Hospitals. They found that facilitating conditions were a considerable influence on the behavioural intention by hospital staff to use HIS. In addition, Bennani and Oumlil (2013) stated that facilitating conditions were an important factor that significantly influenced nurses' acceptance of IT in Morocco. Their study found that technical support and training contributed to such acceptance. Several other studies have discussed the importance of training for the successful implementation of HIS (Al Aswad, 2015; Thurston & Mulberger, 2015; Turan & Palvia, 2014). User training is important in improving computer self-efficacy and maximising IT use. A CDSS could become harmful if users are not fully trained on how to use the system, or if the information presented by the systems is incomplete(Castillo & Kelemen, 2013).

Presenting and providing technical courses for physicians to raise and improve the efficiency of their IT use is a significant contribution to its acceptance. Sambasivan et al. (2012) found that training for physicians in CDSS will contribute considerably to its successful implementation. In addition, Hossain et al. (2019) argued that strategies should be developed to support and assist physicians to use the IT health records system in Bangladesh through training. Moreover, Irfanahemad, Nandakumar, Ugargol and Radhika (2018) evaluated the determinants that influence the use of telemedicine in a tertiary care paediatric centre. The authors stated that appropriate training and improved skills and capability for teleservices were necessary for healthcare employees.

Phichitchaisopa and Naenna (2013) confirmed that facilitating conditions had an effect on the intention to use the HIS. Boontarig et al. (2016) researched the development of a

unified model for accepting and using IT to understand the intention to use health information by relying on social media. The results again confirmed that facilitating conditions affect user behaviour. In addition, a recent study by Garavand et al. (2020) investigated the determinants affecting medical science students in Iran regarding their intention to use m-health by employing the UTAUT model. The results showed that facilitating conditions influence m-health use. Another study (Zhou et al., 2019) assessed both social influence and facilitating conditions to investigate nurses' acceptance of the hospital electronic information management systems in Ghana by applying the UTAUT model. The findings showed that facilitating conditions significantly influenced the behavioural intention to use such systems. Hosizah et al. (2016) evaluated participants' intentions to use a computer-based information system in East Java Province, Indonesia, The authors confirmed that facilitating conditions had a significant influence on the use of computer-based information system in primary health centres.

Rahimi et al. (2018) added that it is important to add both the training and technical support themes to TAM to contribute to building a model that helps achieve a better understanding of HIS acceptance. In addition, Koskela et al. (2016) noted the importance of continuous updating of data in the system, which will make the system easier to use and give more effective results in relation to medical decision-making.

8.1.4 Technology Characteristics

Participants confirmed the role of technology characteristics as an influencing factor in their acceptance of CDSS. This determinant has been added from the TTF model to the principal model approved in this thesis. This study proves the effectiveness of the technology characteristics factor and the need to add it to model, as it shows the factors affecting physicians' acceptance of CDSS. GPs indicated the significance of fast Internet

connections and modern computers that contribute effectively and are influential and thus contribute to their acceptance of the CDSS. Most participants commented that the presence of these in CDSS helps to save time and perform tasks in a timely manner. Further, many GPs commented that a high-speed Internet connection helps to accelerate work performance, obtaining knowledge and information more quickly, and gives the ability to control the software more easily. Another important element that the study GPs mentioned as influencing their acceptance of CDSS is the positive role of data accuracy.

Technology characteristics have been combined in various studies with the UTAUT model, as this has proven effective and important in accepting IT (Afshan & Sharif, 2016; Park et al., 2015; Zhou et al., 2010) Several studies also indicated a positive effect of technology characteristics on user acceptance of HIS (Corazao, 2014; Hsiao & Chen, 2016; Sombat, Chaiyasoonthorn & Chaveesuk, 2018). Yvonne, Pavel and Philip (2020) investigated the factors regarding m-health influences on medical practitioners' perceived quality of care delivery. They found that task characteristics significantly influenced the TTF, and also that TTF positively influenced the perceived quality of care delivery. Tuba, Esra and Ibrahim (2016) also evaluated the development of health informatics to analyse the congeniality of management systems with the tasks conducted by physicians in Turkish private hospitals. The results showed that IT characteristics were the most efficient factors that influenced the TTF in the study.

CDSS creates the opportunity for medical practitioners to develop and increase the accuracy of clinical diagnoses, as well as the reliability of treatment (Alther & Reddy, 2015). Additionally, Shah mentioned that several studies have found that the EHR has the capability to increase data validity and accuracy significantly (Alanazi, 2015). Ritter (2019) found that AI applications in the health field can provide satisfactory medical

diagnoses and surgical results similar to or superior to those provided by human medical professionals. Further, Cha et al. (2019) assessed the performance of a computerised tomography-based CDSS to determine the responsiveness of treatment for muscle-invasive bladder cancer. They indicated that CDSS could identify patients who responded to chemotherapy in an accurate and improved manner.

Zaman, Hossain, Ahammed and Ahmed (2017) pointed out that high-speed Internet has a positive influence on the success and implementation of HIS. The availability of easy access to the Internet can positively affect the user in finding health information (McCloud, Okechukwu, Sorensen & Viswanath, 2016). On the other hand, slow Internet speeds in medical health centres makes doctors frustrated and dissatisfied with the electronic system, and this may affect their performance of medical tasks (Ajuwon, 2015). Regarding the importance of computer quality, Rahi, Khan and Alghizzawi (2020) pointed out that the quality and effectiveness of computers can positively affect patients' acceptance of telemedicine systems. High-quality computers are among the main assets in hospitals that help them to provide better quality services and care (Marful & Winter, 2018). According to Ammenwerth, Iller and Mahler (2006), when IT devices are updated, performance is improved, thus increasing the compatibility and fit between task and technology. They added that the availability of a sufficient number of computers contributes to the positive effect of the technology on appropriate tasks. Further, the authors argued that the presence of good technology, including quality in the performance of devices and the network, makes that technology highly efficient and thus contributes to achieving its purpose.

8.1.5 Task Characteristics

The task characteristics factor has been added to the main model of this study after merging the TTF and UTAUT models. This study confirmed the role of this factor and its positive influence on the acceptance of intention to use CDSS. Most participants mentioned that daily medical work is difficult and complex, as in some cases the patient's diagnosis requires more experience from the GP, which may lead to further tests and examination in some cases. Several studies have stated the positive role of task characteristics to task-technology fit, which influences behavioural intentions to accept an IS (Afshan & Sharif, 2016; Khan et al., 2018; Wang et al., 2020).

Yvonne et al. (2020) found that the nature of healthcare services is complex and not easy because of its tendency to be affected by other problems, including the lack of available medical information and errors in medical prescriptions. The task characteristics factor has been demonstrated in various studies to help with the acceptance of IT. Yvonne et al. (2020) examined the factors of m-health influences on GPs' perceived quality of care delivery. They asserted that task characteristics influenced the TTF and also considered that TTF positively influenced the perceived quality of care delivery. Also, Tuba et al. (2016) indicated in their study, evaluating the progress of health informatics, that task characteristics influenced TTF in Turkish private hospitals.

8.1.6 Task-Technology Fit

The participants in this study indicated the importance and role of Task-Technology Fit in the acceptance CDSS. The GPs indicated that the features of the CDSS were aligned and fitted with the requirements of their medical tasks, and that this would lead to the achievement of satisfactory and effective medical results. The GPs reinforced that the medical and health care and their daily medical practices were aligned to and fit with

CDSS, which would assist them to provide better healthcare services. Several studies have indicated the positive influences of TTF on the acceptance of IS (Afshan & Sharif, 2016; Khan et al., 2018; Wang et al., 2020)

Laugesen and Hassanein (2017) investigated the behaviours of chronic disease patients by employing protection motivation theory, as well as investigating IT adoption by using the TTF model, to introduce a framework that helps with the adoption of electronic PHR. Further, Fossum, Ehnfors, Fruhling and Ehrenberg (2011) stated that CDSS was proportional and fit, improving the task performance of nurses to treat pressure ulcers and provide proper nutrition, by recommending risk evaluation guidelines for nursing home residents in Norway.

