# Telemedicine in Practice: A Sociotechnical Analysis in the United Arab Emirates (UAE)

# التطبيب عن بعد في الممارسة العملية: تحليل إجتماعي تقني في الإمارات العربية المتحدة


**by**

**SHAIKHA ABDULKARIM ABDOOL**


**A thesis submitted in fulfilment**

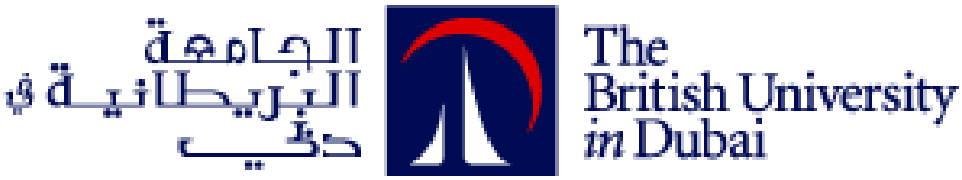
**of the requirements for the degree of**

**DOCTOR OF PHILOSOPHY IN COMPUTER SCIENCE**

**at**

**The British University in Dubai**

**June 2020**



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**Thesis Supervisor**

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| Designation | Designation |

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## ABSTRACT

Telemedicine technology means providing healthcare services by utilizing telecommunication tools without being physically in the same location. The technology is new in the region although it is not the case worldwide and there are gaps that need to be filled in related to it.

This research aimed to conduct a thorough sociotechnical analysis of telemedicine in a realistic environment using a large sample of subjects. Mixed methodology was followed (quantitatively and qualitatively). The sample size was randomly drawn from the UAE population.

The results were in the form of statistical outputs attained from a proven and well-known model and theory [Technology Acceptance Model (TAM) and Diffusion Of Innovations (DOI) Theory]. Analysis and findings indicated that UAE is ready for telemedicine with few enhancements to be made. This research can be said as the first one in the UAE and one of the few in the region that examined telemedicine based on sociotechnical analysis and at the same time applied TAM and DOI Theory on diverse categories of subjects. Also, several hypotheses were tested within the UAE context. Additionally, it would enable decision-makers and healthcare organizations to identify telemedicine's current status in the UAE, demand and acceptance level.

**الخلاصة**

تعني تقنية التطبيب عن بعد تقديم خدمات الرعاية الصحية من خلال إستخدام أدوات الإتصالات دون التواجد فعلياً في نفس الموقع. التكنولوجيا جديدة في المنطقة على الرغم من أنها ليست كذلك على مستوى العالم وهناك فجوات يجب سدها فيما يتعلق بها.

يهدف هذا البحث إلى إجراء تحليل إجتماعي تقني شامل للتطبيب عن بعد في بيئة واقعية بإستخدام عينة كبيرة من الأشخاص. تم اتباع منهجية مختلطة (كمي ونوعي). تم أخذ حجم العينة بشكل عشوائي من سكان الإمارات العربية المتحدة.

كانت النتائج في شكل مخرجات إحصائية تم الحصول عليها من نموذج ونظرية مجربة ومعروفة [نموذج قبول التكنولوجيا ونظرية نشر الابتكارات]. أشارت التحليلات والنتائج إلى أن الإمارات العربية المتحدة جاهزة للتطبيب عن بعد مع القليل من التحسينات التي يتعين إجراؤها. يمكن قول أن هذا البحث كأول بحث في الإمارات العربية المتحدة وواحدة من الدراسات القليلة في المنطقة التي فحصت التطبيب عن بعد بناءً على التحليل الاجتماعي التقني وفي نفس الوقت طبقت نموذج قبول التكنولوجيا ونظرية نشر الابتكارات على فئات متنوعة من الأشخاص. أيضًا ، تم اختبار العديد من الفرضيات في سياق دولة الإمارات العربية المتحدة. بالإضافة إلى ذلك ، فإنه سيمكن متخذي القرار و مؤسسات الرعاية الصحية من تحديد الوضع الحالي للتطبيب عن بعد في الإمارات العربية المتحدة ومستوى الحاجة و القبول.

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In addition, the researcher acknowledges the cooperation and support of Mrs. Suhair Akhlaq (a biostatistician) at MOHAP for her valuable support and guidance in enhancing the research data collection tools as well as analysing the data and to all who helped in conducting this research even with small things. It really helped a lot.

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| | |
|---|---|
| A | Attitude |
| AI | Artificial Intelligence |
| ATA | American Telemedicine Association |
| BI | Behavioural Intention |
| BUiD | British University in Dubai |
| CAPI | Computer Assistance Personal Interview |
| CASP | Critical Appraisal Skills Programme |
| CATI | Computer-Assisted Telephone Intervening |
| CDSS | Clinical Decision Support System |
| CEO | Chief Executive Officer |
| CI | Confidence Interval |
| CME | Continuing Medical Education |
| CP | Clinical Procedure |
| df | Degrees of Freedom |
| DHA | Dubai Health Authority |
| DHCC | Dubai Healthcare City |
| DOH | Department of Health |
| DOI | Diffusion of Innovations |
| DSCD | Department of Statistic's and Community Development |
| ECG | Electrocardiogram |
| EDI | Electronic Data Interchange (EDI) |
| EMR | Electronic Medical Records |

| | |
|---|---|
| FCSA | Federal Competitiveness and Statistics Authority |
| GCC | Gulf Cooperation Council |
| GCI | Global Competitiveness Index |
| GCP | Good Clinical Practice |
| GDEISST | Guía de diseño, evaluación e implantación de servicios de salud basados en telemedicina; in English [Guide for the design, evaluation and implementation of health services based on telemedicine] |
| $H_0$ | Null Hypothesis |
| $H_1$ | Alternative Hypothesis |
| HCT | Higher Colleges of Technology |
| UAEU | United Arab Emirates University |
| HIPAA | Health Insurance Portability and Accountability Act |
| HIS | Health Information System |
| HL7 | Health Level Seven |
| ICT | Information and Communication Technology |
| ICU | Intensive Care Unit |
| IDA | Identity Authority |
| IDI | ICT Development Index |
| IP | Internet Protocol |
| ISDN | Integrated Services Digital Network |
| ISfTeH | International Society for Telemedicine and eHealth |
| ISP | Internet Service Provider |
| IT | Information Technology |

| | |
|---|---|
| KSA | Kingdom of Saudi Arabia |
| LAN | Local Area Network |
| LOS | Length Of Stay |
| MAC | Message Authentication Code |
| MAST | Model for Assessment of Telemedicine Applications |
| ME | Margin of Error |
| MOHAP | Ministry of Health and Prevention |
| MOI | Ministry of Interior |
| MPLS | Multiprotocol Label Switching |
| N | Population size |
| NASA | National Aeronautics and Space Administration |
| NCBI | National Center for Biotechnology Information |
| NIH | National Institutes of Health |
| NRI | Network Readiness Index |
| NUMR | National Unified Medical Records |
| PAHO | Pan American Health Organization |
| PC | Personal Computer |
| PDF | Portable Document Format |
| PEOU | Perceived Ease of Use |
| PHC | Primary Healthcare Center |
| PU | Perceived Usefulness |
| RAK | Ras Al-Khaimah |
| RDC | Research Degree Committee |

| | |
|---|---|
| REC | Research Ethics Committee |
| RFP | Request For Proposal |
| SD | Standard Deviation |
| SMS | Short Message Service |
| SPSS® | Statistical Package for the Social Sciences |
| SQL | Structured Query Language |
| STC | Saudi Telecommunication Company |
| STS | Socio-Technical Systems |
| TAM | Technology Acceptance Model |
| TeleMed | Telemedicine |
| TPB | Theory of Planned Behaviour |
| TRA | Telecommunications and Regulatory Authority |
| TTF | Task-Technology Fit |
| UAE | United Arab Emirates |
| UAQ | Umm Al-Quwain |
| UK | United Kingdom |
| UPS | Uninterruptible Power Supply |
| US | United States |
| VA | Veterans Administration |
| VM | Virtual Machines |
| VoIP | Video over IP |
| VPN | Virtual Private Network |
| WHO | World Health Organization |

| | |
|---|---|
| WoW | Workstation on Wheels |
| α | Cronbach’s alpha |

# CHAPTER 1: INTRODUCTION

In this chapter, several topics were discussed and presented, such as: research setting of interest (UAE), research problem, technology under evaluation (telemedicine), aims and objectives, research questions, hypotheses and how the research would increase knowledge in the field and fill-in gaps along with an outline of the research chapters.

Traditional healthcare is characterized by being practiced and delivered through being physically in the same location; where parties, such as: physicians and patients need to meet face-to-face and interact. With advancements in Information and Communication Technology (ICT), providing healthcare services is evolving; where services can be provided virtually minimizing risks related to physical visits to healthcare institutes or physical contact.

With ongoing evolution and new discoveries, such as augmented reality and brain-computer interface, distant communication and interaction became easier and more efficient. Such evolution and advancements allowed countries worldwide to embrace different types of initiatives to provide services. For instance, in many public areas within United Arab Emirates (UAE), Internet can be accessed 24/7; free of charges (TRA 2016; UAE 2019). As a result of such advancements and availability of the Internet, seeking for services can bring many benefits to different types of stakeholders, such as decision-makers, patients and their families, vendors…etc. So, there is a need to focus on indispensable and most dynamic fields (e.g. healthcare) to find and come up with updated alternatives and strategies.

Furthermore, various factors and reasons require finding innovative alternatives to meet demands and expectations, such as continuous population growth, morbid lifestyle which is causing more complicated diseases to occur and high diseases prevalence rates in which there is a lack of specialized medical professionals to treat patients, growing pressures on services…etc. In

healthcare, where the environment is characterized as being dynamic and involving complex daily activities along with increasing pressures on services; adoption of the latest technologies is needed and considered as a requirement. For instance, in pandemic outbreaks, such as: coronavirus, healthcare institutes are overloaded with confirmed and suspected cases of COVID-19 and at the same time, there are other patients who need healthcare for other diseases; hence, there should be alternatives to provide healthcare and compensate for healthcare professionals being over-occupied. An example of these alternatives would be telemedicine technology which is the focus of this research.

Telemedicine means delivering healthcare services remotely through telecommunication technologies; where parties (e.g. physicians and patients) are in different locations (Al-Qirim 2007; Horoba et al. 2014). Such method of delivering healthcare can reduce the burden of seeking care as well as other potential benefits which are discussed in this research.

Technologies with its diverse tools and applications are being implemented without stop and time-to-time new technologies arise. Though, choosing the ultimate and effective technology to increase efficiency, acceptance and usage is important. Also, not all people accept and use technologies (Alwahaishi & Snasel 2013; Buabbas 2013). Additionally, technology and the Internet have risks and challenges, such as: security and identity theft (Martin, Yen & Tan 2002).

When it comes to technologies in healthcare, such as: telemedicine, it requires continuous process of research as such technologies are complex and confusing as well as people's preferences change over time due to various factors. Also, it was found that people's desires and demands are complex and not well researched (Ekland, Bowes and Flottorp 2012). Another study by Weinstein (2006), cited in Ekland, Bowes and Flottorp (2012) found that population's demographics should be addressed in research to evaluate interventions among diverse socioeconomic groups.

Despite that telemedicine technology existed a long time ago and since then been evaluated in different settings; still, there are gaps and areas for improvements due to various reasons, such as: implementation settings, technologies used, devolvement and implementation strategies, as well as advancement level in networking and infrastructures. Telemedicine has many benefits and yet faces some barriers (e.g. infrastructure readiness) that lead to challenges in accepting and using it. Although many researches have been conducted related to telemedicine acceptance and usage, still more evaluations are needed by applying models and theories in different settings and covering different angles.

A technology that does not meet expectations or is more bothersome than be useful can yield dramatic consequences. Understanding the underlying factors that contribute to technology acceptance and being used is crucial. Therefore, the focus of this research is telemedicine technology in the UAE. The UAE Ministry of Health and Prevention (MOHAP); a federal organization in the country, started implementing telemedicine in its healthcare institutes.

This research aimed to evaluate telemedicine in terms of readiness, demand and acceptance by applying Technology Acceptance Model (TAM) and Rogers' Diffusion of Innovations (DOI) Theory. Searching online for researches conducted between the year (2000-2020) that applied both TAM and DOI Theory together were limited. As a result, this research would be useful for those interested in health informatics and technologies.

Choosing UAE as the research setting was due to its sociodemographic properties uniqueness that was not previously covered in-depth and rapid embracing of technologies in recent years. Also, previous works conducted in the UAE and other Gulf countries related to telemedicine have some limitations as discussed in this chapter, under section 1.6 [How the Research will Increase Knowledge in the Field and Fill-in Gaps]. For example, Al-Qirim study was conducted

in the UAE and the focus was on exploring telemedicine adoption and diffusion among healthcare organizations professionals only and universities where he applied diffusion of innovations theory, but did not address the social or in-depth technicality of the technology. Another study conducted by Pearl et al. (2014) related to neurodevelopmental disabilities using telemedicine between two sites was conducted; one in the UAE and the consultation site was in Washington-US. However, this study was purely clinical and no indication of models or theories were demonstrated.

In addition, Goldberg et al. (1994) conducted their study about telemedicine since time ago to demonstrate the use of voice-grade telephone lines for international transmission of digital images and video consultation between UAE, Saudi Arabia and Cambridge, Massachusetts. Their study did not mention any application of models or theories. It focused on presenting case studies consulted upon by experts and some technical aspects, such as: networking, bandwidth and resolution. Also, the study discussed some benefits of telemedicine.

El-Mahalli, El-Khafif and Al-Qahtani (2012) studied telemedicine in the Saudi Arabia but covered the success and challenges in the implementation as well as application of the technology and the target audience was health professionals; similarly to Al-Qirim study. They did not apply any model or theory. Their study was a descriptive cross-sectional one.

However, a study was conducted in Kuwait by Buabbas (2013) about adoption of telemedicine in the Kuwaiti health system where he investigated the readiness level of individuals (physicians and patients), organizations (policymakers) and technical infrastructure (IT managers). He stated that there is a lack of such researches in the Arabian Gulf Regions. Buabbas study is similar to this current research, yet there are some differences. For instance, the target setting, which here is UAE, types of assessment chosen to investigate readiness level of telemedicine implementation, model and theory applied as well as the target audience. Buabbas assessed the

readiness of telemedicine adoption mainly from individuals been interviewed, while this current research assessed telemedicine implementation readiness and covered other aspects additional to human resources. Furthermore, in this current research, TAM and DOI Theory were applied and several hypotheses were tested, while in Buabbas's study, there was a description of existing models and theories but no clear indication of applying it. The application of the model and theory will help identify factors that play a significant role in accepting and using telemedicine as well as possible benefits and challenges from different types of participants (e.g. patients, healthcare professionals and Information Technology (IT) experts).

So, this research will be useful for MOHAP and other parties interested in health informatics, particularly telemedicine and those in the computer science field to fill in gaps related to information and communication technologies.

### 1.1 Setting of Interest

The research was conducted in the UAE where the technology under evaluation has been implemented. Below is a detailed description of the research setting.

**United Arab Emirates (UAE)**

The United Arab Emirates (UAE) is one of the Arab States of the Gulf located in the North East of the Arab Peninsula with a political system as a constitutional federation of seven emirates (Portal of the UAE Government 2018). The UAE population was 9,366,829 in 2018 (FCSA 2019). Since detailed demographical distribution of the UAE population is not published, the World Bank – Health Nutrition and Population Statistics for the year 2017 was used for calculating research sample size as shown in appendix A: UAE Population Distribution (The World Bank 2018).

Arabic is the official language in the county, while there are other widely spoken languages, such as English, Urdu and Nepali. (Portal of the UAE Government 2018).

In 2017, “there were 1,348,844 Internet subscribers with an average of 15.4 broadband Internet subscriptions /100 inhabitants”, according to Telecommunications and Regulatory Authority (TRA), cited in the Portal of the UAE Government 2018.

**UAE Healthcare System**

Demands in the healthcare field far outpace the available resources (e.g. financially and professionally) in many countries and reforms are the political agendas (du Enterprise 2016).
For instance, in the UAE Ministry of Health and Prevention (MOHAP), around 3972416 outpatients visited MOHAP healthcare entities in 2017, equivalent to 2.2 visits per resident. Over half of those visits were to Primary Healthcare Centres (PHCs) for different reasons: follow-ups, medical consultations, and prescription refill. There is a need for organizing healthcare facilities and establishments as well as providing a patient-centric system, where the patient plays a significant role in his/her care of health and treatment (The Cabinet of the UAE 2019). Therefore, these could be done or resolved via advanced technologies, such as telemedicine, as it would save costs, reduce pressures on healthcare entities and wait time to receive services.

Telemedicine has been implemented in the UAE years ago, but was restricted to each health authority/institutes, not on the national level. Also, the technology involved was simple: over a telephone line (Goldberg et al. 1994). However, the status of telemedicine in the UAE has advanced and different initiatives are there as discussed later in this chapter. Changes in telecommunications, technologies, pervasive fixed Internet, affordable wireless broadband, fibre optics networks…etc. make telemedicine viable compared to previous years, resulting in an inflection point in telemedicine’s acceptance and usage.

So, to achieve the UAE’s vision in healthcare to be [world-class healthcare] and to be the best country in the world by 2071, respond proactively to such dynamic and complex environment

like in healthcare, meet growing demands for healthcare services and manage a huge set of data and information to improve health lifestyle; ICT is being advised to use.

**Ministry of Health and Prevention (MOHAP)**

The UAE MOHAP deals and works collaboratively with other entities and organization, such as MOI, FCSA and internationally, for example, with WHO. Such collaboration and to fulfil its role as a ministry, MOHAP works continuously to improve its services and ensure productivity that meets demands and expectations; as much as possible. As a result, there is a continuous need to be on track with the latest advancements in healthcare, whether related to treatments, technologies, resources…etc.

So, the focus of this research was the Ministry of Health and Prevention (MOHAP), as it has various innovative initiatives in the process to implement or planning to do that. One of these initiatives is telemedicine technology, which is the focus of this research.

MOHAP is the federal healthcare organization in the UAE. The headquarter is located in Dubai Emirate, with 17 hospitals distributed across the country and around 71 primary healthcare centres that include specialized care, such as dental clinics, except Abu Dhabi and some parts of Dubai Emirate. The private sector in the Northern Emirates is licensed by MOHAP. There are other local healthcare entities, such as Abu Dhabi Department of Health (DOH), Dubai Health Authority (DHA), Dubai Healthcare City (DHCC)…etc. Each of these entities has its own healthcare institutes and managed separately from MOHAP. The below figure 1.1 shows the overall division of the public and private healthcare sector in the UAE in 2017 per establishment category and sector. However, there is cooperation between local entities, the private sector and MOHAP.

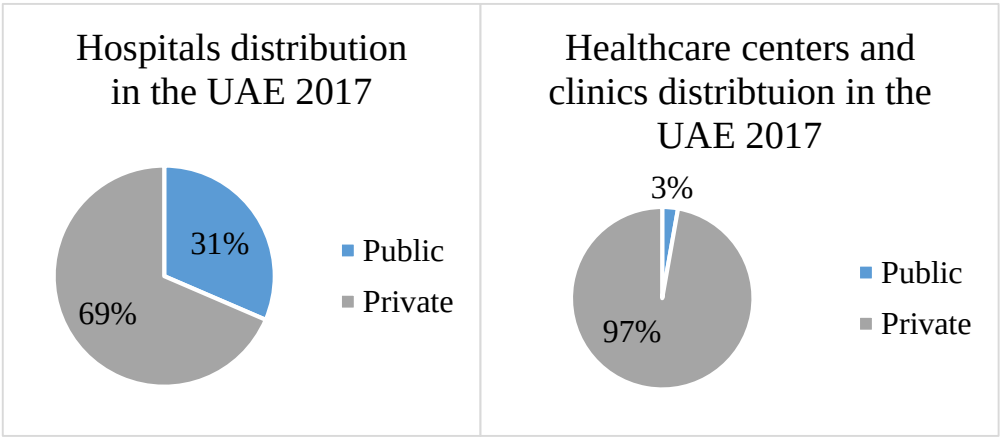

Figure 1.1: Healthcare establishments' distribution in the UAE.

**Sharjah Emirate Public Hospitals**

Since the research evaluates a technology implemented within MOHAP institutes, a case study from two public hospitals under MOHAP that implemented the technology is addressed. These two hospitals are Al-Qassimi and Kalba Hospitals.

The population in Sharjah Emirate according to the Department of Statistic's and Community Development (DSCD), cited in the Gulf News (2017) was over 1.4 million in 2015. However, Kalba is a town located on the East Coast of Sharjah and is away from the centre of Sharjah Emirate, around 120 Km, with time estimation to arrive during regular road traffic is 1hr:20min.

Al-Qassimi Hospital is one of the largest hospitals under MOHAP. It is the main hospital in Sharjah that serves mainly Sharjah's residents but receives cases from other emirates. In 2017, the number of manpower in Al-Qassimi Hospital was around 948 and the number of recurrent patients was around 213123. The hospital consists of two separate large buildings; one as a general hospital and the second one is specialized for maternity and children. Annually, 4.9 outpatient visits per patient for different reasons, but the highest demanded speciality in 2017 was for cardiovascular.

On the other hand, Kalba Hospital is a general hospital under MOHAP and serves mainly Kalba' residents, but sometimes receive cases from other nearby areas. The population in Kalba according to the DSCD census in 2015, was more than 37,000 (The National 2017). In 2017, the number of manpower in Kalba Hospital was around 398 and the number of recurrent patients was around 113641. Annually, 3.5 outpatient visits per patient for different reasons, but the highest demanded speciality in 2017 was for paediatrics.