A study by Gatara and Cohen (2014) defined the factors that helped to assess healthcare setting tasks and m-health device characteristics. They used these factors to theorise and examine a TTF model to examine m-health device use and community health workers' performances. The results indicated that fit between healthcare setting task and m-health device characteristics helped to increase m-health adoption and enhanced community health workers' performance in Kenya. A study by Prgomet, Georgiou, Callen and Westbrook (2019) evaluated the relationship between users, tasks and technology in one of the Australian hospital. They indicated that when there was a suitable agreement between these matters and environmental factors, these positively affected the use of HIS. In addition, Wang et al. (2020) noted that task-fit technology positively influenced users' behavioural to adopt healthcare wearable devices.

8.1.7 Privacy and Security

This research has established the significance of privacy and security factors in the acceptance by GPs of a CDSS. The GPs mentioned the need for these factors, as they are

deemed to be among the basics of the profession and are needed to maintain the confidentiality and privacy of patient information. GPs are very trusting of the privacy and security of new health applications and the many features provided. In contrast, the limited privacy or security in medical systems negatively affects acceptance, as some GPs in this study indicated that this is a basic ethical requirement. Several studies mentioned the role of privacy and the security factor in influencing the acceptance of IT (Cao, Jones & Sheng, 2014; Kim, Ferrin & Rao, 2008) and HIS (Abd-Alrazaq, Bewick, Farragher & Gardner, 2019; Adebesin & Mwalugha, 2020; Enaizan et al., 2020).

A study by Sarathchandra and Rathnayake (2019) concerned the current status of influences that affect EMR implementation in public hospitals in Sri Lanka. The authors mentioned that privacy and security were two main issues considered as challenges and barriers to implementation. The security and privacy factors are two of the determinants to be considered with regard to the influence and acceptance of the CDSS, to ensure that users can trust it (Khairat, Marc, Crosby & Al Sanousi, 2018). Another study by Rahimi et al. (2018) analysed and reviewed scientific articles that employed TAM in HIS implementation. The authors argued that TAM must be extended to include a number of factors such as security and privacy. Further, Turan and Palvia (2014) reviewed significant IT concerns in the healthcare sector in a Turkey: the authors mentioned that privacy and security were considered to be among the top ten IT issues.

8.1.8 Accessibility (Integration)

The participants confirmed that the accessibility factor had a very significant positive impact on GPs' acceptance of CDSS. They indicated that just one application is needed rather than multiple HIS applications. They asserted that integrating all HIS software under one application would provide considerable assistance with the speed of

performing tasks and reducing the time consumed in patient treatment and care. GPs mentioned that the presence of this feature in the CDSS will help them to focus on the system and thus lead to greater acceptance. Further, accessing to one HIS application that includes data such as the patient's records, previous diagnoses, medication and tests will contribute to GP acceptance of and intent to use CDSS.

The accessibility factor has been mentioned in many studies, along with its role in the success and adoption of IT (Afridi & Hashim, 2020; Alghamdi & Beloff, 2015; Lwoga & Questier, 2014). Rho, Choi and Lee (2014) noted the important role of the accessibility factor in users' acceptance of telemedicine directly. Shirazian et al. (2014) found that integration of CDSS with EMR provides better outcomes regarding care for diabetics and chronic kidney diseases. Integrating CDSS with EMR contributes to the provision of directions, recommendations and alerts (Chatzakis, Vassilakis, Lionis & Germanakis, 2018). integration of HIS contributes to making a health application with high flexibility, scalability, thus reducing the time, cost and increasing accuracy (Haule, Dida, Sam, 2019). Further, Bologva, Prokusheva, Krikunov, Zvartau and Kovalchuk (2016) highlighted that integration contributes significantly to better access to information, communication efficiency, reducing errors and improving service quality levels.

8.1.9 Informativeness

GPs indicated the role that informativeness plays in supporting their acceptance of CDSS. This factor indicates that CDSS contributes to the user's increased knowledge from the tools provided by the CDSS. The features of CDSS (alerts, signals and medical directions) and from settings and drug dosages helps to improve and develop GP skills. GPs pointed out that a CDSS provides them with a lot of modern medical information, especially when linked to reliable medical scientific sources that may be designed specifically for them.

Using the CDSS will help them learn through the recommendations and advice provided when diagnosing and caring for their patients. Moreover, using the CDSS will help GPs to identify the most appropriate medications for a disease, as well as identifying medication interactions. Therefore, this helps them to increase their knowledge. Several studies have noted the influence of informativeness on the acceptance of IT (Hasan, 2017; Kim, Joo & Lee, 2016; Zhao & Wang, 2020). Wu, Gao and Shi (2016) indicated in their study that informativeness was a positive factor in supporting using HIS.

According to Alther and Reddy (2015), CPOE systems provided a solid education for its users. CPOE is defined as a DSS that supports medical practitioners to enter orders and prescriptions for their patients through the system. A study by (Zakane et al., 2017) indicated that the role of education in CDSS is an important feature that contributes to increasing user learning and knowledge. In a developing country, Burkina Faso, several health workers were interviewed about their perceptions and perceived requirements of CDSS (Zakane et al., 2017). The results of that study showed that the system was considered an effective way to increase and improve learning in health care.

8.1.10 Communication and Shared Knowledge

GPs in this study confirmed that the communication and shared knowledge factor had a role in their acceptance of CDSS. They mentioned that this feature would provide considerable support to their communications with other physicians, especially during medical consultations, instead of needing to contact them over the phone. Communication and knowledge sharing give a GP more reassurance to accurately diagnose a condition in cases where they might lack the relevant specialisation, or when they need to confirm the appropriateness of a medication and treatment. With this tool, GPs can communicate within the CDSS by writing, using a chat function or by video or voice call. Most GPs in

this study indicated that they needed to connect with their colleagues or with doctors who specialised in different medical fields to consult them and ensure that their decisions were correct. The presence of an advanced HIS would facilitate sharing this knowledge.

There are several studies in different fields indicating the role of communication and knowledge sharing in influencing user acceptance (Al-Emran, Mezhuyev & Kamaludin, 2018; Al-Emran, Mezhuyev, Kamaludin & Shaalan, 2018; Salloum et al., 2020) CDSS provides the physician with the features than enable knowledge sharing, to improve their medical knowledge (AlMotairi & Alshareef, 2017). In addition, supporting and enhancing medical knowledge develops and increases healthcare awareness and contributes to more understanding of medical practice (Gider, Ocak, & Top, 2015). Rahimi et al. (2018) reviewed the scientific articles between 1999 and 2017 that used TAM in the field of HIS implementation. The authors asserted that TAM must be extended regarding the domain of HIS. They recommended including communication as a factor that contributes to having a better understanding of HIS development. Rahmner et al. (2012) assessed the perceived needs for medication information among physicians in Sweden. They indicated that the participants needed to find a way to communicate with colleagues electronically to share knowledge.

Most physicians in a study by Chong and Lin (2008) indicated that the knowledge-sharing factor affected clinical decision-making quality. They mentioned that the absence of knowledge sharing negatively affected physicians. The authors added that the medical knowledge sharing improved the accuracy of diagnoses, and this led to an increase in the quality of clinical decision-making.

Sharing and searching for knowledge in the healthcare sector is critical (Saad, 2016). The presence of knowledge systems in the medical field contributes to improving user

knowledge and learning, and also enhances the role of communication in the health organisation (Gider et al. 2015). Li et al. (2015) stated that it is necessary to establish knowledge systems that contribute to, and enhance the ability of, physicians to communicate. Moreover, Esmaeilzadeh et al. (2015) stated that the positive attitude of medical practitioners regarding knowledge sharing increases their intention to use CDSS. They indicated that it is essential to provide a supportive environment that contributes to encouraging knowledge sharing for medical practitioners. The presence of knowledge systems in the medical field contributes to improving user knowledge and learning and also enhances the role of communication in health organisations.

In another study, Shank (2012) evaluated behavioural health providers' perspectives regarding the advantages and limits of health information sharing. She concluded that HIE enhances the overall knowledge shared among health providers. She indicated that a communication factor will reflect positively on the quality of health care.

8.1.11 Perceived Patient Satisfaction

Perceived patient satisfaction is considered a factor that affects GPs' acceptance of CDSS in this study. GPs in this study considered that patient attitudes to CDSS was important, as when HIS become more advanced, this will lead to the provision of better medical care services. GPs indicated that when patients were satisfied with the outputs of the medical system used by their doctor, this would further increase the patient's confidence in their doctor. The patient's feelings about the HIS was considered an influencing factor in the physician's acceptance of the system. The presence of a high-quality and efficient CDSS contributes to having better satisfaction levels in patients and this directly contributes to the acceptance of CDSS by GPs.

Several studies mentioned the role of patients' satisfaction in influencing the acceptance of HIS (Abdekhoda et al., 2015; Shibl et al., 2013; Sebetci, 2018; Heath & Porter, 2017). Arfi, Nasr, Kondrateva and Hikkerova (2021) asserted that healthcare organisations that fail to use IT to improve their services may not be able to build trust in their patients and thus will eventually lose them as patients.

CDSS has contributed to enhancing and increasing the satisfaction of patients regarding their treatment (Breitbart et al. 2020). Decision-makers and officials in the health sector aim to satisfy patients by adopting EMR and this leads to contributing to better healthcare services, reducing medical errors, providing privacy and providing information in good time (Al Aswad, 2015). Further, Khalifa (2013) indicated (in his studies in four hospitals in Saudi Arabia) that one of the main benefits of implementing and adopting health systems is to contribute to improving patient satisfaction and care. Moreover, Staszewska, Zaki and Lee (2017) noted that the use of high-quality and efficient joint decision-making tools to help choose appropriate treatment for patients contributes significantly to patient satisfaction.

8.1.12 Connectedness with Patients

GPs in this study stated that the role of their connectedness with patients was a factor in their acceptance of CDSS. They noted the importance of medical staff communicating with patients through text messages or emails in the CDSS, logging in to their own web pages or patient applications. The GPs asserted that sending guidance and information for patients about medical information greatly contributed to their acceptance of the system. CDSS will remind the patients about medications or periodic reviews in addition to alerting them to diet and nutritional programs that can contribute to their treatment and care. A number of studies have indicated the importance of the role of connectedness in

user acceptance of IS (Al-Qaysi, Mohamad-Nordin & Al-Emran, 2020; KilYoung & SangJib, 2018; E. Park, Kim, Kim & Kwon, 2018).

Al Ali and Elzubair (2016) assessed the extent of patient satisfaction with their relationship and communication with physicians in a primary care centre in Dammam, Saudi Arabia. They found that communicating with patients was very important in improving the quality of medical care, as it also positively affected the patient's satisfaction. A high number of patients who participated in the study expressed dissatisfaction with their relationship with physicians: around 49%. The researchers recommended better communication skills between the physician and the patient to improve the relationship and thus provide better health services. Trafton et al. (2010) indicated that CDSS contributed to improving communication between the patient and the service provider and worked to remove or minimise obstacles such as insufficient education by the service provider of the patient. They stated that a lack of or poor communication with the patient may affect the patient's use of some treatments, which may increase its negative effects.

Georga, Protopappas, Bellos and Fotiadis (2014) considered the role of modern applications on m-health. They supported the patient's right to communication through enhancing their awareness of their condition and supporting their treatment in, for example, diabetes. Bantom, Harpe and Ruxwana (2016) also concluded that access to personal healthcare records has a positive role in the efficiency and benefit of education for patients. Further, Arora, Peters, Agy and Menchine (2012) evaluated the effectiveness of communication with diabetics by adopting a trial to examine a text-based m-health (TExT-MED) application. TExT-MED is a m-health app that sends text messages to diabetics who are short of resources. Three text messages were sent each day for a period

of three weeks to the study's participants: these included educational and motivational messages, medication reminders, tips and awareness links to management of the disease. The findings of the study showed the effectiveness of the application in communicating with patients through text messages. The authors indicated that the application contributed to increasing health behaviours, diabetes self-efficacy and better adherence to prescriptions, and it also obtained superior satisfaction scores from diabetics. Another study by Patel et al. (2013) involved 50 participants. This evaluated the effectiveness of using a medication reminder program on a mobile phone. Forty-eight respondents completed in the program and received reminders. The study indicated that there was a high satisfaction among the participants with the application of medication reminders. The authors indicated that the application contributed significantly to improving adherence to medicines and blood pressure controls. A study by El-Sappagh et al. (2018) strongly suggested having a text message feature in CDSS to communicate with patients and provide advice and relevant information such as diet, exercise and medication plans.

8.1.13 Perceived Risk

Most GPs acknowledged the influence of the perceived risk factor on their acceptance of CDSS. They considered that perceived risks should be taken into account and dealt with appropriately so any problems with a CDSS were minimised. GPs mentioned two important determinants coming under the perceived risks factor. The first is the time risk: CDSS could be time-consuming to the GPs during consultations with patients, because of the input of data, both necessary and unnecessary, that prolonged the consultation, as well as increasing the waiting time of other patients. A second determinant was the systemic function, which means the CDSS may be suspended or disconnected when it is being used because of the poor quality of the system or network. This may cause delays or slow the process of completing the required patient data and thus affect the acceptance

and use of CDSS. It is essential to consider and address these perceived limitations to avoid rejection of the CDSS: the acceptance of CDSS will contribute to developing a health system that is more efficient and effective.

Several studies have indicated the role and importance of the perceived risk factor and its role in HIS acceptance (Mikles, Haldar, Lin, Kientz & Turner, 2018; Palojoki, Pajunen, Saranto & Lehtonen, 2016; Shi-jie, Xin, Na & Feiyun, 2019). Owing to its role in accepting information systems, it has been integrated with a UTAUT model in different studies (Cabrera-Sánchez & Villarejo-Ramos, 2020; Giovanis, Assimakopoulos & Sarmaniotis, 2019; Martins, Oliveira & Popovič, 2014). According to Martins et al. (2014), perceived risk means uncertainty or doubt about the service in the perception of the consumer or the end user. Moreover, Ayanso, Herath and O'Brien (2015) used the perceived risk factor in their study, and they defined it as the risks that physicians perceive regarding HIS.

Several studies have indicated that the use of HIS during a patient's medical visit and diagnosis may take more time, so it is essential to take this into account and guide program designers and suppliers to address this challenge. Arts et al. (2018) investigated obstacles to the use of CDSS in general practice. The study showed that the principal obstacle and challenge was lack of time during the consultation with the patient. In a German study, Rieckert, Sommerauer, Krumeich and Sönnichsen (2018) evaluated and investigated the PRIMA-eDS-tool, which is an electronic decision support system geared to GPs to reduce inappropriate medications and provide medical advice regarding medications. Twenty-one GPs were interviewed to explore their positions and opinions regarding the use of the system. The findings showed that GPs perceived the data entry in the system for each

patient to be annoying and time-consuming, which could negatively affect the acceptance of the CDSS.

Participants involved in the present study indicated that time may be a challenge in their acceptance of CDSS, through the time spent using the system to diagnose patients or examine them, filling in the blank fields or answering the program requirements, or indeed by the stakeholder in making the decision. Some participants stated that GPs should not be required to fill in all program requirements and that they should have the freedom to act in using the system. Some participants also indicated that CDSS should be more intelligent, so that for a patient who has simple complaints, such as a cold and flu, the program should not need a lot of answers to questions about the patient's condition. Conversely, in the case of chronic diseases, it is sensible to use the software's requirements for information and input more data into the program.

Asan, Carayon, Beasley and Montague (2015) investigated the factors related to the use of EHR as a tool to communicate between physician and patient in primary care centres. The authors interviewed 14 physicians to discuss the issues around using the EHR and sharing the screen with patients to improve the process of communicating with them. The results indicated that the time consumption factor was one of the main reasons why physicians did not share the screen with the patient: they indicated that the time was insufficient or could cause unnecessary distractions. Therefore, the physicians indicated the need to design CDSS effectively and provide training to improve communication with the patient. Another study by Botha, Botha and Herselman (2014) explored the benefits and challenges of e-health in South Africa. The results showed that the challenges outweighed the available benefits, yet modern IT solutions provided more appropriate health programs that contributed to providing better healthcare services. The authors

stated that one of the main challenges was that updating the electronic record may take a long time.

When using a standalone system, which means that the CDSS does not integrate with EHR or the HIS, this leads to the CDSS being time-consuming, given that the user must enter all the necessary information, including the patient's information and the results of the examination (Velickovski et al., 2014). Some HIS in hospitals and primary centres require that patient data be entered manually, which leads to more time being needed for the patient (Teixeira, De Pinho & Patrício, 2019). Therefore, it is important to integrate the CDSS with a health records system to reduce patient waiting time and to increase end-user satisfaction, which will contribute to the successful implementation of CDSS (Mahabee-Gittens, Dexheimer, Khoury, Miller, & Gordon, 2016).