**1.2 Research Problem**

Due to population growth, emerging of new diseases, growing pressures on the healthcare system and seeking medical care abroad due to lack of specialized healthcare professionals, which is increasing healthcare expenditures, adoption of the latest technologies is needed despite that some organizations are in the state of continuous technological change which might impact acceptance and diffusion level. However, technology can be beneficial if it is being accepted and used as intended. Professions that rely heavily on technologies require choosing the ultimate and effective software and hardware to increase efficiency without unnecessarily exhausting the resources. Healthcare is one of the fields where innovation is more of a requirement than a profiteering tool (Cowen 2009).

In a study by Scott et al. (2007), cited in Ekeland, Bowes and Flottorp (2012), it was found out that telehealth is a complex and confusing field that requires a continuous process of research to reach to consistent and reliable descriptions, applications, measures and tools. Also, Ekeland, Bowes and Flottorp (2012) found out that populations' desires and demands are complex and under-researched. For instance, Reger and Gahm (2009) cited in the same study exhibited that individuals preferred information and communication technologies instead of physical visits to healthcare centres. Furthermore, population's demographics (e.g. age and gender) should be

considered in research. For example, Weinstein (2006), cited in Ekland, Bowes and Flottorp (2012) suggested in her study about Internet-based weight loss interventions as a future work to address the applicability of these interventions among diverse ages, ethnics and socioeconomic groups. This was supported as well by other researchers, such as Mo, Malik and Coulson (2009).

Additionally, engaging stakeholders (e.g. patients and healthcare professionals) in the technology development process (e.g. requirements gathering, design, validation…etc.) is with no doubt important to ensure acceptance and usability, reach the desired outcomes as well as co-producing and conceptualising effective telemedicine innovations (Ekeland, Bowes & Flottorp 2012).

Although telemedicine technology existed a long time ago in different styles (e.g. over landline telephone and video-conferencing) and has outstanding benefits as illustrated in many previous literatures (e.g. Atac, Kurt & Yurfakul 2013; Ward, Jaana & Natafgi 2015), still there are gaps need to be filled-in related to this technology, particularly with the ongoing demands for healthcare services that are adding extra loads on this field and emerging of new telecommunication tools that facilitate providing such technology in more convenient ways than before.

The UAE MOHAP has implemented telemedicine as a pilot in two hospitals within its jurisdiction. Such technology is considered a complex one and requires in-depth evaluation, vast resources (e.g. human and capital) and efforts to comprehend it appropriately to ensure acceptance and diffusion.

As a result, it would be interesting to explore telemedicine in a new context than that previous literature did by evaluating demand and acceptance sociotechnically based on TAM and DOI Theory as well as telemedicine's benefits and challenges within the UAE context (Vitacca,

Mazzù & Scalvini 2009) and compare the research's findings with previous works. Therefore, it is imperative in the healthcare and telecommunication fields to determine factors that influence technology demand, acceptance, and sustainable usage. To the best knowledge of the researcher and based on searches done via Google Scholar between the year 2000 to 2020, studies that applied both TAM and DOI were limited. Hence, this research will be helpful to address these factors, particularly in the Arab Region, where there are countable studies related to telemedicine in the light of TAM and Rogers DOI Theory (Buabbas 2013).

### 1.3 Technology Under Study

Telemedicine comes from the Greek and Latin words as "tele" means distance and "mederi" means to heal (Vitacca, Mazzù & Scalvini 2009). Although many researchers defined telemedicine differently, they shared common sense, which will be discussed in-depth; in Chapter 2 [Review of Literatures and Theory Development]. Telemedicine means delivering healthcare services remotely via telecommunication technologies; where parties are not in the same location (Al-Qirim 2007; Horoba et al. 2014).

In the early ages, aural telephones were used in telemedicine; however, significant advancements led to the use of telecommunication satellites (Takahashi 2001). Figure 1.2 illustrates telemedicine evolution:

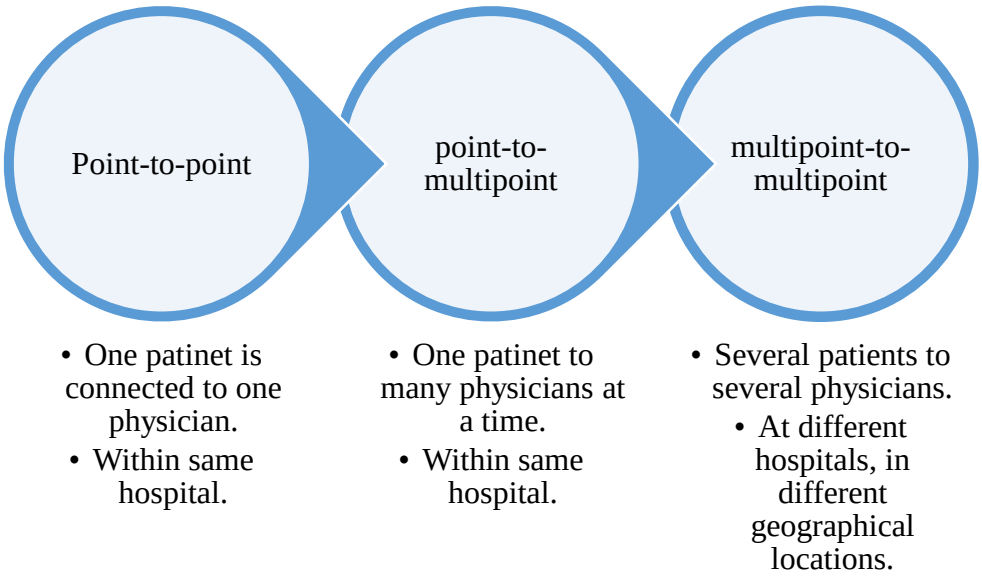


Figure 1.2: Telemedicine evolution (Adapted from Shah and Jain 2015).

## 1.4 Aims and Objectives

The primary aim of this research was to evaluate a complex technology that UAE MOHAP implemented and is known as telemedicine. The evaluation was done empirically based on TAM and DOI Theory along with exploring different determinants that affect demand and acceptance of such technology as illustrated in the proposed conceptual framework; figure 2.16. Thus, the research's aims and objectives are depicted in figure 1.3, which were fulfilled by following mixed research design, quantitatively and qualitatively.

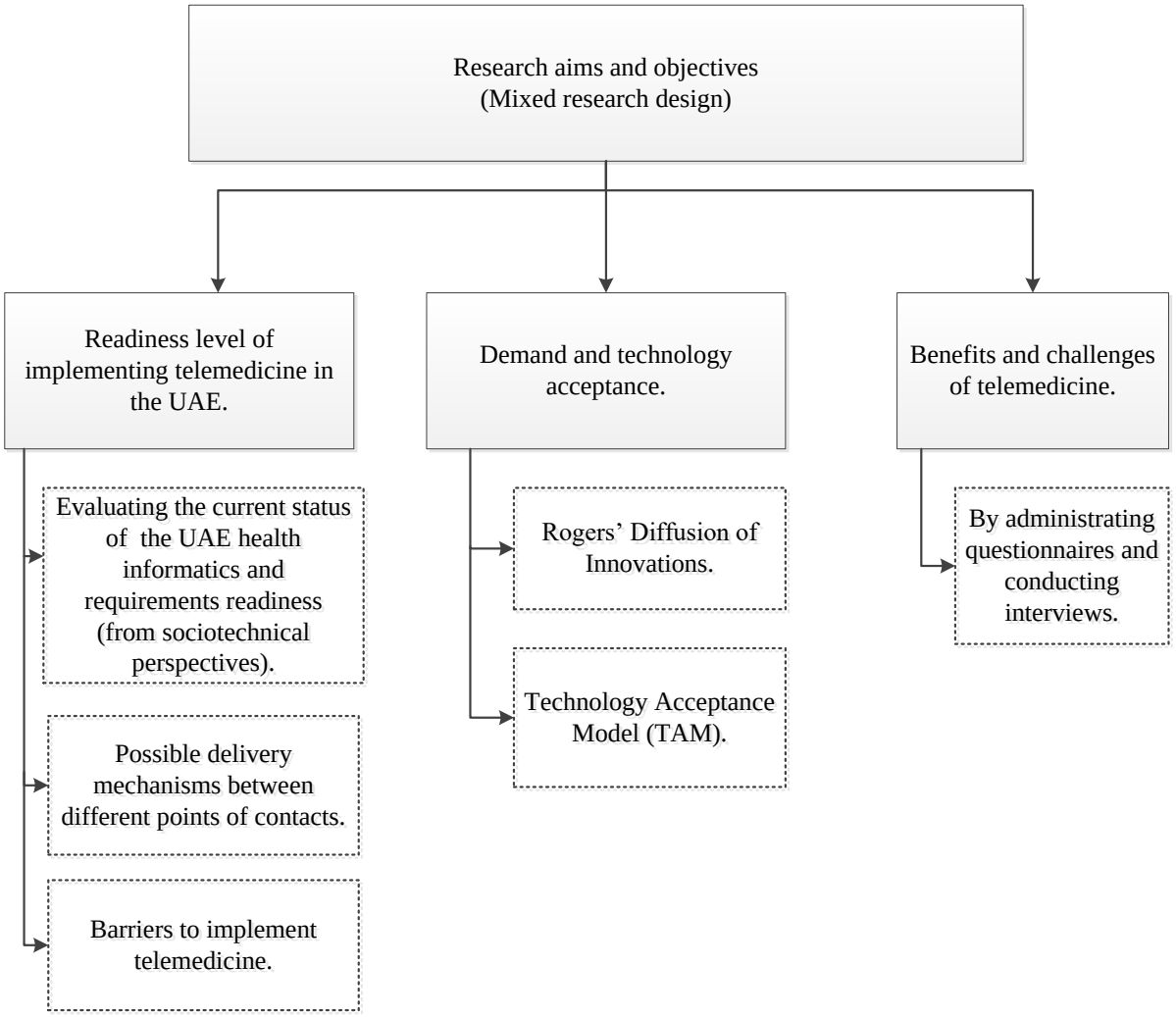


Figure 1.3: Research's aims and objectives.

The first aim was fulfilled by reviewing the literature to understand and define the requirements for health informatics; in general and telemedicine readiness in particular and then compare it with MOHAP readiness. The readiness level was discussed based on various sociotechnical levels (e.g. social, organizational and technical). Also, to empirically address barriers to implement telemedicine implementation; interviews were conducted with the MOHAP team. In addition, some archives were used to extract non-confidential and high-level information. These extracted information were related to the current status of health informatics readiness,

telemedicine's readiness level and delivery mechanisms between different points of contact in telemedicine.

The rest of aims were accomplished almost through similar approaches. For aim two: demand and technology acceptance, additional approaches were used by applying TAM and Rogers DOI Theory as well as through questionnaire and interview. Furthermore, for aim three: benefits and challenges of telemedicine, questionnaire and interview were utilized.

Consequently, a conceptual framework was proposed to achieve the research aims and objective, illustrating the relationship between various variables and outcomes. This conceptual framework was empirically verified and discussed in Chapter 2: Review of Literatures and Theory Development and Chapter 4: Results and Analysis.

Finally, for further clarification, in aim one, barriers to implement telemedicine is different than what is mentioned in aim three related to benefits and challenges of telemedicine. The barriers meant those that might hinder the implementation of telemedicine, while challenges of telemedicine meant to cover drawbacks.

## 1.5 Research Question, Hypotheses and Significance

### 1.5.1 Research Questions

To draw and define the research questions, previous works in the field from different countries; worldwide were reviewed. For example, case studies from India and the USA, which have started telemedicine some time ago. Also, this helped to frame the research structure as depicted in table 1.1 and fulfil the aims and objectives.

1- What is the readiness level of implementing telemedicine in the UAE?

a. What is the current status of the UAE health informatics? In this question, the aim was to provide a general picture of health informatics in the country and where it reached.

b. What requirements readiness are needed, such as technical, financial, business-wise and users? In this question, the aim was to illustrate the requirements needed to implement telemedicine.

c. What are possible delivery mechanisms between different points of contacts in telemedicine? Here, delivery mechanisms mean how telemedicine can be provided. For instance, through networked delivery, internet-based services or monitoring centres networks (ATA 2006).

d. What are possible barriers to implement telemedicine in the UAE? Various barriers may hinder the implementation of telemedicine in the country. For instance, unavailability of legal frameworks to guide the use of telemedicine, technical readiness in rural areas and costs related to acquiring devices (e.g. Atac, Kurt & Yurfakul 2013).

2- What is the demand and how to measure the acceptance level of telemedicine in the UAE? This question measured the demand and acceptance level based on certain determinants as defined in the conceptual framework presented in Chapter 2: Review of Literatures and Theory Development; Section 2.7: Proposed Conceptual Framework. These determinants were drawn from previous works (e.g. Al-Qirim 2007 and Jensen 2002). In addition, Technology Acceptance Model (TAM) and Rogers DOI Theory were applied here.

3- What are possible benefits and challenges of telemedicine in the region? In this question, general benefits and challenges of telemedicine based on the research participants' perspectives were covered and discussed.

### 1.5.2 Research Hypotheses

The below hypotheses were mapped and translated from the research questions and based on the literature in the field, such as Davis (1989), Liu (2014) and Rogers (2003):

- Hypothesis 1: Perceived usefulness and perceived ease of use of telemedicine
- Hypothesis 2: Telemedicine acceptance and positive attitude

- Hypothesis 3: Attitude's influence on behavioural intention toward using telemedicine.
- Hypothesis 4: Telemedicine acceptance and positive behavioural intention
- Hypothesis 5: Telemedicine acceptance and effective usage
- Hypothesis 6: Confounding variables and acceptance of telemedicine

Here, the above hypotheses were statistically answered (e.g. correlation and *p*-value test) using a questionnaire and interview adapted from previous works (e.g. Cowen 2009 and Davis 1989) as shown in appendix B: Previous Works' Hypotheses Testing and Outcomes.

### 1.5.3 Research Significance and Innovativeness

This research has its importance and uniqueness as it covered an innovative technology implemented by the UAE MOHAP known as telemedicine. Despite the fact that telemedicine has been in place in different settings, still, some gaps have not been covered or addressed well, such as financial aspects and social acceptance (Ward, Jaana & Natafgi 2015). In addition, to the best of the researcher's knowledge, there is a lack of studies in the UAE and Arab Regions that covered telemedicine from different perspectives, such as social, technical and legal, as well as applied theories and models (Buabbas 2013). Although Buabbas (2013) conducted a similar study as this current research, it differs from this research from different aspects. One of the important differences that in this research TAM and DOI Theory were applied; while in Buabbas, these were not applied. Also, different settings, target audience and some characteristics of the data collection tools used. Here, the research target setting was UAE MOHAP; a federal healthcare organization in the country covering almost all emirates, public and private. This increases the probability of generalizing the research's findings.

Furthermore, telemedicine needs to be improved on various levels besides the technical level, such as organizational and regulatory. This was supported by Vitacca, Mazzù and Scalvini

(2009) to go beyond experimental research and surge the cooperation with social sciences instead of focusing only on engineering discipline, taking into account economic, cultural, and political factors. Thus, in this research, these sociotechnical levels and factors were addressed.

Telemedicine would probably require some changes to be made, such as organization workflows, utilizing advanced hardware and software, as well as upgrading existing networks to boost live communication between parties better. These changes and other determinants have possible impacts on technology acceptance. So, TAM and DOI Theory were utilized here to examine these determinants as well as to measure the demand and acceptance of telemedicine in the UAE. Better understating of variables and factors that allow understanding demand of telemedicine and increase (potentials) users' acceptance would enable different stakeholders (e.g. organizations) to design and provide services as well as interventions while maintaining intended usage level (Venkatesh & Davis 2000).

Hence, this research will provide a useful pathway for addressing and evaluating such technology. Similarly, different types of decision-makers and stakeholders will probably benefit from this research to make the right decisions related to telemedicine and learn lessons from existed telemedicine technology in other countries. Also, it analysed the participants' thoughts, perspectives and knowledge (e.g. physicians and patients) about telemedicine and demonstrated existed cases of telemedicine in the UAE, such as e-ICU between two hospitals in Sharjah Emirate.

As a result, this research was conducted with focusing on UAE MOHAP as it is the federal healthcare organization in the country that implemented telemedicine. A copy of the research final report will be presented to decision-makers in MOHAP for evaluating the existed telemedicine applications and for future plans related to telemedicine. This will be useful also for other healthcare organizations and vendors planning to implement telemedicine.

### 1.6 Increase Knowledge in the Field and Fill-in Gaps

Based on searching different major and well-known scientific databases, journals…etc., such as Science Direct, National Center for Biotechnology Information (NCBI), PubMed and International Journal of Medical Informatics, it was notable that there is a lack of research contribution in the literature from this part of the world.

As stated above, there are a lack of studies conducted in the Arab Region related to telemedicine from sociotechnical perspectives and applied TAM and DOI Theory. Some of these studies have limitations, such as methodology applied, type of telemedicine covered and lack of variety in selecting participants (e.g. Al-Qirim 2007 and Goldberg et al. 1994).

According to previous studies related to telemedicine, for example, Ekeland, Bowes and Flottorp (2012) and Koch (2006), there is a need for more evidence about technologies' effects from other perspectives, such as: organizational and legal.

Since TAM and DOI Theory were applied in this research, this would possibly contribute to the literature in the field and fill in gaps in research; generally and in the Arab Region; specifically. Such model and theory can also be applied in other fields, such as aerospace to address technologies used there.

Krebs and Duncan (2015) stated that Information Technology (IT) developers usually do not publish information or numbers of applications' users as well as the level at which consumers continue using apps over time or not. Sharing such data and information is important to measure the usability of technology and resolve issues that might impact the usage continuity, diffusion and acceptance.

The research findings might be useful and used in other fields besides healthcare. For instance, using telemedicine in universities for medical students to observe live-performed

surgeries in other geographical areas. Also, the research findings will most probably be useful to learn lessons, make decisions, use as a base to conduct further empirical studies, thoroughly understand telemedicine and the determinants that might impact demand and acceptance of it. Likewise, since in this research mixed methods were applied and the technology addressed was covered from sociotechnical perspectives, different types of professionals, organizations, vendors, researchers…etc. might benefit from this research.

### 1.7 Research's Chapters Outlines

The research's aims and objectives were achieved and discussed through the research's chapters. Below table 1.1 provides an overview of the research's chapters and a brief description of each chapter.

Table 1.1: Overview of the research's chapters.

| Chapter | Title | Description |
|---|---|---|
| Chapter 1 | Introduction | This chapter discussed various topics, such as the setting of interest, research problem, technology evaluated, research aims and objectives, questions, hypotheses generated and tested as well as research significance and importance. Finally, presented an outline of the research chapters. |
| Chapter 2 | Review of Literatures and Theory Development | In this chapter, different topics were discussed. For instance, ICT for the healthcare domain and four pillars, sociotechnical systems, details about telemedicine in terms of history, nomenclatures and definitions, technicality, benefits and challenges and examples of existed cases. Also, the current status of telemedicine in the UAE, wireless medical environment in the 2050s as well as different theories and models. Finally, a conceptual framework was proposed: demonstrating the research variables, theory and model applied along with the relationships between them. |

| | | |
|---|---|---|
| Chapter 3 | Methodology | In this chapter, different topics were discussed, such as research philosophy, research design, approach, methods applied, sampling design, measurements and data collection tools used. |
| Chapter 4 | Results and Analysis | In this chapter, the research's results were statistically analysed and presented, covering various topics, such as pilot phase, outcomes of TAM and Rogers DOI Theory, hypotheses testing, presentation of case studies and comparing between quantitative and qualitative findings. |
| Chapter 5 | Discussion | Different topics were covered, such as discussion of the research questions and related aspects, research biases handled, validation techniques and ethical considerations applied. |
| Chapter 6 | Conclusion | Here, overall of the research main points were highlighted. Also, recommendations, contribution to knowledge, research implications, limitations and future works. |

## CHAPTER 2: REVIEW OF LITERATURES AND THEORY DEVELOPMENT

This chapter presents review of the literature and theory development with discussing various topics, such as ICT for healthcare domain, sociotechnical systems (STS), telemedicine in general and examples of cases, wireless medical environment in the 2050s, theories and models related to the research as well as illustrates the proposed conceptual framework.

Previous works in this field had their uniqueness as well some limitations and different authors pursued similar studies related to telemedicine from sociotechnical perspectives, yet those authors conducted their researches in different contexts and some of them focused on certain parts of telemedicine, such as e-ICU or telecardiology. For instance, Al-Qirim (2007) focused on Abu Dhabi Emirate and patients were not included; only experts involved in the telemedicine projects were the study's participants. Another study conducted by Wootton and Bonnardot (2010) was a retrospective review and no actual evaluation of telemedicine was done. Bowonder, Bansal and Giridhar (2005) conducted a case analysis about telemedicine in Apollo Hospitals – India. Their study's participants were healthcare professionals and administrators. The acceptance of telemedicine was addressed, but no model or theory related to technology acceptance was demonstrated.

Additionally, many of previous studies used a single methodology (e.g. Al-Qirim 2007) or covered certain groups of participants, such as only healthcare professionals (e.g. El-Mahalli, El-Khafif & Al-Qahtani 2012) or addressed specified areas of telemedicine and rarely addressed this technology from sociotechnical perspectives (e.g. Castellano et al. 2015). The characteristics of the literature related to the topic under study ranged from explorative (e.g. Al-Qirim 2007) to case studies (e.g. Bowonder, Bansal & Giridhar 2005; Goldberg et al. 1994) to theoretical framework and others.