Wilson & Opolski (2009) evaluated the use of CDSS in cardiovascular examinations. In their study, 11 stakeholders were interviewed using a semi-structured interview method. Participants presented several solutions and suggestions to improve the implementation of CDSS. The authors suggested assigning the nurses to enter the initial information and data required for the patient into the CDSS to reduce the time required for the physician. This would also give the physician an opportunity to use the CDSS in support of consultations and suggestions. In addition, Rieckert, Sommerauer, Krumeich and Sönnichsen (2018) mentioned that the long of the patient data entry into the system may delay entering the necessary orders into the CDSS, and thus work on the HIS is time-consuming. They also found that it may take physicians time to learn how to use the system. However, CDSS is applied to enhance and improve the degree of accuracy of patient examinations and to minimise the time required to make decisions (Yang, Wei, Guo & Xu, 2017). Further, Robinson, Poirier and Watson (2017) defined the determinants

in GPs using CDSS to help them with early cancer diagnoses, which included identifying the positive and negative aspects of using the system. The researchers stated that the GPs used CDSS after consulting the patient and might use it during the consultation if they thought it was beneficial. Some GPs had concerns about the use of the system while diagnosing the patient: that it may be time-consuming, although most GPs reported the benefits and advantages of using CDSS. Furthermore, Koskela et al. (2016) evaluated the factors influencing CDSS implementation and ease of use by conducting separate focus groups with physicians and nurses. The results indicated that documenting examinations and writing diagnoses in EHR was time-consuming. The authors stated that this was a challenge to implementing CDSS, which required an effective design to address this matter, to support a successful implementation process. They stated that using coding diagnoses for documentation may reduce the time needed to use CDSS.

The breakdown or suspension of HIS is one of the most significant reasons for the failure to adopt a medical system, and the suspension of the program may be due to weak Internet, power outages or a lack of quality of the system design. Zakane et al. (2017) sought to determine the main reasons why healthcare workers failed to use CDSS at six rural maternal care units in Burkina Faso. The data for that study were collected through workshops and focus groups involving 13 users of CDSS. The findings indicated that one of the main reasons for failing to adopt and use the CDSS was the frequent interruption of the program due to program errors and computer problems in addition to power outages. The authors suggested that CDSS should be designed according to the needs of the end user. In addition, repeated pilot-testing of CDSS is required before it can be finally approved and adopted. In another study, Litvin, Ornstein, Wessell, Nemeth and Nietert (2012) sought to understand the facilitators and barriers that prevent CDSS acceptance, to identify the effects of prescribing antibiotics in primary care. The findings of that study

indicated the feasibility and effectiveness of using CDSS and the satisfaction of service providers in general regarding such a system. They added a proviso that one of the barriers was network and computer problems that interfere with CDSS use.

Deborah (2014) identified several major challenges in the implementation of EMR. The author stated that the lack of required infrastructure, such as networks and broadband, was one of the reasons for the failure to implement the system. The lack of the infrastructure was considered the main reason for suspension and disconnection of the HIS, and thus hindered and delayed medical work. This could result in a strained relationship between the patient and the physician. Bouamrane and Mair (2013) studied GPs' perspectives of using HIS in primary healthcare centres in Scotland. They interviewed 25 physicians using the semi-structured interview technique. They concluded that the role of EMR was effective in caring for patients and facilitating access to information. However, the authors also mentioned some challenges, such as failures and breakdowns of the system that caused significant disruption and delays in consultation with the patient. But those participants stated that the failures of the system had happened only a few times or infrequently. In another qualitative study, Bouamrane and Mair (2014) investigated the perspectives of GPs regarding the role and effectiveness of e-referrals in Scotland. Data were obtained through interviews with 25 GPs, using the structured semi-structured interview technique, as well as one focus group. The results showed that the benefits of using e-referrals in primary care centres significantly outweighed the negative aspects. Nevertheless, many GPs in that study complained about their frustrations caused by slow connections and breakdowns in the system, which caused delays or failures to complete the referrals electronically.

Esmaeilzadeh and Sambasivan (2017) sought to determine the factors affecting patients' use and acceptance of a HIE. The authors conducted a literature review of previous studies that examined patients' opinions about such exchanges. They concluded that patients' perceptions of factors affecting such exchanges could significantly affect their level of participation in data exchange and CDSS use. One of the perceived concerns among patients included concerns about CDSS breakdowns that may cause inadequate or delayed provision of medical care. In a similar study by Park et al. (2013) investigated patients' acceptance and need for a HIE in South Korea. They found that patients' acceptance of the exchange was high regarding the benefits that contributed to better medical care. However, some concerns were perceived, one of which was the breakdown or failure of the HIE, which could cause the system to stop functioning system or provide quality health care.

8.2 Answers to the Secondary Research Questions

This research has adopted a qualitative approach by following a semi-structured interview method with GPs in Saudi Arabia. It has contributed to the discovery of several new factors that affect GPs' acceptance of CDSS. This study has gathered rich information from physicians in different primary healthcare centres and hospitals and has obtained a wide knowledge and increased understanding of the research questions through the discovery of many related issues. Further, by combining both UTAUT and TTF, more factors were found that affected the ultimate acceptance of CDSS.

The answers to the secondary research questions are derived from the model that was built and developed based on the findings of this study.

The first secondary question: what advantages and benefits can GPs acquire by adopting the CDSS in Saudi Arabia?

Many benefits reported by GPs would support the acceptance and approval of the system: this was also established in previous relevant studies.

8.2.1 Performance Expectancy

The factor of performance expectancy included five advantages under the respective headings of time, alert, accuracy, reduction of errors and treatment plan.

Time: several GPs indicated that one of the benefits of the CDSS is time. Obtaining relevant information to support the GP's decisions contributes to the overall satisfactory outcome. In addition, referring to patient data is possible at any time without having to search for paper files. On the other hand, time was also included in the perceived risk factor in terms of writing up and filling in the required fields in CDSS to diagnose the patient: this can be time-consuming.

Alerts: alerts are one of the significant benefits that contribute to warning and reminding the end user of essential tasks. This feature also assists in the decision-making of the physicians in many cases. Some participants mentioned that a large number of patients and visitors might cause a physician to forget some things that affect the diagnosis process. Therefore, the alerts tool is very important to remind the physician of elements that will promote a much better decision.

Accuracy: one crucial advantage that drives many healthcare providers to use CDSS is accuracy. The accuracy of information and data, which includes patient data and medical information based on knowledge, gives clinicians more confidence in using the CDSS. The accuracy of diagnoses provided by CDSS, especially in complex diagnoses, is a valuable feature of CDSS. This feature and benefit encourages physicians to accept the use of the CDSS.

Reduction of errors: one of the important advantages of CDSS is its ability to reduce errors. In health care, the percentage of medical errors and medication errors is high. Therefore, the use of such systems assists and supports GPs to reduce those errors. Errors may be due to over-reliance on paper files or because of the large number of patients in primary healthcare centres or hospitals. Using CDSS will promote higher efficiency and quality. The adoption of CDSS in Saudi Arabia will contribute to providing better medical care services with a considerable decrease in medical errors. Further, for a GPs who may have little experience or a weak background in health protocols in Saudi Arabia, using CDSS will enable the provision of much better healthcare services in diagnosis and medication dispensing.

Treatment plan: many GPs have indicated that the using the CDSS will contribute significantly to helping them provide a better treatment plan. CDSS allows the physician to know the number of doses needed and the correct duration of treatment based on CDSS. CDSS provides the GPs with recommendations and suggestions that contribute to providing a more reliable treatment plan. Moreover, CDSS helps the physician to know more about health protocols in terms of the treatment plan and available treatments, especially if the GPs is from outside Saudi Arabia.

Effort expectancy: ease of use is a critical factor in any acceptance of a new technology system. An easy-to-use CDSS design gives physicians more motivation to use the system. Providing a clear CDSS promotes is effective use, with adequate training for GPs and end users. Ease of use in a CDSS makes for faster and easier work. It assists physicians to provide better medical services through their better understanding of the system by their awareness of the features and tools available in CDSS.

Privacy and security: This feature helps the user to accept CDSS by providing a sense of security and confidence that the application used is safe. No one can view patient data, except those who have access, unlike the older systems to which many have access, especially paper files. Privacy and security is a concern of many GPs, as well as of patients, about many medical conditions. However, advanced systems provided by certified and reliable service providers will be a great source of confidence to the data and its protection.

Integration and accessibility: this factor considered one of the most important factors in the acceptance of CDSS. CDSS integrates all the medical patient care services and gives a GPs greater satisfaction in its use. CDSS contains patient files, radiology and laboratory results, as well as a database for medications and diagnoses. This important feature is what physicians are looking for, especially in medical clinics that use more than one medical program, which may be time-consuming in their use, in addition to prolonging the waiting period for patients. Because the CDSS has many features and medical services built into it, this contributes to accelerating the task and reducing diagnostic time.

Informativeness (increased knowledge): because of the ability of CDSS to detect errors and give alerts, this system helps to increase physicians' knowledge and improve their skills. CDSS offers several recommendations and suggestions regarding diagnosis. CDSS also makes recommendations regarding appropriate doses and determines the duration of the use of the drug. With the passage of time in use of CDSS, the physician learns more about prescriptions, especially new medicines. Medicine is a rapidly developing and up-to-date science. Therefore, the GPs must monitor continuous updates in diagnosis and treatment. CDSS, which is based on reliable knowledge and high-quality scientific

databases, provides access to information useful to the physician in providing better medical care.

Communication and shared knowledge: adding a feature to communicate and share knowledge between physicians through CDSS helps to improve user knowledge. Shared knowledge gives users greater satisfaction because they are likely to benefit from the experiences of those who have gone before. The communication feature in CDSS is also necessary in cases where GPs need to consult specialist physicians in various fields. It is advisable to take advantage of CDSS that allow knowledge sharing to increase medical skills.

Perceived patient satisfaction: adopting advanced systems such as CDSS contributes to providing better medical services, and this helps with patient confidence and satisfaction. Physicians indicate that when a patient watches a physician uses advanced HIS applications, this results in greater patient satisfaction. Consequently, this further contributes to GPs' acceptance and use of the CDSS. The CDSS can help to reduce medical errors, giving more accurate information and data, and providing the patient with confidence in CDSS.

Guidance and informing patients: sending notices and messages to the patient is an important feature that GPs have indicated contributes to their own acceptance of CDSS. Alerts and educational messages, in addition to medication instructions and guidance to the patient, help to inform the patient about the treatment plan. Moreover, guidance and information through the messages may help to prevent some complications and remind the patients of future appointments. Physicians who communicate with their patients through text messages strengthen and enhance the relationship between them.

Another secondary questions of this research: what are the challenges and obstacles facing GP acceptance of CDSS in Saudi Arabia?

In this study, GPs identified some perceived risks and concerns that may adversely affect their acceptance of CDSS. Challenges fall within the perceived risk factor in the developed model of this research that investigates factors influencing GP acceptance. There are not many challenges, as indicated by most GPs. However, two challenges were mentioned; namely, the time factor when using the CDSS during a patient's diagnosis, and system suspension and breakdown due to the lesser quality of the designed CDSS or weakness in networks and infrastructure.

Consumption of time: the CDSS could consume time during diagnosis of a patient because of the introduction of both necessary and unnecessary data. Adding to diagnostic data may lead to a longer consultation with the patient. This challenge seems to be an obsession among some GPs regarding their use of CDSS, especially when many patients are waiting to enter the clinic and meet the physician. In addition, if the HIS application used is not integrated with the CDSS, this requires more time to be spent in the use of different medical systems, such as using two separate programs for drug prescriptions and a CDSS. Moreover, if the CDSS requires a report or the completion of more fields to obtain support for the decision, this increases both the time spent using CDSS and the time spent by patients waiting and then being diagnosed (and perhaps further waiting).

Suspension or breakdown of the CDSS: some GPs in the study feared possible pausing or slowing of CDSS during use because of poor or weak CDSS design, or perhaps because of a lack of network and infrastructure. The slow performance of the primary system used means that the GPs cannot obtain the data necessary to diagnose the patient, and it may also lead to patients waiting longer until getting a response, especially where there is total

dependence on this system. GPs also indicated the need for a reliable infrastructure to support the work of such medical systems. Dealing with companies having greater experience in developing and designing modern medical systems will contribute to supporting CDSS and thus provide much better healthcare services.

Such obstacles as these, if not addressed, will have a negative effect on healthcare services, in addition to patient dissatisfaction with and confidence in primary health care and the systems used.

The third secondary question: how can the use of CDSS contribute to the promotion and development of healthcare in Saudi Arabia?

The use of CDSS contributes significantly to reducing medical errors and providing better healthcare services. The CDSS is one of the advanced health systems that help physicians make more correct decisions by relying on an evidence-based decision support system. Health care in Saudi Arabia and developing countries needs more developed systems to better understand the health protocols used. In addition, CDSS assists physicians to make proper diagnoses. They know that CDSS has been developed based on the expertise of physicians and knowledgeable medical institutions. CDSS will contribute to drawing up a treatment plan in addition to dispensing appropriate medications, dosage knowledge, duration of use and conflicts with other medicines. The adoption of CDSS assists the physician to reduce medical errors through the alerts and reminders.

Repeated use of CDSS supports the physician by increasing their knowledge and improving their medical skills through recommendations, suggestions and cautions in CDSS. Features such as communication and shared knowledge contribute to increasing the capabilities and skills of the physician's medical practice.

8.3 Design of a Successful Clinical Decision Support System

Successful design of a CDSS is one of the main reasons for its acceptance by the physician as end user. As discussed above, most of the participants in the study pointed to the importance of ease of use in CDSS, which mainly depends on how the system is designed. Many GPs indicated the importance of the physicians' participation as end users of the program in the CDSS design process: the designers need to understand their needs and desires and know the necessary tools. Further, they mentioned that it is very important to consider the time factor in using CDSS, limiting unnecessary questions directed to the physician.

Several HIS projects and systems have failed because of lack of consideration of the human side and the end-user considerations while designing health systems (Kushniruk & Borycki, 2017). Analysis and determination of the requirements of the end user of CDSS before its implementation and final accreditation will save time, effort and money, and will also contribute to the adoption of a successful HIS (Kilsdonk, Peute, Riezebos, Kremer & Jaspers, 2016). Further, Kabukye, Koch, Cornet, Orem and Hagglund (2018) found that while health systems can improve health care, their adoption is still low because their systems do not meet the requirements of the user. User-based system design contributes to the ease of use of CDSS through the participation of physicians in identifying challenges and clarifying concepts that assist and enhance in designing a solid system (Babion et al., 2020).

A weak design of the user interface, which should increase the accessibility of relevant information that contributes to decision-making, may slow the physicians' work. Therefore, CDSS must be based on a detailed analysis of the needs and requirements of medical practitioners as the end users. Their contributions should produce and present a

successful and effective system that improves the efficiency of health practitioner workflows (Kilsdonk et al., 2016). Razmak et al. (2018) evaluated the CDSS's ability to control patient data. They indicated the importance of understanding the clinical practices of physicians and identifying their needs to promote acceptance of CDSS and build a more effective system. Moreover, Miah, Blake and Kerr (2020) also studied CDSS design and recommended that the design of the CDSS be fit to the requirements of stakeholders, as this could lead to increased user acceptance. Ho, Aridor and Parwani (2012) considered improvements to the design of anatomic pathology systems. They also stressed that the needs of principal users in the workflow must be identified to assist in the design process.

One of the modern methods in the design of CDSS is involving and understanding the end-user to meet their needs. Therefore, programmers and service providers can use tools and methods that are friendly in order to better understand the end user's requirements and needs. Applying a user-centred approach to designing a computing system by involving the end user and using interactive health systems with the user will contribute to more usable systems (Klemets & De Moor, 2015). The user-based design approach contributes to providing improved services and products (Mohr, Lyon, Lattie, Reddy & Schueller, 2017). The user-based design begins with the designer understanding the requirements and needs of the end user who helps design a preliminary document: this is the seed of the system design process (Carr, Babione & Marshall,, 2017). These design documents are very useful in understanding the goals, challenges and motivations of stakeholders in understanding their requirements, and this is usually presented as a video or a preliminary design on paper or tools containing the main functions of the system (Mohr et al., 2017). The requirements and demands of the end user could become known and identified through interviews and focus groups with the stakeholders (Ho et al., 2012). This is in addition to observing the workflow, which may add to an understanding of how

to proceed with the work. It may also identify some important things that help in the initial design of the system (Mohr et al., 2017).