## 2.1 ICT for Healthcare Domain

ICT evolution played a significant role in the development of the ICT healthcare domain, beginning with basic telecommunication to expanding the scope of personalization of ICT (e.g. m-health). It involves four pillars; telemedicine, telehealth, e-health and m-health. These pillars represent different meanings and components and there is a confusion about defining ICT health pillars (Bashshur et al. 2011). Here, these four main pillars are defined and presented as below.

- Telemedicine means the "use of modern information technology to deliver healthcare services and exchange information between parties located apart from each other" (Bashshur et al. 1997, cited in Istepanian & Woodward 2017).
- Telehealth is " a broadening concept of telemedicine which includes public health, health education, services, environmental and industrial health in addition to other aspects" (Istepanian & Woodward 2017).
- e-health, as defined by WHO (2005) means "the cost-effectiveness and secure use of ICT to support health and related fields, such as health surveillance and research".
- m-health as defined by Istepanian, Pattichis and Laxminarayan (ed. 2006), means "emerging mobile communication and network technologies for healthcare".

Bashshur et al. (2011) proposed components for ICT pillars in healthcare as depicted in figure 2.1:

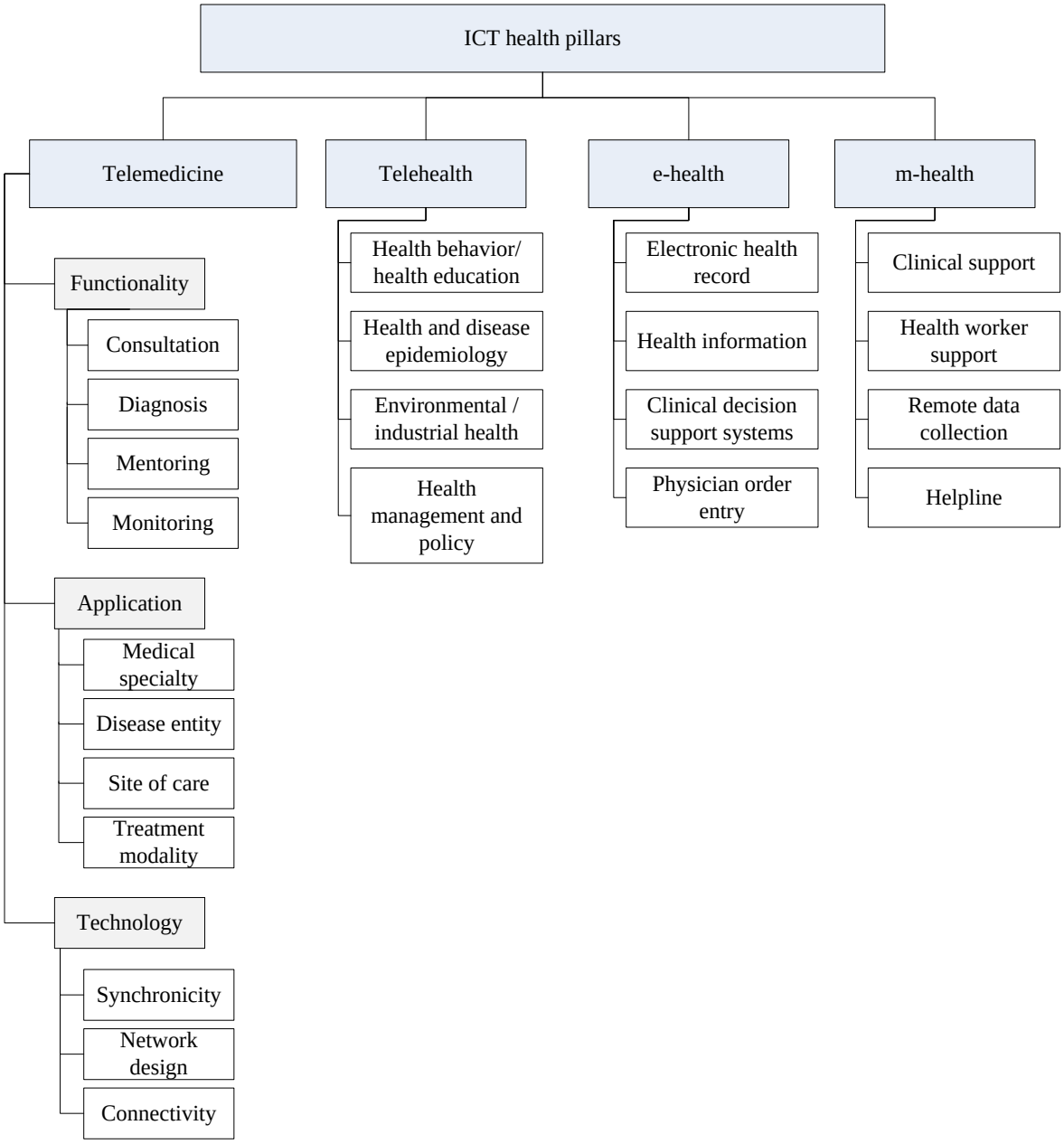


Figure 2.1: ICT health pillars and components (Adapted from Bashshur et al. 2011).

## 2.2 Sociotechnical Systems (STS)

Sociotechnical systems are large scale systems that include people, processes, software, hardware and organizational policies. These systems are often [systems of systems] made up of other independent systems and used to support organizations' business goals and objectives (Ncube 2014). Emery and Trist originally described sociotechnical systems in 1960 as "systems

that involve complex interactions between machines, environmental aspects of the work system and humans" (Baxter & Sommerville 2011). An example of such a systems is telemedicine. Figure 2.2 depicts sociotechnical systems structure layers.

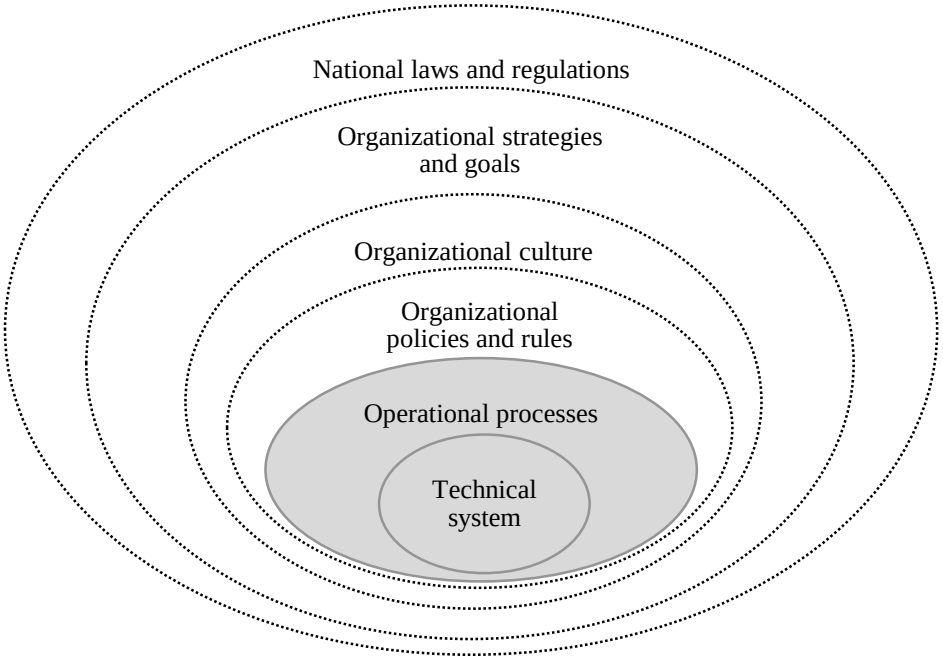


Figure 2.2: Sociotechnical systems structure layers

(Adapted from Ncube 2014).

STS is used within organizations and is highly affected by the organization's environment. Failure to consider this environment when designing STS, the results would likely be users' dissatisfaction and rejection (Ncube 2014). STS characteristics are:

- Emergent properties: e.g. security, reliability and usability.
- Non-deterministic means that a given sequence of input would not always provide the same output as the systems' behaviours are partially dependent on human operators and frequent changes to hardware, software, and data.
- Complex relationships with organizational objectives. For example, stakeholders' views about the system's success.

Badham, Clegg and Wall (2000), cited in Baxter and Sommerville (2011), added other characteristics of sociotechnical systems:

- Contain interdependent parts.
- Adapt goals and pursue it in external environment.
- Systems goals are achievable by more than one means.
- Systems have an internal environment, including separate but interdependent technical and social subsystems.

The sociotechnical view attempts to understand a phenomenon from the human-social level to the technical performance level. This can be seen particularly in complex organizational structures, such as healthcare, where different systems are there and have to interact efficiently and safely without causing harm and undesired consequences.

So, STS need to be covered and evaluated thoroughly in researches more than simply being critiqued. According to Coiera (2003), cited in Coiera (2007), there is a need to describe a phenomenon at the sociotechnical level, draw connections between these phenomena and systems' behaviours, and then artefact designs. For instance, this can be done by translating insights about the nature of clinical works (sociotechnically) into design specifications to have better interpretations in workplaces. Also, to work closely with technologists to shape technologies, processes, cultures and have organization.

Sociotechnical thinking considers social and technical factors that have influences on the usage and functionality of computer-based systems. Adopting sociotechnical analysis in evaluating technologies reduce the risks of not making the expected contributions to organizations' goals (Baxter & Sommerville 2011).

Different designs can be applied in STS, such as participatory design methods where users or their representatives are involved with systems' developers during projects' duration. Other designs are empathic and contextual designs. As part of the development process, developers are put into the users' world.

However, there are some issues related to STS. For instance, understanding the meaning of STS as different fields have adopted this term but often used their interpretation. This results in focusing on one aspect, for example, technical and ignoring other aspects (e.g. social), although they need to be jointly optimized. Multidisciplinary is another issue where different disciplines are involved resulting in misunderstanding and miscommunication.

Hasvold and Scholl (2011) found that many information and communication technologies failed because of poor understanding of sociotechnical interactions and actual processes and suggested that information systems in healthcare need to be viewed as sociotechnical systems, where technical features and work practices have effects on implementation; successfully.

Overall, sociotechnical analysis allows thinking broadly about a phenomenon to decide which technology to build, how to design it and how it would fare once used in the real world (Coiera 2007).

## 2.3 Telemedicine in General

As an innovative method to bridging healthcare delivery gaps, telemedicine has been promoted as one (George, Hamilton & Baker 2012). Telemedicine can be said is a new concept that is being used these days, although it can cause confusion with other terms when it is defined. Telehealth is closely associated with telemedicine and many people use these terms interchangeably, although telehealth encompasses a broader concept (ATA 2014; Alexandru 2015). In this research, telemedicine term was used.

### 2.3.1 Telemedicine History

In 1906, Electrocardiogram (ECG) was transmitted over telephone lines by Einthoven. In the 1920s, radios were used to connect physicians at shore stations with sea ships for medical emergency assistance. While in 1955, the Nebraska Psychiatric Institute was one of the firsts to start closed-circuit television to provide mental health services linking a university's medical centre and a state hospital over 100 miles away. In later stages, connected with Omaha Veterans Administration (VA) Hospitals and VA facilities in other towns.

In the early 1960s, the National Aeronautics and Space Administration (NASA) played important roles in telemedicine development when they started to monitor astronauts' physiological parameters from the spacecraft and the space suits (Bowonder, Bansal and Giridhar 2005).

In the 1970s, paramedics in remote Alaskan and Canadian villages were connected with hospitals in other towns/cities via ATS-6 Satellites. Later in the 1980s, point-to-point interactive video conferencing was possible, where there was access to T1 (a carrier system in telecommunication), fractional T1 or Integrated Services Digital Network (ISDN) lines. In 1998, a telemedicine (live-video sessions) network between the highest point on earth (Mountain Everest) and the US Network was created by AT&T, where data was transmitted via satellites, transoceanic fibre and global ISDN (Bowonder, Bansal and Giridhar 2005).

### 2.3.2 Telemedicine Nomenclatures and Definitions

Most people use telehealth and telemedicine interchangeably, while others may get confused about these two terms. For instance, as cited in Alexandru (2015), telemedicine term has been replaced by the term telehealth in the UK, while the European Union still uses the term telemedicine. As noticed from Alexandru's research, still there is a lack of consensus to

differentiate between telehealth and telemedicine. Some researchers used the term telemedicine (e.g. Broens et al. 2007 and Karsh 2004), while others used telehealth, although the second term is much broader and include both health and care, which Alexandru differentiated between them in her research.

As defined above, telemedicine means providing healthcare services remotely, where parties are located in different locations via telecommunication technologies (Al-Qirim 2007; Tithecott & Sochacki 2015). A white paper produced by du Enterprise (2016) (one of the two telecom operators in the UAE) described telehealth as using digital networks to deliver healthcare to patients where they are in different physical locations from their healthcare professionals.

However, according to the online Oxford Dictionaries (2019), telemedicine means "remote diagnosing and treatment of patients via telecommunications technology". While online Merriam-Webster Dictionary (2019) defined it as "the practice of medicine where physicians and patients are separated by using two-way communication; voice and visual". The online Collins English Dictionary (2019) defined telemedicine a bit different than other dictionaries and previous studies as "diseases or injury treatment by consultants with specialists in distant places via computer or satellite link". Another online dictionary, Cambridge English Dictionary (2019), defined telemedicine as treating ill people by sending information from one place to another via computer.

Figure 2.3 illustrates the common components of telemedicine that many researchers shared when they defined telemedicine.

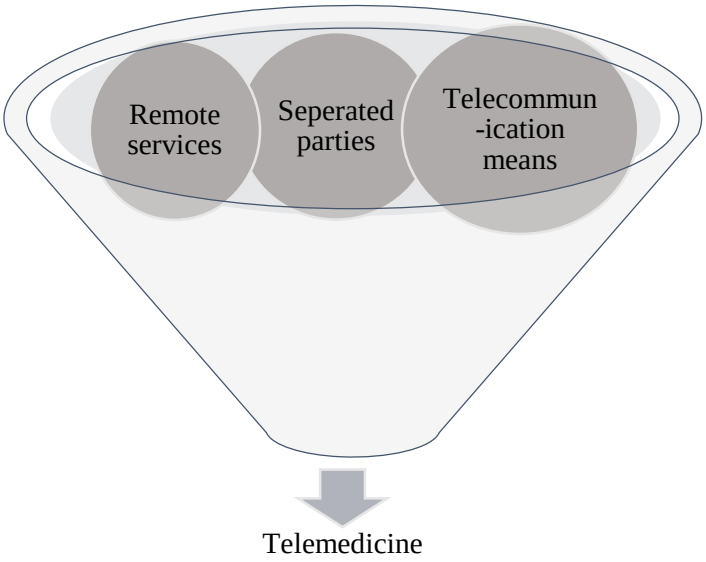


Figure 2.3: Common components of telemedicine.

Fatehi and Wootton (2012) ran the following queries on Scopus Website to retrieve articles that have telemedicine in its title or abstract. Similar queries were run for telehealth and e-health.

1- TITLE({telemedicine} OR {tele medicine} OR {tele-medicine})
2- ABS({telemedicine} OR {tele medicine} OR {tele-medicine})
3- (TITLE({telemedicine} OR {tele medicine} OR {tele-medicine})) OR (ABS({telemedicine} OR {tele medicine} OR {tele-medicine}))

No limitations were applied to the queries in terms of the publication date, documents' languages or journal category, except documents published in the year 2012 were excluded as Fatehi and Wootton's study was in 2012 to avoid incomplete statistics. Telemedicine, telehealth and e-health were often used interchangeably. Telemedicine terminology was the most common one used in 8028 documents from 126 countries, then e-health and last telehealth. They stated that variation in adopting these terms is a possible cause for ambiguity in defining it and lack of clarity.

In this research, searching in Ngram Viewer for the terms [telemedicine, e-health, telehealth, m-health] in English between the year 2000 and 2012 was done and results showed declining in these terms. Yet, the telemedicine term was the most popular, as depicted in figure 2.4.

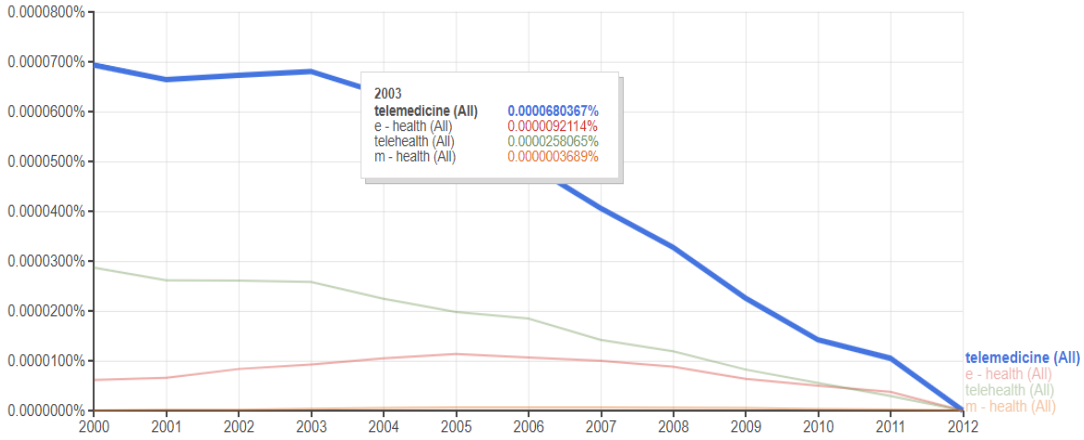


Figure 2.4: Ngram Viewer for related terms between 2000 and 2012

(Adapted from Ngram Viewer 2013a).

However, when the timeline was extended to be between the year 1980 and 2012 for the same terms, it showed similar findings that telemedicine was the most popular term used and been most popular in the early 2000s, as depicted in figure 2.5.

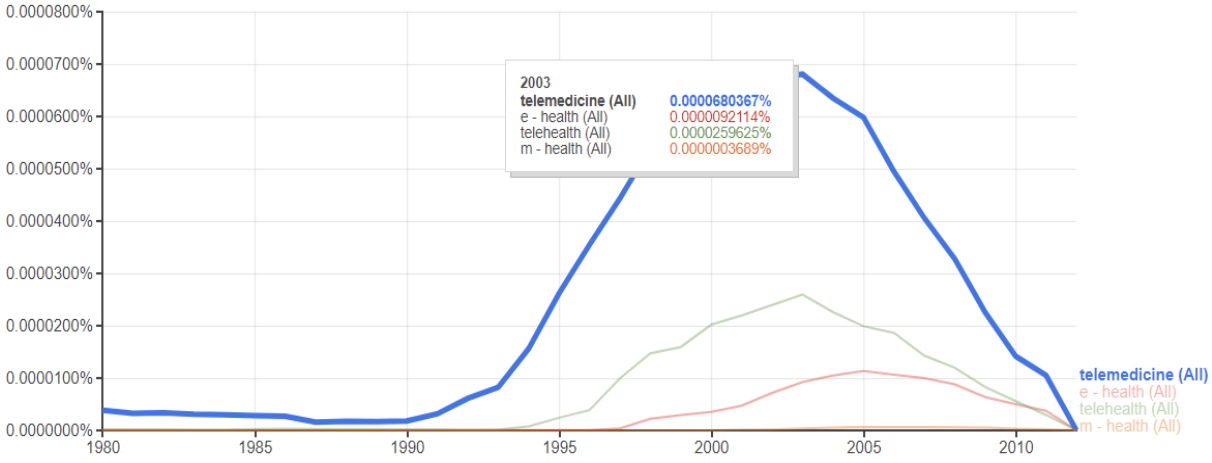


Figure 2.5: Ngram Viewer for related terms between 1980 and 2012

(Adapted from Ngram Viewer 2013b).

As it can be noticed, still there are some ambiguity and misunderstanding in defining telemedicine (Fatehi and Wootton 2012). So, telemedicine could mean different concepts to different people and common ground is essential in addressing and evaluating such technology to avoid misconception and misrepresentation of data and information.

### 2.3.3 Usage, Applications and Possible Stakeholders

Telemedicine has many potentials in delivering healthcare, such as in disease management. For instance, diabetes is one of the prevalent ailments in the UAE and require regular monitor of blood glucose level, taking medications on time, health education and other tasks which could be challengeable for newly diagnosed patients to cope with it without medical assistance and supervision. Such medical care can be delivered through telemedicine, reducing healthcare institutions' Length of Stay (LOS), visits, and related costs. Also, it will reduce developing secondary-health issues, such as blindness and stroke, which could be life-threatening, far more expensive and resources intensive. Simple reminders via telemedicine can help to improve the quality of life.

In addition, diabetic patients can measure their blood glucose level and send the readings wirelessly, which will be saved in a certain secure database that can be accessed by the healthcare professional and patient, as applicable.

Abd Ghani, Jaber and Herman (2015) stated that telemedicine is becoming an integral part for many healthcare organizations, home health agencies, private physicians, universities…etc. as shown in the example figure 2.6, where a large hospital in the city provides medical support through telemedicine to other facilities.