For the successful design of CDSS, the user interface of the system should meet the needs of the end user to adopt more efficient systems. It is important to take into account all the factors that influence acceptance of CDSS, as discovered in this research. The final model of this study provides all the main factors that the GPs indicated were necessary for DSSs that will help GPs provide better health care and perform their medical tasks better. Developers and providers of HIS can design medical systems that are more suitable and fit for physicians and their tasks.

8.4 Limitations of the Research

This study focuses on factors that influence the acceptance of CDSS by GPs in Saudi Arabia. It was challenging to obtain sufficient participants because of the nature of their work and their concerns and being busy with patient care. There was some difficulty in determining an acceptable time for the interviews. In most cases, the interviews were conducted within official working hours, in coordination with the management of health centres and hospitals, but we gave priority to the patients' time. That is, if there were medical conditions that required a consultation, priority was for the patient.

One of the important procedures for conducting this research was to obtain approval by the ethics committee from health authorities in Saudi Arabia, to meet the conditions of the Ministry of Health. Researcher is required to pass a test to ensure that appropriate understanding on the ethical aspects of conducting the research is operationalised in place. Further, as this research was conducted in different health centres and hospitals, some hospitals required independent ethical approval. Consequently, four ethical approvals were obtained to conduct this research, including the ethical approval of

Victoria University (Melbourne). These requirements took some time due to waiting for approvals from the official authorities. It was also important for me to adhere to health safety measures such as social distancing and wearing mask in clinics because all the interviews were in primary medical centres and hospitals. Waiting periods for approval and gaining an appropriate appointment for GPs to conduct interviews were among the most significant challenges that caused some delay in the data collection process.

One of the minor limitations of this study is that this research relied on participants in Saudi Arabia as a developing country. The focus was on two cities: Riyadh, which is the largest city in Saudi Arabia in terms of population and is also the capital, and Al-Qassim, as it is one of the closest areas to Riyadh. All the primary healthcare centres and hospitals from which the study's participants were selected are under the supervision of the Saudi Ministry of Health. These cities were chosen because of travel and location restrictions in addition to the time and cost factors.

The focus of this research was on GPs as detailed in this study: there is a need to conduct more research focusing on GPs regarding acceptance of CDSS and taking advantage of the CDSS features that contribute to decision-making. Further, GPs generally have less medical information and knowledge than specialist doctors and consultants. The focus of this study was on GPs, to support their medical decisions, noting that a patient is usually at the start of his or her medical experience: the first doctor he or she meets is a GP.

This research has relied on a qualitative approach as it explored the factors that affect GP acceptance of CDSS. Consequently, a quantitative approach was altogether inappropriate. Several new influencing factors were discovered that contributed to building the theory. The aim of this research was to build and develop theory instead of testing it. Therefore,

applying a qualitative approach through conducting semi-structured interviews was appropriate for this research.

These limitations neither influenced the results of this research nor affected its importance.

8.5 Research Contributions

This research contributes to the exploration of factors affecting the willingness of GPs in Saudi Arabia to adopt CDSS. It employs in depth interviews which aim to uncover the beliefs and perceptions of the participants. By studying several different models explained in chapter 4, the integration of both the UTAUT and TTF models was found to be the most relevant conceptual framework capable of studying and determining these factors and thereby answering the main question of the research. The information, data and research results provided by this thesis can assist to guide researchers and health system developers in designing and adopting more efficient and successful HIS and CDSS by considering the role of these factors.

The results of the research can also provide an opportunity for developing countries to consider these factors when adopting CDSS and as a result, challenges that may be an obstacle to the process of accepting the CDSS can be minimised. In addition, it is also important for the healthcare management to provide a supportive environment and resources for the success of CDSS acceptance by ensuring the appropriate infrastructure, efficiency and quality of systems. These leads to providing the right technical support teams in a timely manner, adequate training for the end-users, and updating and maintaining systems on an ongoing basis. New knowledge regarding acceptance of the CDSS will greatly be reinforcing the development of health care by providing appropriate information to GPs that can assist in making appropriate medical decisions. Therefore,

management may gain a reduction of the number of medical errors. For example, there are many new diseases that the GP may have a lack of knowledge about it, such as COVID-19, and the role of the CDSS may be important in providing reliable information from official medical authorities in the country. As a result, GP's can have access to current and accurate information which is essential for making the right decisions.

Furthermore, the study contributes to supporting scientific research by providing rich information about the factors that affect the adoption of the CDSS by GPs in developing countries, especially in the case of Saudi Arabia, and by developing a model capable of explaining the opportunities and challenges facing the CDSS's acceptance.

8.6 Future Research

This study has obtained rich data and information that will contribute to understanding of the factors that affect GP acceptance of CDSS. Because this study sought to discover the factors that affect GP acceptance of CDSS, the methodology of qualitative research was the most appropriate, using in-depth interviews, following the semi-structured interview method. This research was conducted in Saudi Arabia through interviews with GPs, so it may be possible to conduct other similar studies in other countries to determine if there are different or new factors. In addition, the focus of this study was on GPs. It is possible to conduct further research that considers specialist doctors or consultants in different medical departments.

The expanded model that was built from the findings of this research can be used in its application and study in new medical systems, such as studying the feasibility of robots in supporting a doctor's decision. This model also contributes to studying the design of DSS based on the views of the end user, as this research provides the technical features and characteristics that doctors need in using such systems.

The model in this research was created through qualitative research using in-depth interviews. Future research may include an opportunity to study, apply and test this model through quantitative studies. Through the findings of this research, impetus may be given to researchers to delve deeper into developing HIS that are more suitable and appropriate for end users. This can be done by making use of the final model of this study, with in-depth interviews or questionnaires for doctors about the successful HIS and CDSS design that are they needs.

8.7 Conclusion

This research aimed to investigate the factors that influence CDSS acceptance among medical practitioners in the healthcare system in Saudi Arabia. This study contributes to the body of research available by providing a deeper understanding of the beliefs and perceptions of GPs. This can consequently contribute important information relating to how to enhance the acceptance of CDSS in Saudi Arabia. The findings of this study have contributed to filling important gaps in the research, and this will benefit societies, especially developing countries. Using CDSS will assist healthcare professionals who can benefit from several features of CDSS. Further, using CDSS will have a positive effect on the workflow and clinical practices to improve healthcare services.

The findings of this study showed that all factors of both UTAUT and TTF influence the acceptance of CDSS by GPs in Saudi Arabia. These include performance expectancy, effort expectancy, facilitating conditions, technology fit for the task, technology characteristics and task characteristics (excluding social impact considerations). The duration of the effect of CDSS on the admission of GPs has not been found. Of 13 determinants, three (performance expectancy, effort expectancy, and facilitating conditions) correspond to those found in the UTAUT model and three (task-technology

fit, technology characteristics, task characteristics) match the TTF model. However, contrary to the UTAUT framework, the participants in this study considered social influence to be either ineffective or irrelevant. In this study, six determinants not in the UTAUT or in TTF model (see Figure 4.6) were discovered through the semi-structured interviews: accessibility, perceived patient satisfaction, informativeness (increased knowledge), connectedness (with patient), communication and shared knowledge, privacy and security, and perceived risks (functional performance risk and time risk).

This research employed the UTAUT and TTF model as a conceptual framework to better understand the factors that influence CDSS acceptance in Saudi Arabia. In-depth and semi-structured interviews were conducted with 54 GPs.

The interviews were conducted in three stages. In the first stage, 12 GPs were interviewed to identify the main factors required for the model, with TTF factors were added to the main UTAUT model during convergent interviewing. In the second stage, 42 GPs were interviewed to investigate and to discuss the factors mentioned in the first stage, to determine the extent of their agreement and to investigate perceptions. In stage three, three physicians who participated in the first phase were interviewed to further review and verify of the final model. Further, through the interviews, discussions were held on the current system and its most prominent issues, as well as how to design more successful CDSS and its fitting for the end users.