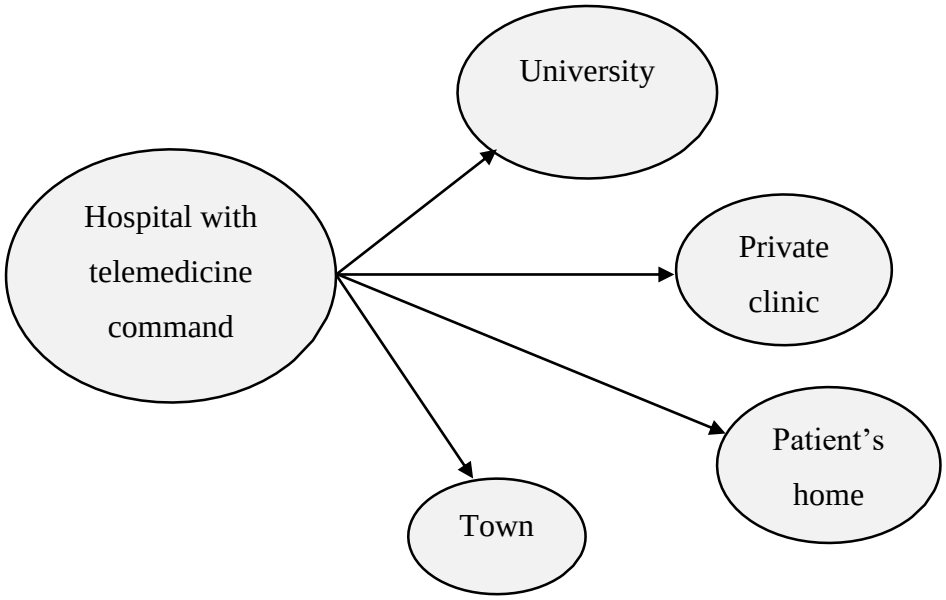


Figure 2.6: Examples of telemedicine service to other entities.

Below are examples of technologies involved in telemedicine (Shah & Jain 2015).

- Medical instrumentation, such as medical imaging, measurements of physical parameters, such as blood pressure and body temperature.
- Telecommunication technology, such as wired network and wireless medium.
- Information technology, such as information storage, processing, re/presentation and retrieval.

El-Mahalli, El-khafif and Al-Qahtani (2012) categorized telemedicine applications into three major categories:

- Patient monitoring: e.g. home care.
- Real-time interaction: e.g. video-conferencing (also known as synchronous video) and telesurgery.
- Store-and-forward non-interaction (asynchronous): e.g. tele-radiology.

While, Bowonder, Bansal and Giridhar (2005) listed three general applications of telemedicine: clinical, administrative and educational applications. However, each of these applications includes various sub-applications and tools. For instance, clinical applications include but not limited to teleconsultation and e-visit, while administrative applications include transferring medical records, examining financial data…etc. Educational applications include teleconference, virtual teaching sessions…etc.

The Pan American Health Organization (PAHO) (2016) described various applications of telemedicine aside from the basic ones (e.g. teleradiology and teledermatology). For instance, telemedicine can be used in psychiatric patients through videoconferencing and chat (telepsychiatry), virtual reality, robotics and artificial intelligence (e.g. support surgical procedures). Figure 2.7 illustrates various usages of telemedicine.

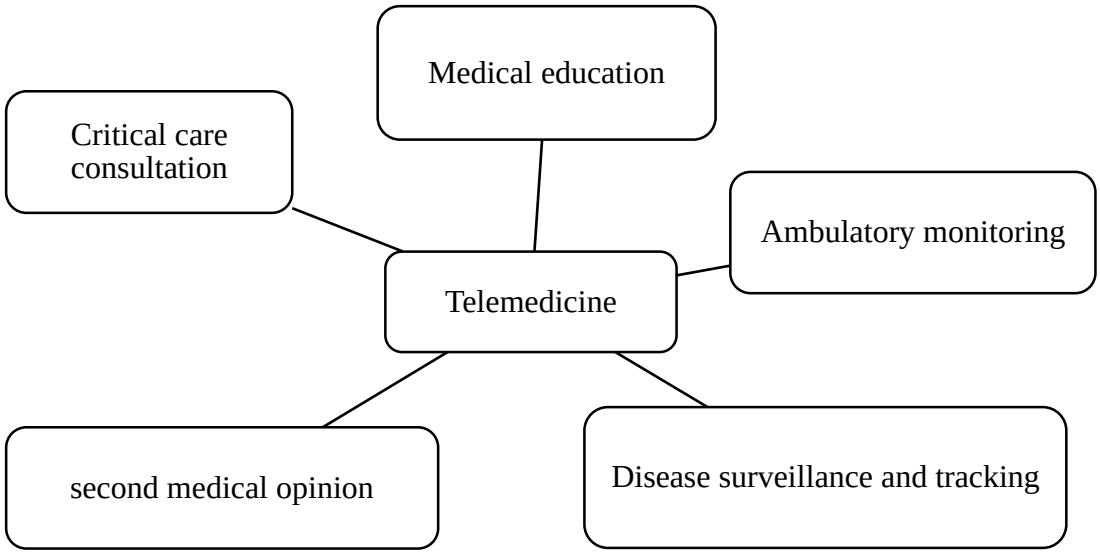


Figure 2.7: Examples of telemedicine areas of usage.

The blow figure 2.8 demonstrates examples of possible telemedicine's key stakeholders.

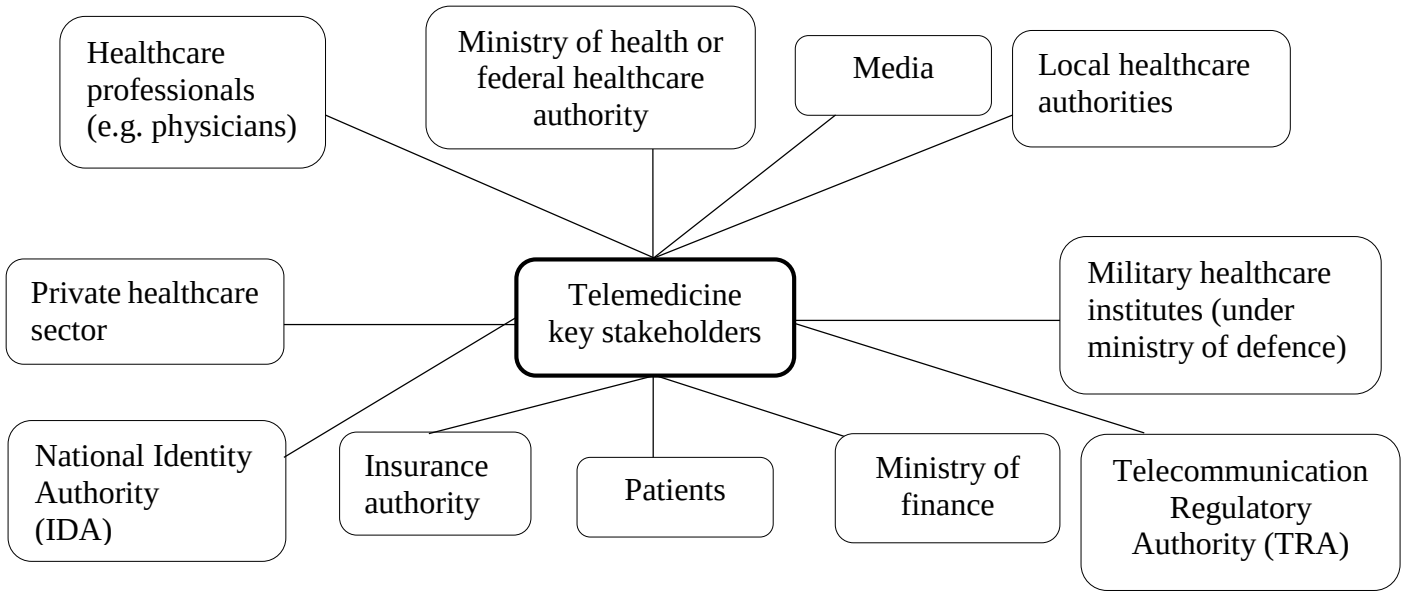


Figure 2.8: Possible telemedicine's key stakeholders.

### 2.3.4 How it Works

Telemedicine includes different solutions that can be used to connect clinicians, patients, medical students…etc., such as built-in webcams, home devices, m-Health devices (Mobile Health) and high-end video-conferencing units that allow as well collecting and sharing different types of data range from small, simple data, such as blood pressure values to complex data (e.g. 3D brain scans). Many healthcare providers that provide advanced telemedicine service have designated areas within their organizations where there are equipped telemedicine command centre, devices, tools…etc. Telemedicine can be delivered to potential users via various mechanisms, such as networked programs, web-based patient health services and point-to-point connections. Below are descriptions of these mechanisms:

- Networked programs: linking different entities together (e.g. hospitals and clinics with distant community healthcare centres in rural areas) via hub-and-spoke network or integrated networked systems (ATA 2006).

- Web-based e-health patients services: where direct consumer services are provided over the Internet (ATA 2006).
- Point-to-point connections: a connection between two endpoints. For example, connects linking two devices or circuits. In healthcare, point-to-point can be used to deliver services directly to independent healthcare providers in ambulatory care sites (ATA 2006).

With advanced technologies, use of mobile applications and availability of Video over IP (VoIP), telemedicine can be provided intra-country and internationally.

#### 2.3.4.1 Technicality

Telemedicine requires advanced technology infrastructure to be in place, particularly in mountain areas where the geographical nature of these areas would be challengeable. So, the more advanced telemedicine needs to be, the more demands it put on the technology infrastructure in terms of network reliability, speed, bandwidth, response…etc. For instance, sending reminders to take medications; a standard mobile Short Message Service (SMS) would be enough. However, "real-time telemedicine video-conferencing would require minimum bandwidth of 384Kbps; provided by three Integrated Services Digital Network (ISDN) lines" (du Enterprise 2016). Yet, ATA (2014) guidelines specified a minimum higher bandwidth than this, around 500Kbps. Kayange & Yotham (2014) demonstrated as depicted in table 2.1 examples of speed needed for health information exchange based on file type, size and network transmission speed.

Table 2.1: Examples of health information exchange and network speed needed (Adapted from Kayange & Yotham 2014, p. 13).

| File type and size | | Network transmission speed | | | |
|---|---|---|---|---|---|
| Type | size | 4 Mbps | 10 Mbps | 20 Mbps | 50 Mbps |
| High definition video conferencing | 1.9 MBs | 23.8 seconds | 9.5 seconds | 4.8 seconds | 1.9 seconds |
| Telediabetic retinopathy screening | 5 MBs | 6.2 seconds | 2.5 seconds | 1.2 seconds | 0.5 seconds |
| Echocardiogram study | 4 GBs | 2.1 hours | 50.8 minutes | 25.4 minutes | 10.1 minutes |

### 2.3.5 Telemedicine Standards, Guidelines and Security

ATA (2014) established practice quality guidelines related to telemedicine and considered it fundamentals when providing healthcare services via telecommunication technologies. The guidelines consist of different categories, as depicted in figure 2.9. Appendix C: ATA Guidelines describes it in detail.

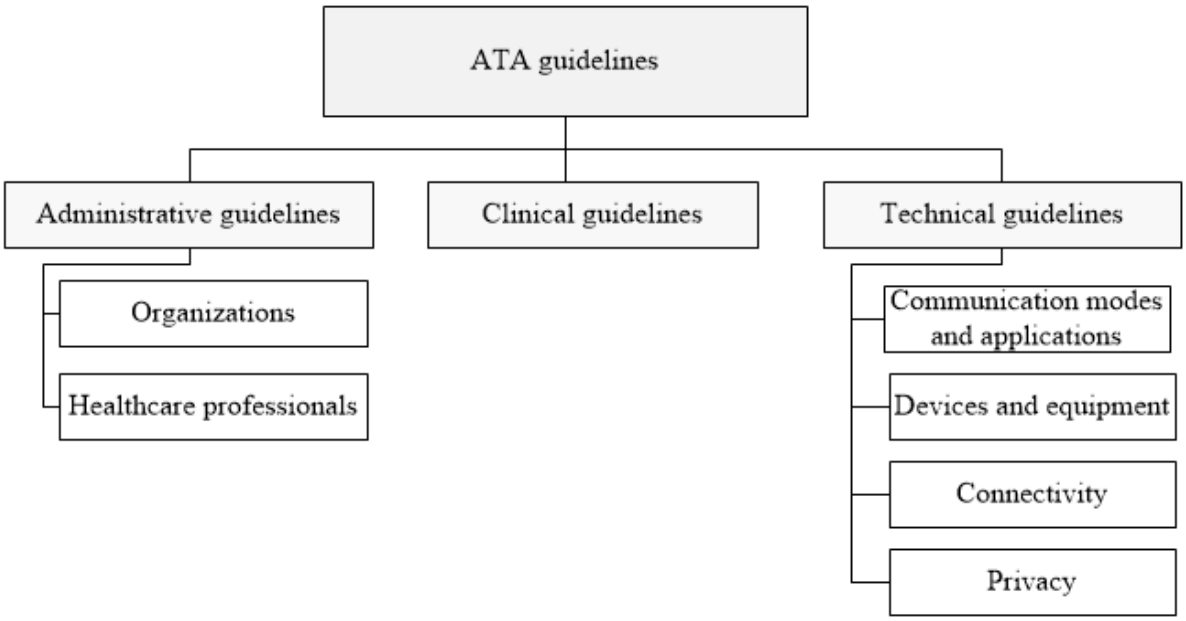


Figure 2.9: ATA guidelines structure

(Adapted from ATA 2014).

Rezaeibagha and Mu (2018) argued that many security schemes have been proposed and discussed in the literature. Still, they did not consider users' (e.g. patients and physicians) mobility and the impact of a changed computing environment. They proposed security protocols based on symmetric-key schemes while maintaining security properties (confidentiality, integrity, anonymity, freshness and authentication).

To ensure confidentiality against attackers, a long-term symmetric key is shared by a user with its home server. The attacker can be a registered person in the network and has an owned shared key with its home server but can not have others' keys. For each session, there is a new key issued for the patient-physician communication. In case of user's mobility, a temporary key is issued by the patient, for example.

For ensuring integrity, Message Authentication Code (MAC) based on a secure cryptographic hash function is used. Data transmitted are embedded in MAC with a MAC key (a long-term key shared by a user and its home server).

To achieve anonymity, subliminal ID of the user is used. In each new session, a new subliminal ID is used. Also, this ID is encrypted by the home server, which only the corresponding user can decrypt. Freshness is provided against replay attacks by utilizing nonce, where the communication session has a new and random nonce and must be returned to the session's initiator. Furthermore, the previous session's information can not be added to the current session as it has a different nonce and the server keeps a record of all nonce of previous communications.

Authentication is achieved based on MACs symmetric-key authentication service shared between parties.

### 2.3.6 Telemedicine Benefits and Challenges

In the past, telemedicine services tended to be used for serving isolated, rural and inner areas. This has changed and telemedicine applications expanded to advanced levels, such as military, prison care and home-healthcare (Moore 1999). This technology provides various benefits to diverse people, such as healthcare professionals, investors, technologists and patients. Its benefits have been noticed on different occasions, for example, in healthcare for international teleconsultation and education for observing remote surgeries.

Many benefits and challenges of telemedicine have been covered in different researches. Yet, this technology attracts decision-makers to consider it despite its complexity and difficulty in deployment. The benefits of telemedicine can range from an individual level to healthcare systems to national and international level. For instance, telemedicine can support patients' healthcare, particularly those with chronic diseases and reduce healthcare expenditures for organizations and individuals. Telemedicine benefits and challenges have some similarities worldwide regardless of its context and environment (Al-Qirim 2007; European Commission International Society and Media 2009; Tithecott & Sochacki 2015). Below table 2.2 depicts these benefits and challenges that the researcher extracted from different previous studies and categorized them into different dimensions (e.g. Atac, Kurt & Yurfakul 2013; Ekeland, Bowes & Flottorp 2010 and Ward, Jaana & Natafgi 2015).

Table 2.2: Telemedicine benefits and challenges.

| Dimension | Benefits | Challenges |
|---|---|---|
| Social | - Providing unique healthcare services which might reduce mortality and morbidity rates (Atac, Kurt & Yurfakul 2013; | - Lack of trust, particularly from elderly people (Vitacca, Mazzù & Scalvini 2009). |

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|---|---|---|
| | Bowonder, Bansal and Giridhar 2005; Ward, Jaana & Natafgi 2015). | - Lack of social acceptance and dissatisfaction (Buabbas 2013; Vitacca, Mazzù & Scalvini 2009). |
| Organizational | - Therapeutic effectiveness (e.g. medical interventions) (Bowonder, Bansal and Giridhar 2005).<br>- Collaboration between professionals and share medical knowledge and experiences (Atac, Kurt & Yurfakul 2013).<br>- Enhancing continuity of care (Bowonder, Bansal and Giridhar 2005). | - Broken of reliable communication between participants (e.g. patient-physician) (Atac, Kurt & Yurfakul 2013).<br>- Process reengineering and modifying work routines (Vitacca, Mazzù & Scalvini 2009).<br>- Licensure (George, Hamilton and Baker 2012; Vitacca, Mazzù & Scalvini 2009). |
| Financial | - Cost-effectiveness by reducing costs of visiting hospitals (Al-Qirim 2007); Atac, Kurt & Yurfakul 2013; Bowonder, Bansal and Giridhar 2005).<br>- Cost of travelling to seek specialized care (Bowonder, Bansal and Giridhar 2005). | - Expensive to provide tools and devices for monitoring home cases (Bowonder, Bansal and Giridhar 2005).<br>- Insurance coverage (George, Hamilton and Baker 2012). |
| Technical | - Telemedicine would facilitate availability of services online (Al-Qirim 2007; Atac, Kurt & Yurfakul 2013).<br>- Quality of information shared (Vitacca, Mazzù & Scalvini 2009). | - Difficult and complex to practice it (Vitacca, Mazzù & Scalvini 2009).<br>- Security and privacy (George, Hamilton and Baker 2012; Atac, Kurt & Yurfakul 2013).<br>- Interoperability of systems and technologies involved (Vitacca, Mazzù & Scalvini 2009). |

| | | |
|---|---|---|
| Legal | - Telemedicine would require a defined legal framework; hence, protect users' rights (Buabbas 2013; Vitacca, Mazzù & Scalvini 2009). | - Liability of misconduct (Atac, Kurt & Yurfakul 2013; (Vitacca, Mazzù & Scalvini 2009).<br>- Lack of understanding by political and legal bodies about such technology might obstruct its progress (Vitacca, Mazzù & Scalvini 2009). |

## 2.4 Examples of Telemedicine Cases Worldwide

A systematic review was conducted to identify literature published on telemedicine from different journals and databases, such as PubMed, ProQuest and Science Direct. Also, manual search in web-based resources was executed through Google Scholar. Reference lists of the identified publications were also reviewed. Keywords used to search the relevant literature included telemedicine, telehealth, e-health, mobile health, implementation, acceptance, United Arab Emirates (UAE) and Gulf Cooperation Council (GCC). Inclusion criteria of the articles chosen were:

- Full-text in the English language.
- Studies published in peer-reviewed journals.
- Articles focusing on telemedicine from different regions of the world.
- Priority is given to studies conducted from 2000 onwards.
- Studies clearly addressing telemedicine, telehealth, e-health and/or mobile health.

The systematic search identified around 138 records, of which about 13 were included after screening the abstracts and titles of the articles to present examples of telemedicine cases. Those articles were reviewed in a full-text version for eligibility. Those excluded were due to not being relevant to the title of the research, did not meet the criteria listed above and/or were of low quality. To assess the selected studies' quality, the Critical Appraisal Skills Programme (CASP) checklist was used (CASP 2018).

Studies' characteristics (bibliographical information, study design, study population, type of ICT health pillar addressed, outcomes and recommendations) were extracted. These studies were divided into three layers: globally, GCC and UAE.

### 2.4.1 Telemedicine Globally

Below table 2.3 presents examples of studies reviewed and those conducted globally.