The model developed in this research provides a framework that helps to understand the factors that influence the use of HIS and CDSS, and will greatly benefit researchers, developers and providers of medical systems in designing more successful systems in implementation. In addition, the new model provides a better understanding regarding the

features and tools in CDSS that help GPs to provide quality and effective medical services and care.

8.8 Chapter Summary

This is the eighth and final chapter, where the final findings of the main aim and question of the research are presented. All factors affecting acceptance of the CDSS were explored through semi-structured in-depth interviews with GPs. These factors have been investigated and supported by relevant previous studies. The following 13 factors were thus found to influence acceptance: (1) performance expectancy (including timeliness, alerts, reduction of errors, and treatment plan); (2) effort expectancy; (3) facilitating conditions (including training, technical support, and provision of updates); (4) task-technology fit; (5) technology characteristics (including accuracy, fast Internet and quality modern computer systems); (6) task characteristics; 7) accessibility (integration); (8) perceived patient satisfaction; (9) informativeness (increased knowledge); (10) connectedness to patients; (11) communication and shared knowledge; (12) privacy and security; and (13) perceived risks (functional performance risk and time risk).

Secondary questions were also answered in this chapter, by investigating the opportunities and challenges that GPs can gain or face through accrediting CDSS in Saudi Arabia. Where these were linked with the main findings of the factors that affect physician acceptance of CDSS, I also investigated how the system could be designed effectively by considering and meeting the wishes and needs of the end user, the physician.

The final model of this research also helps and supports developers and providers of HIS and CDSS to provide health systems commensurate with the needs and tasks of physicians.

Regarding future studies related to this research, this study was conducted in Saudi Arabia with GPs by relying on in-depth interviews, so it may be possible to conduct future studies in other countries to determine if there are different or new factors or to compare them. It is also possible that the final expanded model of this study can be applied and studied in future studies of new his.

In-depth interviews with GPs contributed to obtaining rich information and knowledge related to their acceptance of the CDSS, which led to the provision of a final model that contributes to increasing knowledge and research on the acceptance of the HIS in general and the CDSS in particular.

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Appendices

Appendix A: Consent form for participants involved in research.

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

CONSENT FORM FOR PARTICIPANTS INVOLVED IN RESEARCH

INFORMATION TO PARTICIPANTS:
We invite you to be a part of a study into Acceptance of a Clinical Decision Support System for Improving Healthcare Services in Saudi Arabia by participating in the interview .

The main purpose of this research is to investigate and assess the use of CDSS in Saudi Arabia in order to determine the factors that affect its adoption in health care in that nation. The research includes the interview the general practitioners in Saudi Arabia for generating new understanding and knowledge in order to address challenges to using CDSS. This is particularly important in contributing to improving and developing health care services through providing consistent, high quality research and understanding for the country's development and health of Saudi societies.
There is no potential risk to participants in this study, which aims only to gather information and experience about the use of CDSS by general practitioners. The researcher will not request any patient information in this study. In addition, you will not be affected by participating in the research.

CERTIFICATION BY PARTICIPANT

I, (name of participant)

certify that I am at least 18 years old* and that I am voluntarily giving my consent to participate in the study: Acceptance of a Clinical Decision Support System (CDSS) for Improving Healthcare Services in Saudi Arabia. being conducted by PhD candidate Soliman Aljarboa from Victoria University.

I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully explained to me by Soliman Aljarboa.

AND that I freely consent to participation involving the following procedures.

- Completing the interview.
- participating in the interview.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed:

Date:

Any queries about your participation in this project may be directed to the researcher
The researcher: Soliman Aljarboa
Phone: 0061 459311102 Or 00966 505146427
Email : solimansalehm.aljarboa@students.vu.edu.au
Chief Investigator: Associate Professor Shah Jahan Miah
Phone: 0061399199835
Email: shah.miah@vu.edu.au

If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email Researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

V.1/2013 1 of 1

Appendix B: Information to participants involved in research

VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

INFORMATION TO PARTICIPANTS INVOLVED IN RESEARCH

You are invited to participate

You are invited to participate in a research project entitled: Acceptance of a Clinical Decision Support System (CDSS) for Improving Healthcare Services in Saudi Arabia.
This project is being conducted by a student researcher, Soliman Aljarboa as part of an (integrated PhD study at Victoria University under the supervision of Associate Professor Shah Jahan Miah from the College of Business.

Project explanation

The aim of this research is to investigate and assess the use of CDSS in Saudi Arabia in order to determine the factors that affect its adoption in healthcare in that nation. This research is being conducted in fulfilment of the requirements of the degree of Doctor of Philosophy at Victoria University and has been approved by Victoria University Human Research Ethics Committee. You are invited to participate in this research study by completing an interview which will take approximately 1 hour. All your responses will remain confidential and the collected data will be used for academic purposes only. The audio recorded data of the interview will be stored in the website of the Victoria University Drive and also in a secure file with the password in my personal computer. Although we appreciate your voluntary participation, you may choose to withdraw from this study at any time with no obligation to explain. We hope that this research will provide valuable insight to the knowledge of healthcare services in Saudi Arabia. Furthermore, in this study the researcher will not ask for personal details about the patients, whose privacy will always be observed.

What will I be asked to do?

You will be asked to complete an interview about the acceptance and usage of clinical decision support systems in hospitals in Saudi Arabia. This interview include questions about your experiences and opinions regarding the technologies that help to provide the medical decisions or recommendations or advice for the medical practitioners.

What will I gain from participating?

There will be no direct benefit for you from your kind participation in this study. However, we hope that the information obtained from this study will help practitioners and academics to understand the use of CDSS in order to improve and develop health care services.

How will the information I give be used?

The information collected from the interviews will be analysed and form the basis of the conclusions in the final thesis.

What are the potential risks of participating in this project?

Your participation in this research involves no risk. In addition, the researcher will not request any patient information.

How will this project be conducted?

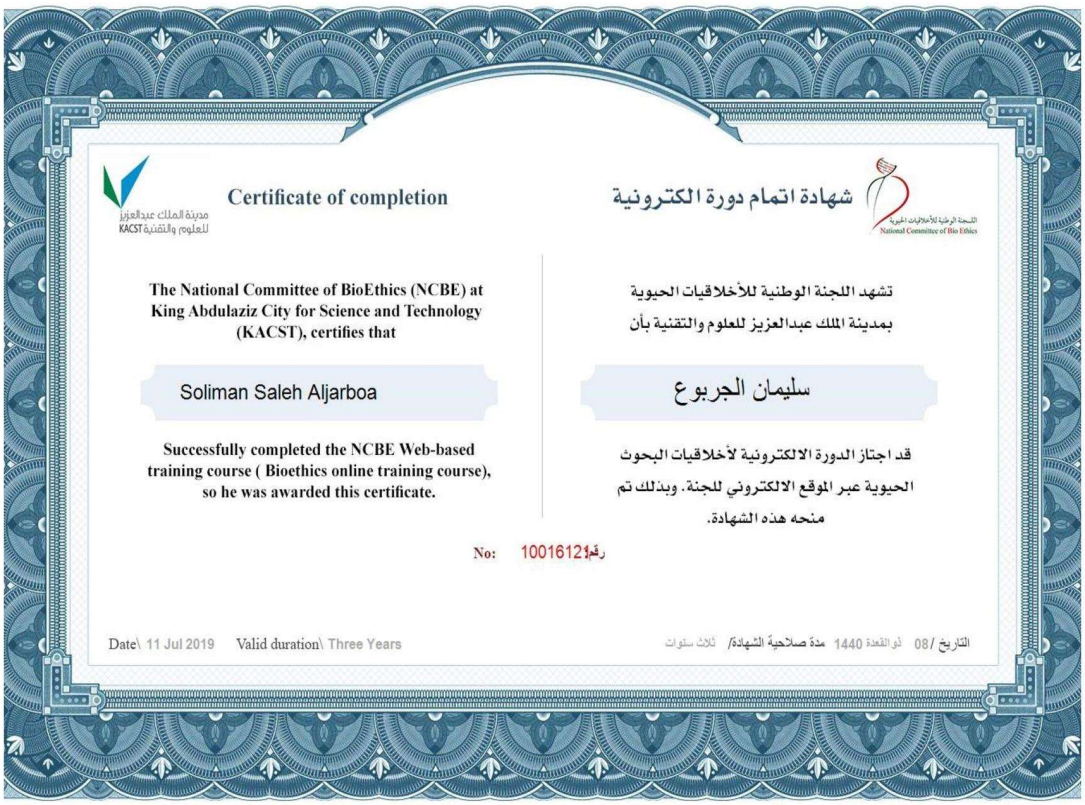
The research will be conducted by collecting relevant information from participants. The interviews will be analysed using NVivo software and manual analysis as well as in order to understand the use of CDSS.