Table 2.3: Examples of telemedicine cases globally.

| Author/ date | Country | Study's design | Type of ICT health pillar addressed | Study subjects | Outcomes and main results | Recommendations |
|---|---|---|---|---|---|---|
| Bowonder, Bansal and Giridhar (2005) | India | Qualitative-Case study | Telemedicine | Administrative personnel and physicians. | Medical science works will be radically changed by Information Technology (IT) and telemedicine would benefit patients in terms of better care, cost-effectiveness and convenience. | Conducting detailed requirements analysis, end-user training and improving acceptance of telemedicine by increasing awareness via seminars, building up patient-physician trust, availability of |

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| | | | | | However, telemedicine in India faces some challenges, such as cultural, legal, safety and technological issues (bandwidth limitation and telecommunication infrastructure). | pamphlets in different languages and medico-legal rules are prerequisites. |
| Ekeland, Bowes and Flottorp (2012) | Not restricted to a country | Systematic review | Telemedicine | No subjects | There is a knowledge gap related to evidence of the clinical effects of telemedicine.<br>Despite that many reviews identified and argued about needing more extensive studies, there is little discussion on how larger studies may be conducted to produce clinically sufficient relevant evidence to implement telemedicine.<br>There is a concern about the quality of telemedicine researches along with debate related to the flaws and appropriate methodologies. | Need to know the reasons behind acceptance of certain services and conducting formative assessments.<br>Engaging stakeholders to assess telemedicine.<br>Objectivist and subjectivist research methodologies are needed on different aspects of telemedicine. |

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| | | | | Telemedicine effects evaluated in reviews were considered to be contingent upon users' participation, knowledge, attitudes and motivations.<br>Success and usage of telemedicine services rely not only on the technology per se but also on patients or medical staff's motivation, work efforts, and knowledge.<br>Medical technologies not necessarily undergo a strict and controlled assessment prior to use. | |
| George, Hamilton and Baker (2012) | United States | Qualitative – Telemedicine focus group | African American and Latino participants from the public. | Applied DOI Theory to assess perceptions about telemedicine.<br>Participants shared some similarities in their perceptions of relative advantages of telemedicine (e.g. telemedicine usefulness in reducing waiting time and increasing access to specialists). Yet, they had their | Tailoring introduction, marketing and implementation of telemedicine among different population before extensive introduction of telemedicine takes place. |

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| | | | | differences. For example, African-Americans had concerns about physicians' physical absence and monitoring a specialist's qualifications. In contrast, Latinos had concerns related to privacy and the availability of telemedicine to uninsured people.<br>Both groups emphasized upon two DOI factors that could shape the diffusion of an innovation: relative advantages and compatibility with past experiences. | Conducting more extensive studies in different geographical regions and different populations. |
| Wamala and Augustine (2013) | Africa | Meta-analysis | Telemedicine | Telemedicine practitioners | Several countries in Africa started implementing telemedicine technology, such as Congo and Uganda.<br>There are technological and non-technological challenges in Africa to implement telemedicine. | Motivating healthcare providers to achieve proper implementation.<br>Enhancing awareness and training.<br>Observing social, political and economic implications of technologies. |

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| | | | | | There is a slow appreciation of modern information technologies in African countries. | Underpinning technologies impacts per capita income, environment and employment. |
| Monaghesh and Hajizadeh (2020) | Worldwide (US, China, Iran, Canada, UK and Italy | Systematic review | Telehealth | No subjects | Telehealth can incorporate different organizations and healthcare situations into one virtual network.<br>Through telehealth, fighting against coronavirus can be thwart.<br>Also, it has a significant impact in preventing morbidity and avoiding the presence of the public in high-risk areas. | Telehealth should be used to fight the COVID-19 outbreak.<br>Training for healthcare professionals and patients to ultimately use telehealth tools.<br>Restructuring traditional concepts of clinical practice and using online platforms.<br>Evaluating the effectiveness of telehealth in different health areas. |

The researcher developed the below table 2.4 based on information extracted from Abd Ghani et al. (2018) study about telemedicine in different countries. However, since this current research was conducted in the UAE, particularly in MOHAP, the researcher added (UAE MOHAP) in the comparison as well.

Table 2.4: Comparison between countries related to telemedicine implementation (Adapted from Abd Ghani et al. 2018).

| Characteristic / Country | Telemedicine objective | Network | Challenges |
|---|---|---|---|
| Taiwan | Provide services on the national level for remote diagnosis, patient management, support clinical training and Continuing Medical Education (CME) for healthcare professionals. | ISDN. Broadband telecommunication networks with a bandwidth range between 128kbps to 2mbps. | Less focus on integrating and linking telemedicine with patients' electronic medical records. |
| Singapore | Increase medical care efficiency, promote health, control healthcare costs and empower citizens to manage their health. | High-speed broadband backbone with a bandwidth range of up to 622mbps. | Compared to these listed countries, Singapore faces fewer problems as the country's geographical nature and population size are not barriers. Also, it does not require a significant investment in telecommunication infrastructure. Yet, legislation and regulations aspects related to telemedicine needs improvements (Kang & Tai 2017). |

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| Hong Kong | Improve healthcare delivery as well as better availability of health information to both; healthcare professionals and patients. | Broadband Internet access with bandwidth from 384kbps and above. | Integration with existing healthcare systems. |
| Canada | Mitigate healthcare challenges. | ISDN lines. Bandwidth range from 128kbps to 2mbps. | Integration with existing clinical information systems. |
| United Kingdom | Manage minor injuries and share long-life electronic health records. | ISDN line. Broadband telecommunication range from 128kbps up to 2mbps bandwidth. | Integration with existing healthcare systems. |
| Malaysia | Support the future of the healthcare system and provide accessible and affordable healthcare. | Virtual Private Network (VPN) used with bandwidth ranging from 64kbps to 2mbps, while 100mbps used for the Local Area Network (LAN) of the hospital. | Readiness and costs to provide advanced infrastructure. |
| UAE MOHAP | Improve the healthcare system, cover shortage in specialities and reduce related costs. | The bandwidth required is at least 8mbps, with ideally 4mbps dedicated for the Tele-ICU solution. | No Uninterruptible Power Supply (UPS). Integration with other existing telemedicine solutions in the country. |

Below table 2.5 depicts telemedicine integration characteristics among these countries. Here the researcher added as well UAE MOHAP to the comparison.

Table 2.5: Telemedicine integration characteristics among countries (Adapted from Abd Ghani et al. 2018).

| Integration characteristics | Taiwan | Singapore | Hong Kong | Canada | United Kingdom | Malaysia | UAE MOHAP |
|---|---|---|---|---|---|---|---|
| Delivering telemedicine services by using central EMR as a base for integrating/sharing health information. | No | Yes | No | Plan | Plan | Plan | Yes |
| Integration of telemedicine into existing healthcare delivery services instead of establishing new separate telemedicine centres. | No | No | No | Plan | Plan | Plan | Yes |
| Integration between telemedicine services (e.g. teleradiology and telepathology). | No | No | No | Plan | Plan | Plan | No |
| Telemedicine can be integrated with the existing application system (e.g. HIS). | No | No | No | No | Yes | Plan | Yes |
| Network integration. | No | Yes | Yes | Yes | Yes | No | Yes |
| Integration with the legacy system. | No | No | No | No | No | Plan | No |
| Using portable devices to integrate patient health records across healthcare levels (e.g. smart cards) | No | No | Yes | No | No | Yes | Yes |

As it can be noticed from above table 2.4, the objective of implementing telemedicine is similar across countries which is mainly to improve the healthcare system. Likewise, the challenges across them were as well similar. The common challenge was integration. Lack of integration with patients electronic medical records across healthcare institutes and thus having centralized electronic medical records impact telemedicine's objective to provide seamless care without boundaries. These issues are still occurring in different settings, such as Hong Kong and Canada (Abd Ghani et al., 2018).

Table 2.5 depicts comparisons about telemedicine integration characteristics in seven countries. From these scenarios, different lessons can be learned and choosing best practices that fit the UAE context. For instance, telemedicine should be a nationwide initiative and designed with flexibility and scalability capabilities. Also, it should not be developed separately from existing systems, processes and activities. Other lessons can be learned, such as focusing on crucial functions to be included in telemedicine as it is not possible and achievable to have all functions in a single short term. This would increase as well acceptance and reduce integration issues.

Furthermore, having disparate systems would aggravate integration and interface issues, particularly when there are other legacy systems. Such issue would impact telemedicine sustainability in the long term. Additionally, centralising patients’ medical records on the national level would facilitate creating a Patients' Lifetime Health Records (PLHR) repository that is scalable, interoperable, and accessible across and from different platforms by healthcare professionals and patients.

### 2.4.2 Telemedicine in the Gulf Region

Below table 2.6 presents examples of studies reviewed and conducted in the Gulf Region.

Table 2.6: Examples of telemedicine cases in the Gulf Region.

| Author/ date | Country | Study's design | Type of ICT health pillar addressed | Study subjects | Outcomes and main results | Recommendations |
|---|---|---|---|---|---|---|
| El-Mahalli, El-khafif and Al-Qahtani (2012) | Kingdom of Saudi Arabia (KSA) | Cross-sectional | Telemedicine | Healthcare professionals | Demographic variables indicated a significant association with willingness to use telemedicine among telemedicine adopters but not among non-adopters.<br>The non-adopters of telemedicine showed higher perceptions about telemedicine's benefits compared to the adopters.<br>The non-adopters had concerns about barriers to use telemedicine (e.g. lack of knowledge about the technology | Dissemination of information via national programs, awareness, education and training for healthcare professionals.<br>Restructuring healthcare professionals' works.<br>Better utilization of existed telemedicine networks. |

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| | | | | | and its benefit). Lack of knowledge was the main barrier for the adopters as well. | |
| Buabbas (2013) | Kuwait | Mixed research design | Telemedicine | Physicians, patients, policymakers and IT managers. | Telemedicine has demonstrated to be feasible and effective in delivering similar quality of healthcare as to conventional methods. Telemedicine is a supportive tool to provide healthcare services. Patients' education level had an impact on awareness of telemedicine, but other demographic characteristics (age and gender) did not show any significant relationship with willingness to use telemedicine. Some concerns were raised related to telemedicine, such as privacy, confidentiality and the ability to use the system easily and effectively. | Observing how a system works and piloting would increase trust and facilitate understanding its benefits. It needs to be user-friendly to facilitate procedures. Policymakers should learn lessons from past experiences worldwide to avoid those problems and ensure successful implementation and sustainability. Involvement of healthcare providers, coordination and cooperation between stakeholders to provide feedback related to the technology. |

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| | | | | | Physicians expressed two main factors that may impact telemedicine adoption: lack of training and negative attitude of individuals involved in the implementation process.<br>Lack of understanding of technology readiness can be an essential reason for the failure of telemedicine programs.<br>Policymakers interviewed stated that unpreparedness of the technical infrastructure is an obstacle to telemedicine. | Assessing organizational needs and providing funds that match the needs and size of services. |
| Weber et al. (2017) | GCC Countries | Systematic review | e-health | No subjects | Since 2000, all GCC countries have made significant investments in telecommunications and electronic health infrastructure.<br>All GCC countries have a national e-health strategy. | Conducting studies about e-health while considering religion and gender factors.<br>Conducting rigorous controlled studies to elucidate the effectiveness of e-health in improving healthcare outcomes, cost |

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| | | | | | KSA and UAE were the first among GCC countries to implement modern telemedicine; beyond simple telephone consultations. | reduction, educational usefulness and efficient workflows. |
| Al-Samarraie et al. (2020) | Middle eastern countries | Systematic review | Telemedicine | No subjects | Telemedicine progress varies across middle eastern countries.<br>Various barriers prevent telemedicine from being fully used, such as: cultural, legal and technological.<br>Telemedicine has dramatically changed in these countries due to demands on healthcare and technological developments. | Availability of simplified systems and should be user friendly and effective.<br>The technology should be adapted to the existed technological capacities and infrastructure.<br>Developers should ensure health data are successfully processed and transmitted across different healthcare platforms.<br>Adopting Cloud computing technologies to collect, analyse, present and visualize data. |

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| | | | | | | Understanding cultural needs by involving key users in the development and deployment of telemedicine. |
| Waqas et al. (2021) | Arab countries | Quantitative-scientometric analysis | Telemedicine | No subjects | There is a disparity in digital health research in the Arab Region.<br>Telemedicine research is still in its infancy stage.<br>There is a lack of controlled trials of medical devices, telemedicine and different algorithms in the Arab world.<br>Gender, religion and ethics have impacts.<br>Security, confidentiality and privacy are important concerns. | Conducting qualitative studies to explore end-users preferences to increase acceptability.<br>Boosting e-health literacy and readiness to embrace technologies.<br>Developing policies and roadmaps for digital health programs implementation. |

### 2.4.3 Telemedicine in the UAE

Below table 2.7 presents examples of studies reviewed and conducted in the UAE.

Table 2.7: Examples of telemedicine cases in the UAE.

| Author/ date | Country | Study's design | Type of ICT health pillar addressed | Study subjects | Outcomes and main results | Recommendations |
|---|---|---|---|---|---|---|
| Goldberg et al. (1994) | UAE, KSA and USA | Qualitative | Telemedicine | Healthcare professionals | The video links for UAE were highly reliable, but for KSA, the bandwidth was marginal with some downtimes.<br>Telemedicine was well received by both; UAE and KSA.<br>Telemedicine offers potentials for healthcare delivery worldwide. | Conducting cost-benefit analysis of telemedicine.<br>Using existing telecommunication infrastructures to provide affordable access to telemedicine. |
| Al-Qirim (2007) | UAE | Qualitative | Telemedicine | Experts involved in telemedicine (e.g. surgeons | Telemedicine and telehealth terms are not widely recognized in the UAE. | Providing training, learning and motivation to increase acceptance. |

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| | | | | and IT professionals) | Tawam Hospital, Al-Mafraq Hospital, UAE University (UAEU) and Higher Colleges of Technology (HCT) were the only ones that adopted telemedicine.<br>Telemedicine as a medical tool was being adopted at a minimal level while it was well-noted for educational and administrative purposes.<br>Concerns raised were about the security and accuracy of the information collected via telemedicine compared to on-site. | Learning from other telemedicine experiences in the region.<br>Initiating more comprehensive and interactive telemedicine projects in the country.<br>Considering telemedicine as one of the strategic and national health programs.<br>Conducting more consequent studies to monitor the progress and development of telemedicine technology and research field in the UAE. |
| Pearl et al. (2014) | UAE and USA | Qualitative | Telemedicine | Healthcare professionals | International consultations using telemedicine is a | More training.<br>Coordination with local services on-site. |

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| | | | reliable and productive method.<br>The technology provides clinical and interdisciplinary expertise to patients and families which might not be available on-site.<br>Video and audio sessions simulated the typical experience as to patient-physician experience. |

#### 2.4.3.1 Current Status of Telemedicine in the UAE

**a. Abu Dhabi Telemedicine Center**

In 2014, Mubadala Development Company in Abu Dhabi announced the opening of the Abu Dhabi Telemedicine Center as a joint venture between the Abu Dhabi Emirate and a Switzerland telemedicine provider (Medgate). Abu Dhabi Telemedicine Center was established to serve UAE residents who have Daman insurance card. According to the patient's insurance plan, the teleconsultation service is provided for non-emergency cases and covered by Daman Insurance. The service is aligned with Abu Dhabi Department of Health (DOH) policies. It is a mobile application [TeleMed] and the service is available 24/7 as well as through the landline (8004959). TeleMed can be used as a call or video conference to share images of medical conditions; when applicable (e.g. skin rash) (Abu Dhabi Telemedicine Center 2016). Users can access their care plan, book telemedicine sessions, share reports and search for nearby physicians, pharmacy and healthcare institute. The platform is available in two languages, Arabic and English, as well as there are different registered healthcare professionals who speak different languages and is indicated in their profiles (Abu Dhabi Telemedicine Center 2016).

**b. Dubai Health Authority (DHA) Telemedicine**

At the end of 2017, DHA announced its pilot telemedicine technology as part of its strategy for 2016-2021. A regulatory framework for telemedicine was as well placed since then (Zain 2019). According to the Health Regulation Sector CEO at DHA, standards for telemedicine were put based on the Federal Law Decree No. (4) of 2016 related to medical liability.

As part of His Highness Sheikh Mohammed bin Rashid Al Maktoum, Vice President and Prime Minister of the UAE and Ruler of Dubai; Fifty-Year Charter, Article 5 “A doctor for every

citizen", a distinctive model for telehealth services which includes 7 main components was placed: (Gulf News 2019):

- Providing medical consultation via telehealth services.
- Using electronic medical records.
- Using telemedicine to prescribe medications.
- Raising awareness on how to use medical devices (e.g. thermometer, blood pressure and blood glucose devices) for initial diagnoses.
- Investigating the ideal options to apply the model to provide telehealth services free of charges.
- Incentivizing the use of telemedicine services through developing packages.
- Developing a proper legislative framework for the provision of telemedicine services in the emirate.

DHA signed with 3 private hospitals to collaborate on providing telemedicine services (Nazzal 2019). The provided telemedicine service is based on video conference sessions and focused on eyes diseases, smart home care and smart headaches clinics. Various tools are used to provide telemedicine services and connect healthcare professionals across DHA institutes, such as digital retina cameras and ROBODOCS, a robot where healthcare professionals at different locations can consult together. Also, users can download the application from smart devices applications stores. However, telemedicine sessions are appointment-based system.

Other functionalities users can benefit from DHA telemedicine are: sharing images of the medical condition, when applicable (e.g. skin pigmentation), providing care plan and referring the patient to another hospital/clinic. The platform is available in two languages; Arabic and English.

The platform for telemedicine is included in the DHA app, which means no need to download a separate application for telemedicine service and reduce device storage space (Abdel Hamid 2019).

In 2017, DHA published its Administrative Decision No. (30) of 2017 about approval of telehealth services regulation (DHA 2017) and in 2019, published a document related to standards for telehealth services which includes details of telehealth services, related definitions, scope, inclusion and exclusion cases, types of telehealth services as well as other aspects (DHA 2019). The standards were placed in accordance with the federal law in the UAE and local law in Dubai Emirate.

DHA was the only authority in the UAE that created clear and comprehensive standards document related to telemedicine technology. However, compared to the Abu Dhabi telemedicine service, this need to be improved where a direct call or video conference can be initiated instead of scheduled sessions.

**c. Dubai Healthcare City (DHCC) Telemedicine**

In 2019, DHCC announced its first regulated telemedicine technology with GetBEE Company for live consultation (video conferencing) and Remote Patient Monitoring (RPM), connecting patients and licensed physicians remotely as part of Fifty-Year Charter (Ismail & Bashir 2019).

The platform is a web-based service that enables customers (e.g. patients) to receive healthcare at their convenience, with flexibility and from the comfort of their location. Also, it allows customers to choose a physician based on their preference, such as physician's gender and spoken language, speciality and time of availability. It is available in English. Registration is free

of charge and the process is simple, but it does need more security measurements, such as verification (e.g. CAPTCHA).

**d. Ministry of Health and Prevention (MOHAP)**

MOHAP infrastructure readiness:

As per the MOHAP facilities infrastructure readiness report in 2018 (UAE MOHAP 2018), in terms of network infrastructure readiness, devices availability, Etisalat Multiprotocol Label Switching (MPLS) link and Health Information System (HIS) implementation, all MOHAP hospitals are ready and the majority of its healthcare centres are as well ready except for few sites; particularly in Al-Fujairah Emirate due to devices not fully procured, difficulty in placing fibre optics, pending HIS implementation, infrastructure maintenance not completed and cabling not done. However, these issuers are expected in technologies implementation, particularly for advanced technologies, such as telemedicine, but are not obstacles for MOHAP to proceed with their technological projects.

Telemedicine technology started in MOHAP in 2017 by being implemented in two sites (Al-Qassimi and Kalba Hospitals) for Intensive Care Unit (ICU) service to manage critical cases; where physical transfer of patients is a risk, share knowledge between experts and online patient portal. MOHAP plan between 2019 and 2021 was to expand its telemedicine technology scope by including other services (Tele-Rheumatology and Home Care: Remote Access) (UAE MOHAP 2019a).

Tele-ICU provider is Philips and installed on the desktop. Currently, telemedicine service is only used by healthcare professionals. The technology is synchronous telemedicine (real-time video-conference). The platform is available in English. The below technical details describe MOHAP Tele-ICU technology:

- Connectivity:
  a. Bandwidth
    - The bandwidth required is at least 8 MBPS with ideally 4MBPS dedicated for the Tele-ICU solution.
  b. Internet (e.g. Wi-Fi/cable Ethernet)
    - The application runs within the MOHAP intranet. According to a member from the vendor side, “it is preferred to have the connectivity to be on Ethernet” (Ganapa 2019).
  c. Networking

    Figure 2.10 illustrates a brief overview of how the current Tele-ICU technology is set up in MOHAP:

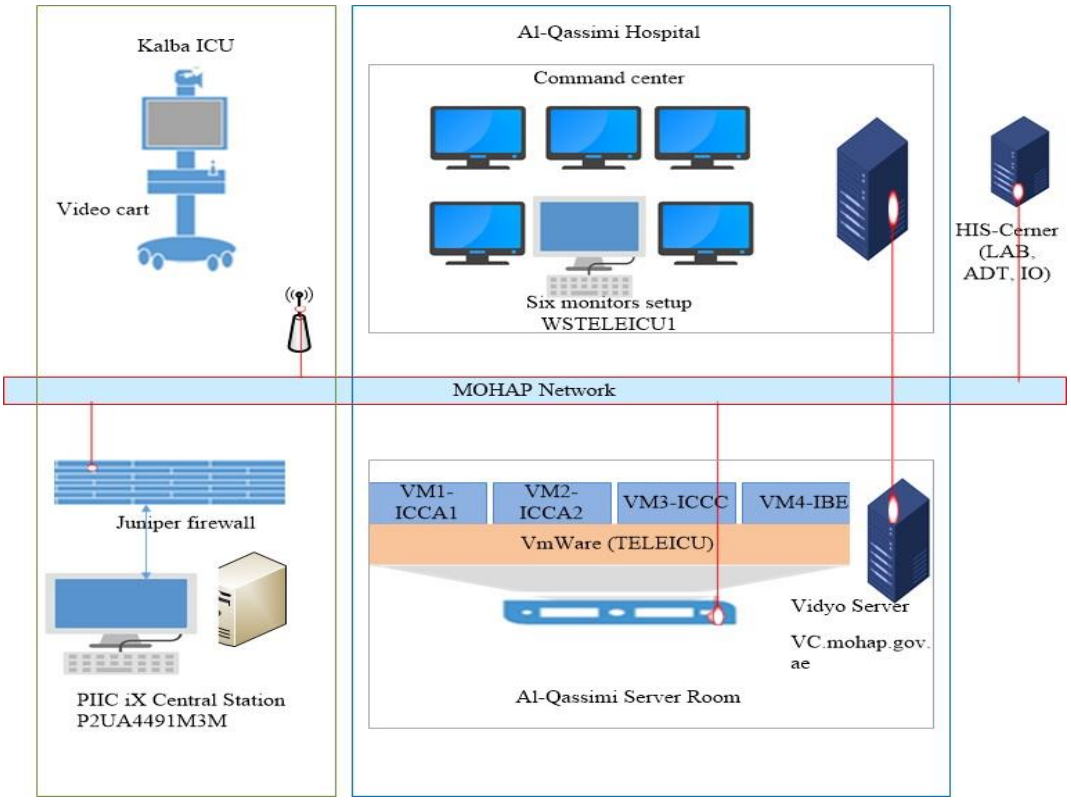



Figure 2.10: Tele-ICU technology setup in MOHAP (Adapted from Ganapa 2019).

- Other technicalities:

a. Installation

- The application is installed on virtual machines (VM). There are currently 4 VMs, as shown in figure 2.10. The installation is done on Windows Server Operating System and SQL database is used.

b. Access privilege

- The application is linked with the Hospital Active Directory and therefore, users are given access based on their profile, for example, physicians, nurses and admin users.

c. Licensure

- For human resources to practice telemedicine, licensing is done as per the MOHAP licensing process and UAE laws.
- For telemedicine (Tele-ICU) products, the licenses are based on the number of ICU beds connected.

d. Security measurements used

It is client-server architecture. The client needs to be installed on the system and then configured in the application for giving access. As the system is within the domain, all the security policies of MOHAP were applied to the client's system, too, such as Internet Protocol (IP) security, certifications, identity and access management, application whitelisting and cryptography (e.g. time stamping).

e. Maintenance

The maintenance is done to ensure that the system is working as required. It is ideally recommended a backup server which is located at the MOHAP datacenter. Issues raised can be resolved through on-site support via VPN access.

f. Telemedicine integration with Health Information Systems (HIS)

The Tele-ICU solution is interfaced with the current HIS. Patients' clinical events data are received from HIS and automatically shared with Tele-ICU based on HL7 messages, as depicted in figure 2.11.

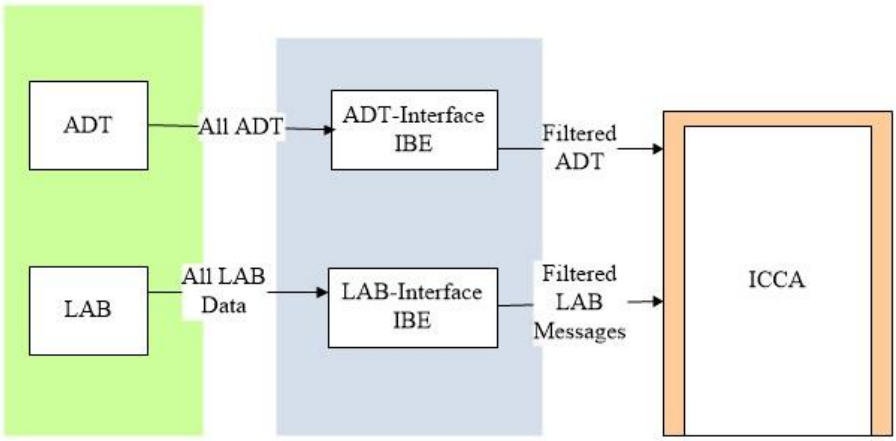



Figure 2.11: Tele-ICU ADT interface

(Adapted from Ganapa 2019).

- Features:

a. Does it work only on desktop computers/ Workstation on Wheels (WoW)/ laptops?

The clients can be installed on Windows PC/laptop or workstation. The Tele-ICU solution needs a dedicated workstation with multiple screens to provide users with the necessary information for providing the appropriate care.

b. Is it web-based or installed software?

Server-client system. Need to install the application locally.

c. Can users import/export files?

There are options to export documents, such as Portable Document Format (PDF). The system supports the HL7 interface for exchanging different information between HIS and Tele-ICU solution.

d. Can users scan files and upload it?

The system can be configured to upload scanned files or PDF documents.

e. How can users get assistance/support?

The application has help files in the toolbar. Training is provided to users, as well as the availability of on-call support for any queries.

f. How are cases (e.g. patients) monitored?

Patients can be seen directly via audio/video communication and healthcare professionals (consultations site) can talk to patients and the clinical users at the bedside. Patients' vitals are monitored and charted in real-time by the application, including patients' review data, as illustrated in figure 2.12.

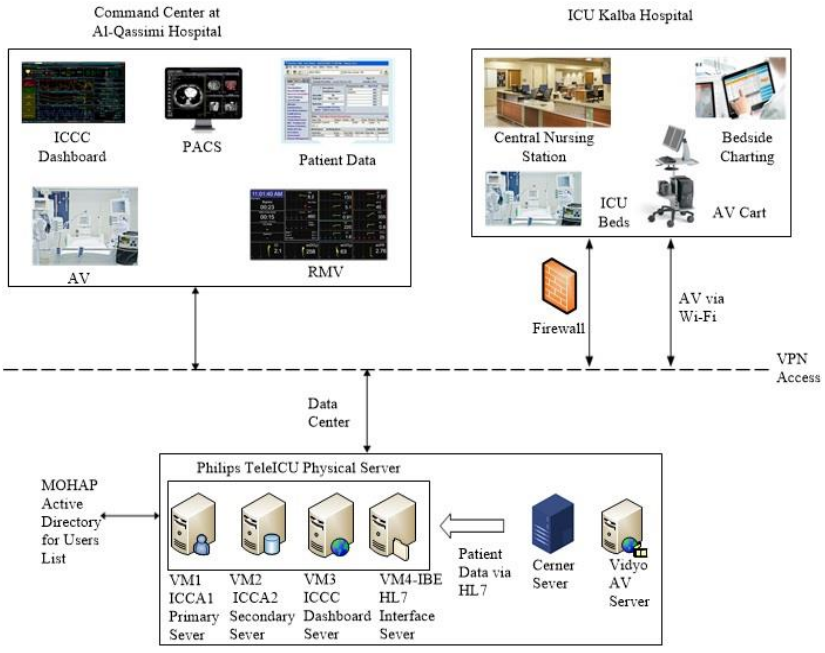



Figure 2.12: MOHAP Tele-ICU solution (Adapted from Ganapa 2019).

In 2019, MOHAP started to implement telemedicine for rheumatology speciality between Shaam Hospital in Ras Al-Khaimah and Al-Kuwait Hospital in Dubai and later on will be rolled out across other hospitals (Al Ali 2019). In the same year, UAE Government approved a federal law related to Using Information and Communication Technology in Healthcare No. (2) of 2019 (UAE MOHAP 2019b), as well as the UAE Cabinet approved the Annex of the Cabinet Decree No. (40) of 2019 concerning the Executive Regulations of the Federal Law Decree No. (4) of 2016 on Medical Liability (UAE MOHAP 2019c) which includes providing telemedicine services. Along with existed laws and regulations, there is a need to create a detailed and thorough standards document similar to DHA standards in each healthcare entity aiming to provide telemedicine services

Overall, UAE is advanced technically, which is evident from different international reports (e.g. ICT Development Index) and the country's infrastructure (TRA 2016). Also, various technologies initiatives are implemented, such as robotic surgery and virtual care. The researcher developed the below table 2.8, which presents the social technical gap in the UAE related to telemedicine (Jefee-Bahloul 2014; Al-Samarraie et al. 2020; Waqas et al. 2021).

Table 2.8: UAE telemedicine social technical gap analysis.

| Gap<br>Aspect | Social | Technical |
|---|---|---|
| Geographical structure of the UAE | Urban and rural people might vary in their acceptance of telemedicine in the UAE. Usually, the urban population has a higher tendency toward accepting technologies. | Telemedicine might be challenging to implement in mountain areas; compared to cities. |
| Individuals | UAE society includes diverse age groups, traditions and cultures, education levels, nationalities, ethnicities and computer | Computer literacy varies among the UAE population due to differences in age groups and education levels. |

| | | |
|---|---|---|
| | literacy levels. These need to be well considered before telemedicine implementation takes place.<br>Social acceptance and trust in telemedicine.<br>Different levels of knowledge, perceptions, awareness and motivation. | Availability of technical support 24/7 would require extra human and capital resources. Also, availability of medical personnel.<br>Confidentiality, privacy and security remain as main concerns for the majority of people. |
| Financial | Diverse levels of individuals' incomes and expenditures.<br>Beliefs in spending money on telemedicine services compared to physical interaction with healthcare professionals. | Financial government support is not a barrier in the UAE. However, insurance coverage and reimbursement for telemedicine services could vary across the population.<br>Covering expenses related to software update, upgrade, maintenance and acquiring related products for effective use. |
| Skills | Telemedicine would require computer literacy to use, such as familiarity and knowledge with portable devices.<br>Elderly people might require assistance. | Telemedicine would require personal technical skills to use as well as technical experts to provide support to users and handle issues. |
| Infrastructure | Households with internet access and personal computers would not be barriers, particularly to people living in the urban areas. Still, reliable Internet connectivity and high bandwidth might be interrupted in mountain areas. | UAE infrastructure (e.g. electricity and networking) is available and ready for telemedicine implementation. However, some mountain areas might hinder technology implementation. |
| Technology usage | Generally, technologies usage is evident in the UAE, but it might differ for telemedicine for several reasons, such as lack of knowledge, experience, and trust. | UAE is advanced and has a high level of technologies usage. Yet, systems easiness and quality need to be monitored and evaluated routinely. |

## 2.5 Wireless Medical Environment in 2050s

By 2050, the world population is estimated to reach around 10 billion. Such increasing would have various significant impacts, such as inadequate infrastructures, especially hospitals to cover growing demands on healthcare services as resources would not be proportional to the population's ongoing growth (Roser 2019). Also, difficulty in providing adequate nutrition to the world's population as a whole. Hence, extreme challenges are posed, such as: requiring huge expenses and the rise of chronic diseases. As a result, decision-makers are migrating healthcare services toward virtual care, which is becoming more feasible due to emerging of innovative technologies and telecommunication tools (Malik et al. 2018).

According to Malik et al. (2018), one of the latest technological inventions that many vendors are looking to explore is Global Internet Access using direct communications with low-earth-orbit satellites. Such invention is expected to change the scenario of human thinking as it would enable remote areas to be connected to the rest of the world and compel governments to embrace it as lower expenses would be required to provide services, such as healthcare by delivering care at home, reducing loads on hospitals and resources…etc.

Additionally, medical equipment is expected due to such invention to gradually evolve into autonomous and portable units with independent communication mechanisms. For medical equipment to be completely autonomous, it needs to be self-efficient related to power capabilities that do not rely on local grid-power supplies or generators. Such independent power abilities would be vital in situations where infrastructure is likely to be devastated. Also, advancements in solar technology (e.g. perovskite), battery/ storage cell technology (e.g. wonder material: graphene) and energy consumption for devices (e.g. 24/7 connectivity performing functions needed with reduced power consumption) would make more feasible independent power abilities (Malik et al. 2018).

The positive impacts of improvements in these domains will be reflected as well in the healthcare field. Demands for healthcare services will be less as these services would be moved to patients' home/remote communities. Also, less exposure to infections and pandemics (e.g. COVID-19) from other patients in the healthcare entity and more comfort by staying in a familiar environment. Furthermore, providing healthcare services in disaster situations without being worry about power-blackouts consequences.

However, moving medical equipment to patients' homes/remote communities and expansion of networked medical devices would require a greater focus on security triad (confidentiality, integrity and information availability) from being compromised. For instance, mitigation of vulnerabilities related to data-in-transit and data-at-rest by having in-built functionalities within medical units, quantum cryptography and isolation from homes/communities' modems as these are highly likely insecure as well as a review of past medical data security breaches and propose improvised policies and communication frameworks. In addition, a study by Abd Ghani et al. (2018) stated that the design of technology (e.g. telemedicine) should be flexible and capable of handling telecommunication limitations when they occur, such as network disruption. For instance, in synchronous telemedicine, the service requires the availability of a reliable telecommunication network between parties involved and physical attendance of involved parties at a scheduled time in front of the video device. This requires finding alternatives to avoid discontinuity of care due to inadequacy of telecommunication network and system downtime.

## 2.6 Theories and Models

According to Wade, Gray and Carati (2017), little attention is paid to theories. This could be due to the belief that theories can be added in results interpretations. Different models and theories have been explored and implemented in the information technology field. Some of them are based on other theories implemented in other fields than information technology. For instance, Coiera (2007) discussed how Human-Computer Interaction (HCI) Theory provides the means to study people works and users' needs that can be translated into interaction design which would describe human and computer working together. "Occasionally, in clinical works, what is presented as an STS analysis is an HCI analysis" (Coiera 2007).

Action Theory which is used in HCI as well analyses the relationship between subjects and objects, which is mediated by tools (technical instruments) or signs (psychological instruments). Also, it emphasizes the role of the community (e.g. rules and rituals). This theory has three levels of activity [activity, actions and operations] (Beaudouin-Lafon 2012).

In addition, Technology Acceptance Model (TAM) is driven from previous models, such as the Theory of Reasoned Action (TRA) and proven over time to be a reliable model. Below are examples of models and theories used to evaluate technologies' usage behaviour and acceptance as well as minimize as much as possible undesired consequences with the justifications for choosing TAM and Rogers Diffusion of Innovations (DOI) Theory in this research.

a. Theory of Reasoned Action (TRA)

Fishbein and Ajzen developed it in 1975 to understand how users' beliefs and attitudes are related to their intentions to perform, as illustrated in figure 2.13. It formed the basis for TAM.

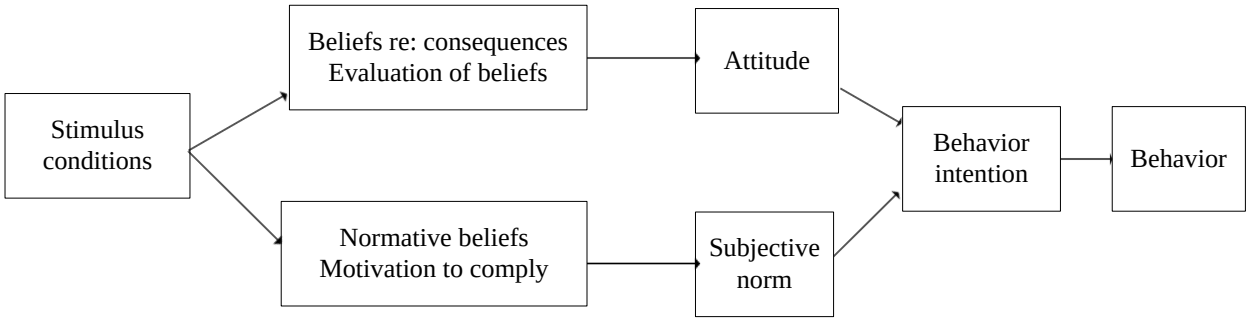



Figure 2.13: Theory of reasoned action (Adapted from Jensen 2002).

b. Technology Acceptance Model (TAM)

Davis developed it in 1989. External variables in TAM could be any factors not explicitly included in the model (e.g. system design), as depicted in figure 2.14.

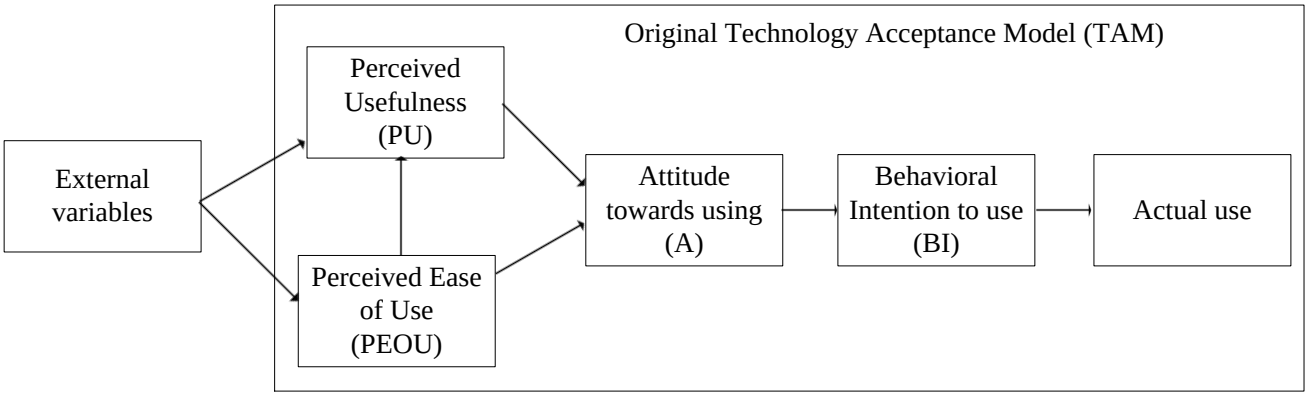



Figure 2.14: Technology acceptance model (Adapted from Jensen 2002).

c. Theory of Planned Behavior (TPB)

This theory was adapted by Ajzen in the 1980s from TRA. In TPB, a third antecedent of intention "perceived behavioural control" was added as depicted in figure 2.15.

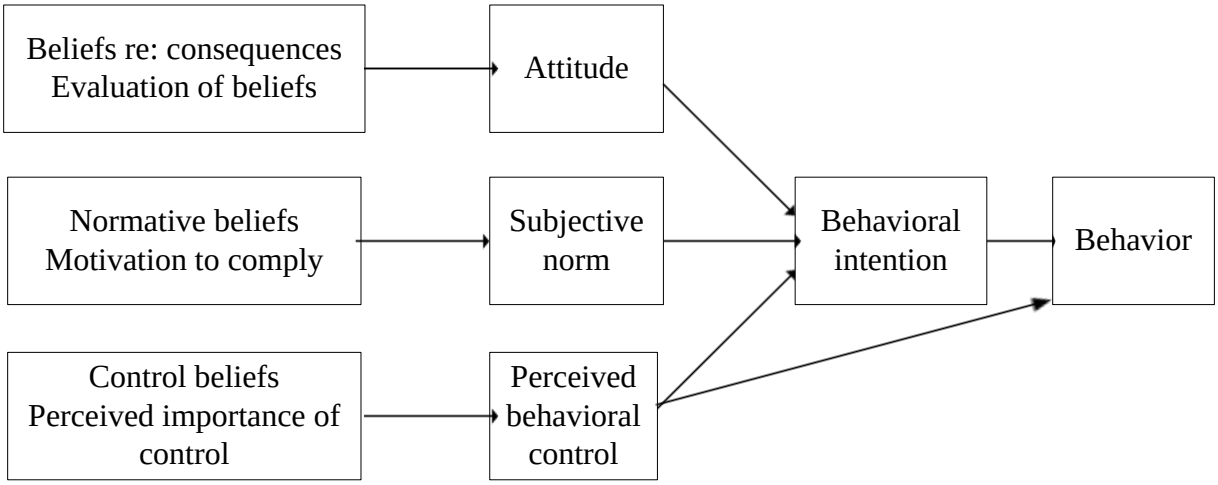



Figure 2.15: Theory of planned behaviour (Adapted from Jensen 2002).

### 2.6.1 Technology Acceptance Model (TAM)

In the late 1980s, Fred Davis proposed Technology Acceptance Model (TAM) to explicate and predict users' behaviours in using technologies and systems, particularly users' acceptance. TAM is widely used in the Information Technology (IT) field to understand technologies acceptance and usage.

Different theoretical foundations for TAM's core constructs (PU and PEOU) existed a time ago. For instance, Robey (1979); cited in Davis (1989) stated that systems which do not help people performing jobs are not likely to be favourable even with careful implementation efforts. Also, self-efficacy theory; where "judgments of how well a person can perform courses of actions to deal with prospective situation" (Bandura 1982; cited in Davis 1989). There are other theoretical foundations that Davis used it to develop his model, such as diffusion of innovations theory and channel disposition model. However, TRA formed the basis for TAM.

According to Liu (2014), TAM is an extension of TRA, which is a psychosocial theory that attempts to explain people's actions by recognizing the causal connection between different components: beliefs, attitudes, intentions and behaviours. In contrast, TAM is a theory in

information systems discipline to model the ways users accept and use technology. TAM theorizes that a person's behavioural intention to use a technology or system is determined by two beliefs: PU and PEOU. In 1993, Davis theorized that actual usage of an information system is determined by Behavioural Intention (BI), which is jointly determined by the users' attitudes and PU toward using the system. Also, TAM theorizes that the impacts of external variables (e.g. training and systems' characteristics) on intention to use are mediated by PU and PEOU (Venkatesh and Davis 2000). Hence, PU is defined as "the degree to which an individual believes that using a system or technology would improve his/her job performance". In contrast, PEOU is defined as "the degree to which an individual believes using a system or technology would be free of efforts" (Davis 1989). Attitude towards using is defined as "the degree of evaluative effects that individuals correlate with using a system in their job" (Davis 1993).

However, TAM has some limitations. For instance, behaviours can not be reliably quantified in empirical investigations as various subjective factors might impact behaviours, such as social values, norms and personal attributes (Ajibade 2018). Though, different settings, systems, technologies as well as different types of users might cause variations in TAM relationships. So, this does not mean it is imperfect.

#### 2.6.1.1 Original TAM Case Study

In 1989, Davis camp-up with TAM and tested his model in two case studies with separate systems (study one: PROFS electronic mail and XEDIT file editor, while study two: Chart-Master and Pendraw). In study one, 120 participants from IBM Canada's Toronto Development Laboratory were asked to complete a questionnaire rating usefulness and ease of using PROFS electronic mail and XEDIT file editor. The response for each statement in the questionnaire was

based on agreement-disagreement level; ranged from strongly agree to strongly disagree (7-point Likert scale) and the response rate was 93%.