Who is conducting the study?

The research will be conducted by the student researcher, Soliman Aljarboa.
Phone :0061459311102 Or 00966505146427
Email : solimansalehm.aljarboa@students.vu.edu.au
Chief Investigator :Associate Professor Shah Jahan Miah
Phone : 0061 3 9919 9835
Email: shah.miah@vu.edu.au
Victoria University – The graduate School of Business – City Flinders Campus – 300 Flinders St, Melbourne VIC 3000.
Any queries about your participation in this project may be directed to the Chief Investigator listed above.
If you have any queries or complaints about the way you have been treated, you may contact the Ethics Secretary, Victoria University Human Research Ethics Committee, Office for Research, Victoria University, PO Box 14428, Melbourne, VIC, 8001, email researchethics@vu.edu.au or phone (03) 9919 4781 or 4461.

V.1/2013 1 of 1

Appendix C: Completion certificate of Bio-Research Ethics Course



مدينة الملك عبدالعزيز للعلوم والتقنية KACST

Certificate of completion

شهادة اتمام دورة الكترونية

اللجنة الوطنية للأخلاقيات الحيوية
National Committee of Bio Ethics

The National Committee of BioEthics (NCBE) at King Abdulaziz City for Science and Technology (KACST), certifies that

تشهد اللجنة الوطنية للأخلاقيات الحيوية بمدينة الملك عبدالعزيز للعلوم والتقنية بأن

Soliman Saleh Aljarboa

سليمان الجربوع

Successfully completed the NCBE Web-based training course (Bioethics online training course), so he was awarded this certificate.

قد اجتاز الدورة الالكترونية لأخلاقيات البحوث الحيوية عبر الموقع الالكتروني للجنة. وبذلك تم منحه هذه الشهادة.

No: 1001612 رقم

Date\ 11 Jul 2019 Valid duration\ Three Years

التاريخ /08 ذو القعدة 1440 مدة صلاحية الشهادة/ ثلاث سنوات

Appendix D: Letter of approval to conduct the research from Saudi Ministry of Health

Kingdom of Saudi Arabia
Ministry of Health
Central IRB
GDRS

المملكة العربية السعودية
وزارة الصحة
اللجنة المركزية لأخلاقيات البحوث
الإدارة العامة للبحوث والدراسات

اللجنة المركزية لأخلاقيات البحوث بوزارة الصحة

Central Institutional Review Board

National Registration Number with NCBE-KACST, KSA: (H-01-R-009)

Approval Letter

Date: 17/07/2019
Central IRB log No: 2019-0098E
Category of Approval: Exempt
Affiliation: Qassim U.

Dear Soliman Saleh Aljarboa
The Central IRB-MoH pleased to inform you that submission dated 14/07/2019 for the study mentioned below was reviewed and approved.

Protocol Title	Factors that Influence the Acceptance and adoption of Clinical Decision Su Systems in Saudi Arabia
Principal Investigator	***Soliman Saleh Aljarboa***
Affiliation	Qassim University – Management Information Systems
Documents Reviewed	Study proposal, CV, Request for exempt status, PI statement, signed consent form, MOH data base information, signed Data Share Agreement, Questionnaire E, NCBE certificate, supervisor statement.

Decision:
The Central IRB **was approved** the protocol according to ICH-GCP. Approval is given for **one year** from the date of this letter.

Approval Conditions:

- Abide by the rules and regulations of the Government of Saudi Arabia, NCBE, Central IRB and the IHC-GCP guidelines.
- To conduct research as per the approved documents.
- Research participant confidentiality should be protected at all times.
- All researchers are required to have current and valid certificate on Protecting Human Research Participants (NIH or NCBE certificate).
- Amendment to the approved documents, the Principal Investigator is required to advise the Central IRB for its approval before implementation.
- You are required to submit a Progress Report every **6 month.**
- If PI is unable to complete your research within the validation period, he will be required an extension letter from the Central IRB one month before the expiry of the approval.

e-mail: GDRS-IRB@moh.gov.sa

Kingdom of Saudi Arabia
Ministry of Health
Central IRB
GDRS

المملكة العربية السعودية
وزارة الصحة
اللجنة المركزية لأخلاقيات البحوث
الإدارة العامة للبحوث والدراسات

- Document Retention: all study documents should be kept by the Principal Investigator for a period of **5 years** from study completion.
- This letter gives you an ethical clearance to implement your study according to the approved documents and you still need to obtain administrative approval from the site/s where the study will be conducted.
- **At the end of the study**, please submit Final Report including the results or copy of the manuscript intended for publication to MOH data base: www.marifah.gov.sa

We thank you for submitting your study for review by the Central IRB-MoH and wish you all the best with this study.

If you have any further questions, feel free to contact me.

Sincerely Yours,

Dr. Hisham M. Aziz - M.D
Consultant
Central IRB-MOH Chairman-KSA
Phone: + 966 11 2125555 Ext. 4337
e-Mail: haziz@moh.gov.sa

Appendix E: Approval letter from Saudi Ministry of Health

Kingdom of Saudi Arabia
Ministry of Health
General Directorate for Research and Studies
(GDRS)

Approval Letter ***Date: 17/07/2019***

To whom it may concern

Victoria University
Faculty of Business
Australia

Subject: To facilitate the mission of Mr. Soliman Saleh Aljarboa
Academic No.: 3840339

Dear Sir/Madam,

This is to inform you that, this is an approval letter to ***Mr. Soliman Saleh Aljarboa*** who submitted an application to The General Directorate for Researches and Studies, Ministry of Health, Kingdom of Saudi Arabia (***GDRS-MoH***) to collect data for his research project titled "***Factors that Influence the Acceptance and adoption of Clinical Decision Support Systems in Saudi Arabia***" as a part of his Ph.D degree thesis at Riyadh and Qassim Hospitals and PHCCs, KSA to be started from **(01/12/2019)** till **(29/02/2020)**.

Please note that, his proposal was reviewed and approved scientifically and ethically and he is ready to commence data collection.

Yours Faithfully,,,,

Director General
General Directorate for Research and Studies

المملكة العربية السعودية
وزارة الصحة
الإدارة العامة للبحوث والدراسات
الشئون الادارية و المالية
الإدارة المساعدة للتخطيط والتطوير

Athari F. Alotaibi

e-mail: research@moh.gov.sa

Appendix F: Ethical approval from Victoria University (Melbourne) Human Research Ethics Committee

Your amendment request for the following ethics application has been formally reviewed and finalised.

» Application ID: HRE18-008

» Investigators: MR Soliman Aljarboa

» Application Title: Acceptance of a Clinical Decision Support System for improving Healthcare Services in Saudi Arabia

» Form Version: 13-07

The amendment request for this ethics application has been accepted and deemed to meet the requirements of the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2007)' by the Victoria University Human Research Ethics Committee. Approval has been granted for two (2) years from the original approval date; 06/02/2018.

Continued approval of this research project by the Victoria University Human Research Ethics Committee (VUHREC) is conditional upon the provision of a report within 12 months of the above approval date or upon the completion of the project (if earlier). A report proforma may be downloaded from the Office for Research website at: http://research.vu.edu.au/hrec.php

Please note that the Human Research Ethics Committee must be informed of the following: any changes to the approved research protocol, project timelines, any serious events or adverse and/or unforeseen events that may affect continued ethical acceptability of the project. In these unlikely events, researchers must immediately cease all data collection until the Committee has approved the changes. Researchers are also reminded of the need to notify the approving HREC of changes to personnel in research projects via a request for a minor amendment. It should also be noted that it is the Chief Investigators' responsibility to ensure the research project is conducted in line with the recommendations outlined in the National Health and Medical Research Council (NHMRC) 'National Statement on Ethical Conduct in Human Research (2007).'

On behalf of the Committee, I wish you all the best for the conduct of the project.

Secretary, Human Research Ethics Committee

Phone: 9919 4781 or 9919 4461

Email: researchethics@vu.edu.au