The PU scale scored Cronbach's alpha reliability of 0.97 for both systems; pooled and for PEOU was 0.91. Correlations tests and regression analysis were conducted and results indicated a significant correlation of usage with PU and PEOU in both systems. The regression analysis was performed to measure the effect of PU and PEOU on usage and it indicated that the effect of PU was significant when PEOU was controlled, while the effect of PEOU was not significant when PU was controlled. According to Davis (1989), in situations where there is a prototype testing or system selection, "potential users are typically given a brief demonstration; less than one hour to interact with a candidate system. Then, those are asked to rate usefulness and ease of use they would anticipate from the system being rated".

In study two, 40 students from Boston University were involved and at the same time were full-time employees in different industries (e.g. health, finance and manufacturing). To evaluate behavioural expectations about the usage of the technology, Davis (1989) utilized a 7-point Likert scale by asking the students to rate "I predict that I will use it on a regular basis in the future". The PU scale scored Cronbach's alpha reliability of 0.98 for both systems; pooled and for PEOU was 0.94. The results in study two indicated that usage was correlated with usefulness across both systems as well as with ease of use. Additionally, ease of use was correlated with usefulness. However, the significance of usefulness- use correlation was greater than ease of use- use correlation.

Furthermore, in study one, PU was correlated 0.63 with self-reported use and in study two, 0.85 with self-predicted use. Whilst, PEOU in study one was correlated 0.45 with use and in study two was 0.59. Overall, the regression analysis indicated that the effect of usefulness on usage was

significant when ease of use was controlled, while the effect of ease of use on usage was borderline significant when usefulness was controlled. The findings from both studies indicated that the effect of ease of use on usage was mediated by usefulness and "usefulness had a significantly greater correlation with usage behaviour than ease of use" (Davis 1989).

Davis (1989) concluded his findings that research on how usefulness and ease of use can be effected by external factors, such as training, systems' characteristics and users' involvement in the design phase is important.

#### 2.6.1.2 TAM Application Case Studies

Researches that have been conducted applying TAM in different industries, such as business (Davis 1993), air force (Jensen 2002), education (David, Bagozzi and Warshaw 1989) and transportation (Liu 2014), used similar data collection tools (e.g. questionnaire) and achieved high Cronbach's alpha reliability for TAM constructs $\geq 0.70$, which means that the questions used to measure TAM constructs were internally consistent and reliable. Their findings were almost similar in that systems' characteristics influence perceived usefulness, perceived ease of use and attitude towards using it. Also, there is a strong relationship between perceived usefulness and perceived ease of use. Furthermore, the main determinant of people's intentions to use computers/technology is PU and there is a need for future research to examine other external variables and their role within TAM, such as users' involvement, training, system familiarity/experience and complexity.

#### 2.6.1.3 Extended Version of TAM

Although there is an extended version of TAM known as TAM2, which includes additional constructs, such as subjective norm, voluntariness and image…etc. These were not included in the original model due to its insignificant effect on using a technology according to some previous

studies (e.g. Mathieson 1991), as well as having minimum relevance in explaining human behaviours in settings where technology usage is not mandatory (Venkatesh & Davis 2000). Yet, studies found subjective norm to significantly affect technology usage (e.g. Taylor & Todd 1995).

Venkatesh and Davis (2000) conducted a longitudinal study and applied TAM2 in different settings; mandatory and voluntary usage of technology. They found that PU was the primary factor in acceptance and PEOU was statistically significant but to a lesser level. This result was found as well in other previous works that adopted the original TAM (e.g. Davis 1989, Davis, Bagozzi and Warshaw 1989 and Jensen 2002). Also, the effect of subjective norm was less than PU and PEOU.

Different studies attempted to extend the original TAM by adding external variables to study the effect of these variables on attitude, behavioural intention to use and technology usage. For example, Fathema, Shannon and Ross (2015) added and examined systems' quality as an external factor. The extended models shared the main constructs of the original model. Furthermore, other researchers tried to integrate the main competing acceptance models in one model, such as Unified Theory of Acceptance and Use of Technology (UTAUT), which is based on 8 models (e.g. TAM, TRA, DOI theory…etc.) (Lescevica, Gintersa & Mazza 2013).

### 2.6.2 Diffusion of Innovations (DOI) Theory

According to Rogers (2003), researches on the diffusion of innovations started during the 1940s and 1950s. The main foundations of the diffusion model were: "the Frenchman Gabriel Tarde, the German Georg Simmel as well as the German-Austrian and British diffusionists".

"Diffusion research contributions have reached a point where these contributions are highly regarded in terms of providing a theoretical understanding of human behaviours changes and giving rise to more effective social changes programs around the world" (Rogers 2003).

DOI Theory by Rogers in 1962 has as said multiple disciplines, such as; sociology and anthropology. It is used to know the spread of a new idea or technology by answering how/why/what. The theory consists of four elements:

- The innovation and defined as a new idea, object or practice that individuals or units perceived it as new. Perceived newness of innovation plays a role in determining individuals' reaction toward it. Newness is not just about new knowledge; it might be expressed in terms of persuasion, decision or knowledge. For instance, an individual might have knowledge about technology (e.g. telemedicine) but still did not develop an attitude (e.g. favourable or unfavourable) towards it.
- Communication channels: for example, mass media to create awareness-knowledge. Also, interpersonal channels (e.g. face-to-face communication). This type of channel is more effective in convincing individuals to accept innovation. Furthermore, interactive communication through the Internet has become more crucial in recent decades to diffuse certain innovations.
- The time element is involved in the innovation-decision process, which consists of several steps, such as knowledge, persuasion and implementation, as well as in the rate of adoption. At first, few individuals adopt an innovation in a time and then more individuals adopt it and eventually, the trajectory of adoption rate starts to level off as fewer individuals remain to adopt the innovation.
- Social system: it involves interrelated units in which could be individuals, organizations, informal groups...etc. The social system can influence DOI through social structure where “the units in a social system are not all similar in their behaviours” and type of innovation-decision (e.g. collection, authority and optional innovation-decision) Rogers (2003).

While innovation's attributes are:

- Relative advantage: in which an innovation is perceived as better compared to the one it replaces. It can be measured in terms of economic factors, social, convenience, satisfaction…etc.
- Compatibility: an innovation is perceived as being consistent with potential users'/adopters' needs, existing values and past experiences.
- Complexity: where innovation is perceived as difficult to understand, use and requires developing new skills.
- Trialability: where innovation can be experimented with or tried.
- Observability: where an innovation's results are visible to others.

However, there are some limitations of diffusion research. For instance, the pro-innovation bias in which innovation should be diffused and embraced by the entire social system's members and spread rapidly without being modified. Also, the individual-blame bias, in which individuals are held responsible for their problems rather than the system they are part of it. Furthermore, the recall problem; where respondents have to recall data since the date of embracing a new idea.

Yet, these can be overcome. For instance, investigating the diffusion of innovation while still in process instead of collecting data after completing the innovation diffusion process. In addition, using alternative research designs to collect data about time element in the DOI, such as archival records and case studies, as well as emphasizing upon pretesting the questions in data collection tools to obtain valid and reliable data as much as possible.

### 2.6.3 Integrated TAM and DOI Theory

Different researches integrated TAM and DOI theory to evaluate computer systems/technologies and found similarities between TAM constructs and DOI characteristics. For

instance, Jones and Seckman (2018) found that prior experience with technology was likely to affect end-users perceptions. In addition, they encouraged involving end-users (e.g. patients and physicians) in the innovations decision process as it promotes a sense of inclusion and ownership which is likely to influence perceptions and acceptance.

Mutahar et al. (2017) explained that TAM core constructs (PU and PEOU) are similar to DOI attributes raised by Rogers (relative advantage and complexity). They found that PU and PEOU had a positive influence on intention to use mobile banking services and were important predictors, which means that usefulness, flexibility and ease of use are important when using mobile banking services, while innovation's attributes were not critical factors, but improved the perceptions of PU and PEOU; hence effect the intention to use such services.

### 2.6.4 Reasons for Choosing TAM and DOI Theory

TAM principle constructs (PU and PEOU) are consistent with and support Rogers DOI Theory, in which users' perceptions of a technology predict acceptance of an innovation (Jones and Seckman 2018). As a result, both; TAM and Rogers DOI Theory were used here concomitantly.

TAM is more precise compared to other models (e.g. TRA) as it focuses on users' acceptance of technology rather than predicting behaviour in general. Also, it is easy to apply for addressing external factors' impact on users' acceptance of technologies. In addition, for predicting acceptance and subsequent use of technology, TAM is more appropriate and practical. DOI Theory was as well applied as telemedicine is considered as a new and innovative technology in the region. "As innovations occur so frequently, the application of diffusion theory and research can be noticed and found almost in all sides" (Rogers 2003).

In this research, applying TAM and Rogers DOI Theory allowed investigating perceptions, intentions and attitudes toward telemedicine in the UAE along with examining the current status of health informatics in the country as well as benefits and challenges of such innovation.

## 2.7 Proposed Conceptual Framework

The below figure 2.16 depicts the proposed conceptual framework developed for this research. It was developed based on the literature (e.g. Davis 1989) and modified to fit the research setting (UAE). The framework illustrates the relationship between several variables, research structure and the interrelationships between different components. For instance, the sociotechnical analysis covers four dimensions: social, organizational, technical and legal and for each dimension, related variables were addressed. While several variables were measured for telemedicine demand, such as lack of specialised care and acceptance was measured based on the Technology Acceptance Model (TAM) and Rogers Diffusion of Innovations (DOI) Theory.

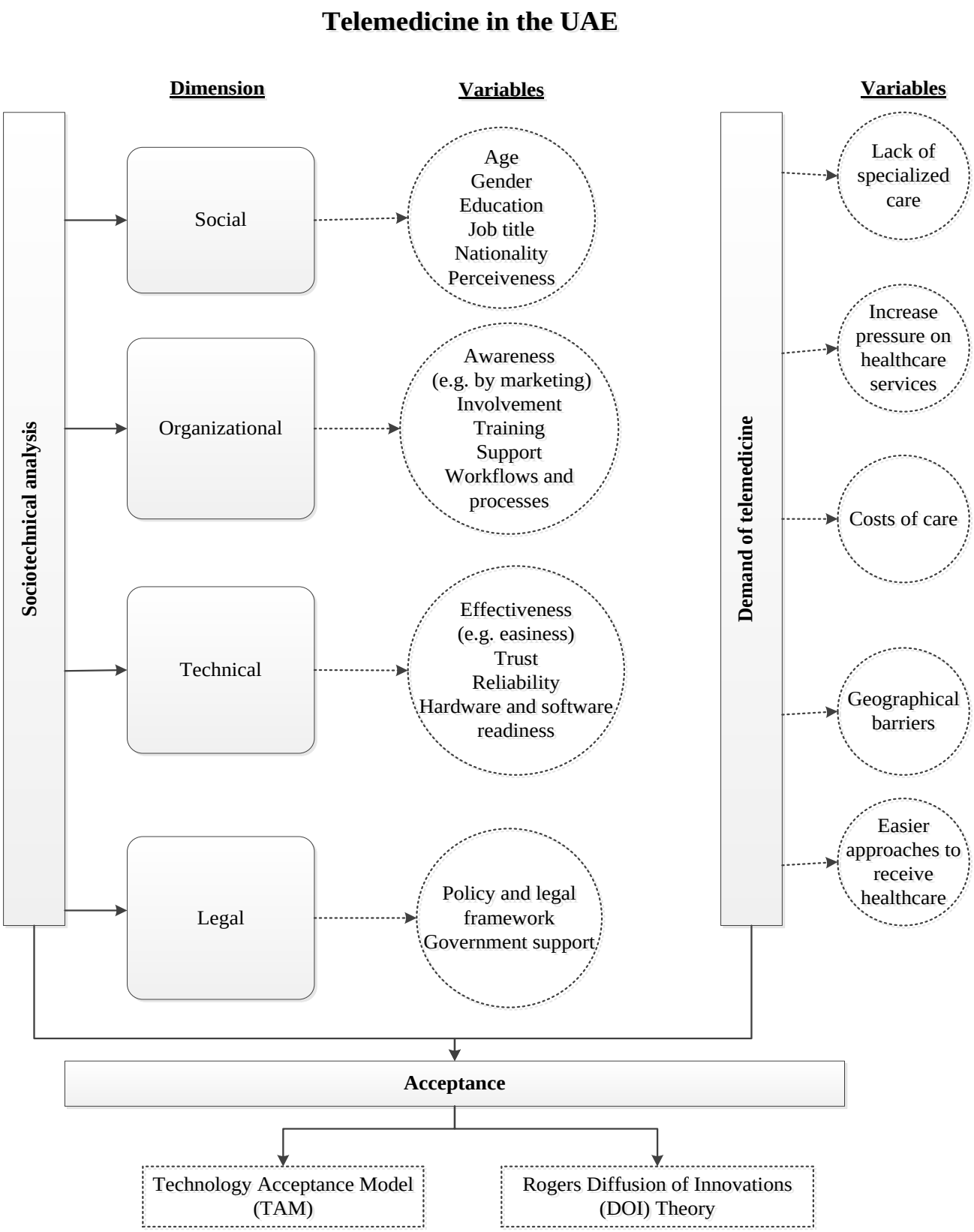



Figure 2.16: A conceptual framework of telemedicine in the UAE.

# CHAPTER 3: METHODOLOGY

This chapter illustrates the research methodology, philosophy, research design and approach, methods as well as sampling techniques, measurements and data collection tools used.

Rogers (2003) encouraged to creation new scale of items when evaluating an innovation as the attributes of innovation differ in each study. This cross-sectional research combined both; descriptive and analytics design as the research questions varied with those that described a situation and included hypotheses testing.

## 3.1 Research Philosophy

Choosing a research philosophy is determined by the research's nature, researcher, questions...etc. It helps drawing the research methodology, what methods to apply and properly answer research questions. Research philosophy guides in how, why, where and what data to be collected and analysed (Amer 2016; Wilson 2014). Here, the research aims and questions required following inductive and deductive approaches as well as employing mixed research methodology where descriptive and analytical explanation to be made. However, deductive approach is the main one used as general ideas and theories were deducted from literature and were validated via empirical tests and results (Amer 2016; Wilson 2014).

By this, pragmatism research philosophy was followed (Brierley 2017). Using such philosophy allows researchers to be flexible in choosing methods to answer their research questions (Brierley, J. 2017). Pragmatism opens the doors in mixed design research to different worldviews, assumptions, different methods and various data collection techniques as well as analyses (Creswell 2014).

In line with pragmatism philosophy, both quantitative and qualitative methods (e.g. questionnaire and interview) were used here to answer the research questions and cover its aims

and objectives (Wilson 2014). Because there is a rich knowledge and theory existing in the literature, the conceptual framework was developed here, as depicted in figure 2.16, and hypotheses were tested through mixed approaches.

## 3.2 Research Design, Approach and Justifications

To investigate telemedicine technology in the UAE from a sociotechnical perspective and cover research questions; mixed research design (quantitative and qualitative) was followed to support each method used and overcome the disadvantages of applying mono-method because it fetches together the benefits of breadth and depth of these two methodologies, for data triangulation to minimize potential research biases and improve results' validity and generalization (Bowling 2009). Also, it allows clarifying the case under study by providing a clearer picture and knowledge.

Additionally, it attempts to legitimize using quantitative and qualitative methods instead of choosing either of them and creating a bridge that links the schism between them (Johnson and Onwuegbuzie 2004). Furthermore, allows capturing data and information from multiple sources to represent findings better and make inferences. Also, some research questions are better answered using certain research methods; for example, when evaluating a technology while being used, interviewing people using it would be better, while collecting data from a large population about their perceptions; a questionnaire is more practical. Finally, having different data collection techniques allows more flexibility with the research subjects.

However, mixed methodology requires an extensive data collection process, might pose complexity in analysing both quantitative and qualitative data and time-intensive (Creswell 2014).

Descriptive and analytical research were followed. Descriptive design aims to describe a phenomenon, what has happened and what is happening. It also intends to answer questions in

general without looking into the rationale. However, analytical research aims to test hypotheses and answer how and why situations occurred. It involves critical thinking and investigating the relationship between variables. Mixing between descriptive and analytical research allows easy obtaining of data and information and is more thorough than solo type. This research composed of three research questions as mentioned above. The first and third questions were descriptive, while the second question was analytical.

There are different research traditions, such as case study and grounded theory. However, for this research, case study was used by conducting an in-depth analysis of existing telemedicine technology and observing the technology while in use at two sites: Al-Qassimi and Kalba Hospitals. Data was collected from multiple sources, such as interview and documents. The analysis was done based on themes (Creswell 1998).

The research was conducted based on existing theories and model (TAM and Rogers DOI Theory) and analysis of a real case study of telemedicine in the UAE. In addition, findings from existing researches in a similar field were considered and discussed. To cover the research aims and objectives as well as due to the dynamic requirements of research these days, research methods need to complement each other to provide superior research and reliable findings.

## 3.3 Methods

### 3.3.1 Embedded Mixed Methods

Embedded mixed methods design as depicted in figure 3.1; where one method is embedded within another method was applied. It "encourages researchers to embrace their design as it uses a recognized research design (e.g. quantitative) and includes within it a secondary data collection form (e.g. interview)" (Creswell 2014). Also, consumes less time and resources as well as allows understanding findings by incorporating individuals' perspectives. Yet, embedded design has

limitations, such as difficulty in integrating results and little has been written about it (Creswell 2006).

The embedded design was chosen in this research as quantitative data were used to answer the primary research questions and qualitative data were embedded to supplement quantitative data related to the technology under evaluation (telemedicine). Also, to explain the relationship between various variables.

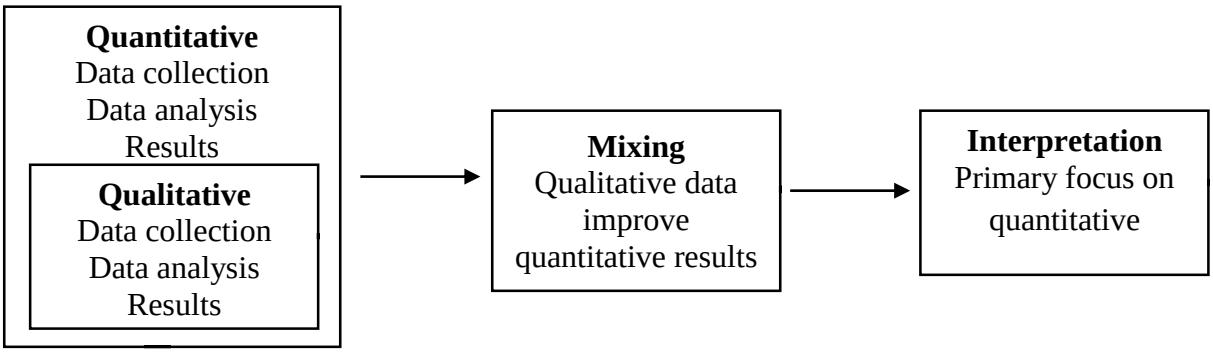



Figure 3.1: Embedded mixed methods (Adapted from Plano-Clark et al. 2008, p.1551).

### 3.3.2 Computer Data Analysis Program

There are many quantitative and qualitative data analysis software/programs. For quantitative data, Statistical Package for the Social Sciences (SPSS®) (Nie, Bent & Hull 2019) and SAS® (SAS Institute 2019) are one of the most popular software. In this research, SPSS® was used, while for qualitative data MAXQDA® (VERBI Software 2019), Atlas.ti® (Muhr 2015) and NVivo® (QSR International 2018) are the popular ones (Creswell 2014). Here, the interviews sessions were few and the information collected was manageable. Hence analysis of qualitative data was done using Atlas.ti® (Creswell 2014; Nation 2014). Reasons for using Atlas.ti® not NVivo® (QSR International 2018), although the latter is more practical and used in the research field, is easy to obtain Atlas.ti®, low cost, and performing similar functionalities like other software (e.g. coding and analysing) and supporting different documents formats.

## 3.4 Sampling Design and Population

There are factors that determine the choice of sampling method in research, such as research aims and objectives, types of questions, subjects of interest…etc. (Field & Morse 1989, cited in Britten 1995) and different sampling techniques are available, such as random and non-random sampling, which sometimes causes false dichotomy that random sampling is related to quantitative research and non-random is related to qualitative research. However, in one of the previous researches carried out by Carrese, Mullaney and Faden (2002), cited in Onwuegbuzie and Collins (2007), random sampling was used to study ill housebound patients (chronically sick) and subsequently conducted interviews with those patients to examine how they think and approach future illnesses and end of life. Breaking down this false dichotomy, researchers would significantly have more options to select their samples (Onwuegbuzie and Collins 2007).

Since telemedicine is a new concept in the country and may serve all people regardless of their backgrounds or professions, selecting individuals randomly would be much appropriate to measure their perceiveness, acceptance and draw a relationship between different variables, such as age and acceptance. Also, it would not be necessary to group the research subjects in equal groups as telemedicine users could be the public, healthcare professionals and/or decision-makers, so different perspectives about the technology even for those who share the same profession or education level.

In this research, probability sampling technique known as simple random sampling was adopted to collect quantitative data. This sampling technique is useful when the population is large and diverse. In this technique, every member of the population has the same probability of being selected and is more appropriate when inferences are to be made from a large population. Furthermore, it saves time, costs and does not require complex technical knowledge to apply it

compared to non-probability sampling, which can be difficult to apply as it requires certain expertise and more susceptible to biases. Creswell (2014) suggested applying random sampling as randomization allows selecting a representative sample from the population, thus generalising the findings. SPSS® was used to analyse the quantitative data. However, non-probability sampling was followed as well, particularly purposive sampling to collect qualitative data and the researcher personally conducted the interviews with audio-recording the sessions and then transcribed these sessions using (NCH Software: Express Scribe®) (NCH Software 2019).

Qualitative works that follow purposive sampling rely on the researcher's ability to appropriately follow the research structure and fill in gaps where there are ambiguous answers. Yet, purposive sampling might be time-consuming due to interaction with subjects individually since individuals may alter their responses if they are in groups or feel threatened if they respond differently than others. So, it can be lengthy, particularly if there is only one researcher handling data collection and there is a possibility for intentional bias that occurs when individuals provide certain answers that might benefit some needs; either for the researcher or research subjects.

### 3.4.1 Research Population

In previous researches, the number of subjects was different from one research to another. For instance, Davis (1989) 160 subjects, Davis (1993) 112 subjects, Jensen (2002) 71 subjects, Mutahar et al. (2017) 482 subjects, while, Jones and Seckman (2018) 24 subjects. The response rate in these studies was above 90%. However, in Liu (2014) study, the number of subjects was 211 with a response rate of 70%. The variations in the number of subjects could be due to the research aims and objectives, area of interest, population size, where the study's subjects are drawn from, voluntariness to participate, incentives…etc. In this research, the total number of subjects

involved was 342 and this was determined based on the calculation strategy discussed below and compared with previous works.

To determine the appropriateness of the sample size, saturation might be one factor to consider. Saturation is reached when further information will not add new discoveries or values to the study (Morse 2000). For instance, Creswell (2002), cited in Onwuegbuzie & Collins (2007), recommended 3-5 participants for a case study and Onwuegbuzie et al. (2004), cited in Onwuegbuzie & Collins (2007) suggested that as a minimum sample size for most common research designs which was as well described in other introductory research methodology, statistics guidelines and documents to be around 64 participants or 82 in correlational research depending on the testings' types. Guest, Bunce & Johnson (2006), cited in Onwuegbuzie & Collins (2007), recommended 12 participants. For an interview, Creswell (2014) stated that the number of interviewees could range from 6-8.

Since TAM was applied in this research, previous research samples were considered a guide to drawing the sample size. For instance, Jensen (2002) specified that to implement TAM, a study sample needs to be at least 40 individuals and according to Jensen, the reliability of TAM results as well as with other statistical models decreases as the sample size decreases.

The research was conducted in the United Arab Emirates public areas, MOHAP Headquarter, hospitals and PHCs. These areas were selected randomly, except Al-Qassimi and Kalba Hospitals were selected purposively as a case study since these two sites are the only ones currently live with telemedicine under MOHAP jurisdiction.

The targeted population was selected as well randomly, such as healthcare professionals (e.g. physicians and nurses), public (patients were included with the public), directors and IT professionals. The sample size was statistically calculated via available online calculators

('Raosoft' 2004 and Select Statistical Services Limited 2019). Generally, three key aspects need to be considered when calculating a sample size:

N= population size. Since in this research random sample of people across the UAE who are aged 18+ are the ones to be included, then the population size would be around 8,093,766 (Appendix A: UAE Population Distribution).

ME%= Margin of Error: in this research, 5% was applied.

CI%= Confidence Interval: here, 95% was applied.

As a result, the recommended sample size for this research was = 385 participants. Although having a larger sample size might lead to more statistically significant results, which means less chance that the results happened by coincidence, it still might cause more errors and biases, which will impact the reliability of the research's findings. Also, it might reduce the response rate.

According to Bowling (2009), for qualitative methods, where interview is utilized to collect data, there is no clear cut-off point that constitutes an appropriate and representative sample size. However, the most frequent rule of thumb is when participants give the same data and information, then it can be said that sufficient sample size has been reached. For qualitative methods, purposive sampling was followed in which the researcher selects participants who meet the research' purposes, have knowledge that is valuable to the research and can be easily approached. The findings from purposive sampling can be generalized when random sampling is employed as well, which was done in this research (Bowling 2009; Neutens & Rubinson 2010). In this research, the number of interviewees was 12, selected from MOHAP.

Overall, research participants were approached by visiting public areas, such as malls. People there were asked if they would like to participate or not. Also, visitors to MOHAP

headquarter and institutes, MOHAP staff, patients and their families/companions were invited to participate. Appendix D: Research Participation Process: depicts the workflow. Participation was entirely voluntarily, without any coercion, penalties or risks for participation or withdrawal from the research at any stage. The number of participants involved was 342 (330 participants completed the questionnaire and an additional 12 were interviewed). Data collection started on 7th May 2019 and ended on 2nd August 2019. There were certain eligibility participation criteria considered:

- The participants must be Eighteen years old and above.
- Speak at minimum either Arabic or/and English, because the research was in English, but data collection tools were available in two versions: Arabic and English. Also, the research setting is the United Arab Emirates. The official language in the country is Arabic and English is the second language as well as it is one of the most commonly used languages worldwide (Myers 2018).
- Competency by the ability to take actions freely, express thoughts, share information without coercion as well as have proper intellectual and mental capabilities (e.g. make decisions by themselves, voluntariness…etc.).
- Well-being: not in critical conditions (e.g. patients).

Participants had to sign a consent form as shown in appendix E: Informed Consent Form. In addition, the research's aims and objectives, duration of data collection session and confidentiality statement were all explained in the data collection tools' cover page and the invitation letter as shown in appendix F: Invitation Letter to Participate in the Research.

### 3.5 Measurements and Data Collection

Various measurements were taken to cover the research's questions, aims and objectives. During constructing the questionnaire and interview questions, two important factors were

considered to avoid participation rejection as much as possible. These factors were: required time to respond to questions and simplicity. Also, a thorough review of the literature was done to check if similar researches were conducted and based on that, the questions were structured for measurements' standardization while taking into considerations participants' characteristics, commonly used languages in the country, avoiding double-barreled questions and using multiple questions to evaluate the same construct. For example, to evaluate the use of telemedicine, question 11 and 12 were asked to compare between responses as shown in appendix G: Telemedicine in the United Arab Emirates (UAE) Questionnaire.

The implementation of TAM and DOI Theory in this research followed prototype testing/system selection procedure in which a short video demonstration of telemedicine; approximately one minute (video link: Mcreynolds 2012) was done and then participants were asked to respond to the questions. Validated questions from previous research (e.g. Cowen 2009, Davis 1989 and Venkatesh & Davis 2000) were adapted to measure the applied model and theory in this research as shown in appendix H: Questionnaire Items and References. Such an approach saves time, costs, and efforts to develop new instruments (Michael and Dillon 1997; cited in Jensen 2002).

To ensure the adapted and used measurements scales are appropriate to the current context, piloting the instruments was done in this research with 25 individuals from different backgrounds, gender and age groups. Some modifications were suggested and performed, as illustrated in Chapter 4: Results and Analysis.

In order to gain a thorough understanding of the technology's capabilities and limitations, the researcher was granted access to related documents (e.g. RFPs, memos…etc.) as well as

visiting sites that implemented telemedicine in MOHAP and observing the technology under evaluation while it is being used.

Another measurement was taken to ensure a high response rate and avoid or at least minimize biases in which participants were reminded to complete the online questionnaire or proceed with the interview process at different time intervals via telephone and/or e-mail. The number of reminders sent was around 2 to 3 times post initial invitation to participate (Lemon 2007). This was possible, particularly for those within MOHAP jurisdiction, as their contact details were available in the MOHAP intranet. Furthermore, a video demonstration of telemedicine technology before starting data collection assisted in giving the participants a quick orientation. However, there were some concerns when collecting data from elderly people as they might not be patience compared to younger people. This was sorted out by giving them the chance to assist them in filling in the questionnaire by their companion or the researcher.

Mixed instruments were used in this research, as described in table 3.1.

Table 3.1: Research data collection instruments.

| Instrument | Questionnaire | Interview | Case study | Documents |
|---|---|---|---|---|
| Type | Paper-based and online. | Semi-structured; face-to-face interviews. | Multiple-case study. | MOHAP's departmental documents (e.g. statistics), journal articles and mass-media records (e.g. newspapers). |
| Justifications for the type chosen | Easy to conduct.<br>Does not consume time. | Allows more control during the session and obtaining rich descriptive data from participants.<br>Allows collecting focused information and offers more flexibility in raising questions and responding to them than structured interviews.<br>Before the interview session, predetermined questions were shared with the participants to get an idea about the questions, particularly that the topic is somehow new. | It allows addressing a phenomenon in and across locations.<br>Offers evaluating different cases and compare between them for similarities (literal replication) and differences (theoretical replication) (Yin 2003). | Convenient, easy to access, save time and expenses and in some situations cover the entire population in a specific time. |

| | | | | |
|---|---|---|---|---|
| | | Face-to-face interview is more convenient in terms of resources availability (e.g. financial, technical and human resources), time management and better evaluation and interpretation of responses. | | |
| Aim | Measure participants' demand and acceptance of telemedicine technology in the UAE.<br>Measure users' intention to use telemedicine.<br>Evaluate telemedicine's benefits and challenges in the UAE. | Evaluate telemedicine technology from MOHAP employees' perspectives.<br>To compare responses between those in MOHAP (interview) and the public (questionnaire) and better understand the technology under evaluation. | In-depth analysis of Tele-ICU, explaining phenomena and cover contextual conditions that are expected to be relevant (Yin 2003).<br>To have a clear picture and better understating of the technology and for comparison purposes between two cases. | Better understating and familiarization with telemedicine. |
| Questions' reference | Based on TAM and Rogers DOI Theory.<br>Different researchers, such as Davis (1989), | Different researches, such as Davis (1989), Jensen (2002), Rogers (2003) and Tithecott & Sochacki (2015). | Same as to questionnaire and interview. | Not applicable. |

| | | | | |
|---|---|---|---|---|
| | Jensen (2002), Rogers (2003) and Atkinson (2007), as shown in appendix H: Questionnaire Items and References | | | |
| Topics covered | It consisted of 29 questions and covered the following areas in which it mirrored as well TAM and Rogers DOI Theory: sociodemographic characteristics, familiarity with technologies in the UAE, demand and acceptance level, perceived usefulness, perceived ease of use, attitude, behavioural intentions towards | It consisted of 5 main questions that covered the following areas: sociodemographic characteristics, familiarity with telemedicine, demand and acceptance level, sociotechnical impacts of telemedicine, benefits and challenges, as well as possible suggestions to improve telemedicine. | Same as to questionnaire and interview. | Telemedicine related statistics, historical data, technicality, services, regulations and future plans. |

| | | | | |
|---|---|---|---|---|
| | telemedicine, usage, diffusion of innovations attributes, benefits and challenges. | | | |
| Location | Public areas in the UAE, such as shopping centres.<br>MOHAP and its institutes. | MOHAP Headquarter, Al-Qassimi and Kalba Hospitals. | Al-Qassimi and Kalba Hospitals | MOHAP Headquarter, Al-Qassimi and Kalba Hospitals, as well as those published online. |
| Subjects | The public in the UAE and MOHAP employees. | MOHAP employees; ranged from executive level to junior employees, such as directors, IT professionals and physicians. | Healthcare and IT professionals, representatives from the vendor and visitors to the sites, including patients. | Not applicable. |
| Type of questions | Mainly were close-ended questions with response options based on the Likert scale. | Open-ended accompanied with other types of questions, such as follow-up questions (e.g. why and how), probing and direct questions. | Same as to questionnaire and interview. | Not applicable. |

| | | | | |
|---|---|---|---|---|
| Instrument's language | Arabic and English. | Arabic and English. | Arabic and English. | Arabic and English. |
| Tools and documents used | SPSS® to process collected data.<br>Several documents: such as questionnaire and informed consent form. | Audio recorder and handwritten notes.<br>NCH Software: Express Scribe® to transcribe interview sessions<br>Atlas.ti® to process the collected data.<br>Several documents: such as invitation letter to participate, interview questions and informed consent form. | Audio recorder and handwritten notes.<br>Archival records and departmental documents. | RFP, departmental documents, articles and newspapers. |
| Reporting methodology | Descriptive and analytical. | Thematic. | Since there were two different settings covered, Yin (2003) approach for reporting case studies was used: comparative. | Descriptive. |
| Duration | Around 10-15 minutes to complete the questionnaire. | Maximum 30 minutes per session resulted in a total of approximately 6 hours | Same as to questionnaire and interview. | Documents were collected and accessed during conducting interviews and visiting the hospitals. The duration to read |

| | | | | |
|---|---|---|---|---|
| | | | | and elicit data/information depended on the document's type, such as newspaper took around 20 minutes, while RFP took days. |
| Limitations | Susceptible to response bias, faulty scale (e.g. missing interval) and intrusiveness. | Requires time and effort to transcribe the sessions.<br>The interviewer needs to establish rapport with the participant and stay focus by avoiding diversion from the research's purpose.<br>A researcher presence may cause response bias (Creswell 2014). | Time-consuming and expensive since different settings are covered and a large amount of information is required to be recorded and analysed (Yin 2003). | Materials might not be completed; information might be protected and subject to classification errors, society and cultural biases, as well as imperfections, particularly with historical records (Bowling 2009; Creswell 2014). |

The reasons for developing the data collection tools in different versions were to allow for more flexibility, increase response rate and elicit information as needed. Although the official language in the UAE is Arabic, there is a large segment of non-Arabic speakers. Also, research subjects were from different backgrounds and ethnicity and a high percentage of the UAE population are at minimum bilingual; mostly speak Arabic and English. Furthermore, the current telemedicine technology implemented in MOHAP is in English.

During the interview phase, several documents were used, such as invitation letter to participate, as shown in appendix F: Invitation Letter to Participate in the Research was used before conducting the interview. The invitations were sent individually to the interviewees via e-mail along with the interview questions and consent form. This was easy as the interviewees were from MOHAP and their e-mails addresses were available in the MOHAP master e-mails list. After receiving e-mail approval to participate and agree on the date, time and location to conduct the interview, two copies of the interview questions (one for the interviewer and one for the interviewee), printed informed consent form for both parties' signatures as shown in appendix E: Informed Consent Form and interview protocol template to record the responses were used during the interview session despite that the sessions were audio-recorded as shown in appendix J: Interview Protocol Template.

Before completing the questionnaire, participants were asked to sign a consent form. Those who filled in the online questionnaire were asked to tick a box indicating their willingness to participate and a demo video of telemedicine was added for them to better understand the technology under evaluation, as shown in appendix K: Online Questionnaire's Cover Page.

The below figure 3.2 depicts the questionnaire's sections and a brief description:

| | |
|---|---|
| Cover page | It included a brief description of the research, aims and objectives as well as definition of the technology under evaluation (telemedicine). Also, time required to complete the questionnaire, importance of participation, voluntariness and confidentiality statement. At the end of the cover page, the researcher's contact details were provided. This would allow the participant to approach the researcher; as needed and can add comfort for the participant and feel more legitimate. |
| Sociodemographic characteristics | The sociodemographic variables included age, gender, education...etc. to verify that the participant meets the research criteria and for statistical analysis. Also, to assess the impact of these variables on telemedicine technology. Name was optional to reduce sensitivity and maintain confidentiality. Additionally, contact number and e-mail address were added to follow-up with the participants; as needed. The participants were asked to provide their age in exact to facilitate accurate statistical analysis of the research population sociodemographic profile. |
| Questions | After providing sociodemographic details, questions section started. The questions were divided according to certain headings. These headings were added according to the research questions as well as TAM and DOI Theory applied:<br>- General awareness about technologies in the UAE.<br>- Telemedicine demand.<br>- Acceptance, which included Perceived Usefulness (PU) and Perceived Ease of Use (PEOU).<br>- Attitude Towards (A) using telemedicine.<br>- Behavioral Intention (BI) towards telemedicine.<br>- Telemedicine usage.<br>- Diffusion of Innovation (DOI) and external attributes related to telemedicine.<br>- Benefits and challenges of telemedicine.<br>- Overall about telemedicine.<br>There were questions in which the participants were asked to answer based on their actual usage of telemedicine technology or future expected usage. For example, in section related to usage.<br>There questions were in different formats, mainly Likert Scale. Also, selection from available options and multiple choices were there.<br>Total number of questions was 29, which is acceptable and similar to what was done in previous researches, such as: Davis (1989) and Cowen (2009). |
| Closure | At the end of the questionnaire, the participants were allowed to add their comments and recommendations. Also, gratitude statement was added. |

Figure 3.2: Summary of the questionnaire's sections.

Different ranges of Likert Scales were used by different researchers, especially when applying TAM and Rogers DOI Theory. For instance, Atkinson (2007) used a 6-point Likert scale, while Jensen (2002) used a 7-point Likert scale and allowed for a [neutral] response as a middle

point. In this research, a 5-point Likert scale, almost similar to those used in previous researches (agreement and disagreement level), was applied with a midpoint labelled as [neutral].

The filled-in hardcopy questionnaires were skimmed for completeness at the time of submission except for questions that were optional, while in the online version, all the questions aside from the optional ones were mandatory to answer and participants would not be able to move to the next page without completing it. Furthermore, to track the research participants for further details or clarifications, the participants were asked to provide a unique identifier, such as email address and contact number. Almost all of them provided such information. Furthermore, a note was mentioned in the questionnaire that in case the participant already completed the questionnaire in one of the versions (language/hardcopy or online) not to repeat it.

In this research, real data were gathered from various sources by utilizing different approaches. This allows data triangulation and better reliability of the findings. As a result, the obtained findings were based on empirical evidence rather than rationalistic views. The UAE Ministry of Health and Prevention (MOHAP) Research Ethics Committee (REC) approval was granted for the entire research, including the methodology applied here. Also, the British University in Dubai (BUiD) Research Ethics Committee and Research Degree Committee (RDC) approval was granted.

# CHAPTER 4: RESULTS AND ANALYSIS

This chapter reports the results and outcomes of the procedures outlined in the Methodology Chapter along with presenting the pilot phase conducted, quantitative and qualitative analyses and comparison between findings.

The research followed mixed methods data analysis, mixing between quantitative and qualitative analysis. Each type of analysis method was presented separately as the type of data collection techniques used were different and the research subjects involved were different as well. Also, the response mechanism to questions differed.

SPSS® was used to analyse the quantitative data, while Atlas.ti® was used to analyse the qualitative data. In addition, different statistical analyses were done, such as descriptive analysis about the research subjects, reliability analysis to determine that the items measure and reflect what it intended to measure as well as correlation test to measure the relationship between variables.

## 4.1 Pilot Phase

Designing reliable data collection tools as much as possible requires being tested before full-scale utilization. Also, to collect the required data and information from participants and ensure alignment with the research's aims and objective, piloting data collections tools (e.g. questionnaire) is an approach considered in scientific research to assess questions' clarity, consistency, semantics, appropriateness, comprehensiveness and time needed to collect data which have impacts on research's validity and reliability. In this research, the pilot phase was done randomly among [n=25] participants with different backgrounds and expertise, such as biostatistics, engineering, health informatics and healthcare professions (Bowling 2009 p. 301;

Hunt, Sparkman & Wilcox 1982). This phase was conducted almost in the same way and environment where the actual data collection phase took place.

The participants were informed about the pilot phase to avoid as much as possible reluctance and allow them to provide their feedbacks liberally. Blind piloting was not followed in this research as those who participated could be by chance selected during the actual data collection phase. Instead, piloting was conducted in the form of face-to-face interaction and using hardcopy of the questions. Before starting the pilot phase, face-to-face orientation sessions were conducted, in which participants were giving a brief introduction about the research and then were asked to read the definitions of main variables in TAM and DOI Theory applied here.

The pilot phase consisted of two stages; expert review and cognitive testing, as explained below (Caspar et al. 2016):

- Stage one; expert review: experts in the field of health informatics and scientific research were involved to pretest the data collection tools [n= 15 participants]. The comments received were as the following:
    - Providing a brief description of telemedicine on the cover page of the questionnaire and before interviewing participants as there are people who might not be familiar with telemedicine.
    - Simplifying the terminologies used and rephrase some questions/statements.
    - Adding questions related to being familiar with telemedicine and technical impacts of telemedicine.
    - Deleting repetition.
    - Formatting and restructuring the questions to have more sense of consistency and coherence.

- Sectioning the questions based on the research questions and model/theory applied.
- Adding titles for the questionnaire's sections, removing comments column for Likert scale questions, adding [Acceptance Section] and adding subsections under it [Perceived Usefulness and Perceived Ease of Use].
- Rearrange Likert scales to start from strongly disagree to strongly agree.

- Stage two; cognitive testing: after modifying the data collection tools based on stage one [expert review], cognitive testing was done with members from the population; randomly [n= 10 participants]. The comments received were as the following:
  - Simplifying questions and terminologies used.
  - Availability of online version of the questionnaire.
  - Providing two versions of the data collection tools: Arabic and English.
  - Video demonstration of telemedicine before starting data collection.

The above comments were discussed with the participants during the pilot phase and were applied as much as possible. Conducting pilot phase allowed having face and content validity of the data collection tools in which it measured what it is intended to measure and to be in line with the research's aims and objectives (Davis 1989). Content validity was done to ensure careful selection of scale items used in this research and that those items represent the concept under evaluation; where generalizations are to be made (Bohrnsted 1970, cited in Davis 1989) by having subject matter experts (e.g. biostatisticians and software engineers) to evaluate the items used here before final construction of the measures. Furthermore, those experts were provided with conceptual definitions of what is intended to be measured and then were asked to match items with definitions.

In addition, extrapolating from previous studies was done to roughly identify the number of items needed for each construct in the applied TAM and DOI Theory while maintaining the reliability and validity of the measurements used. For instance, Davis (1989) used 6 items per each core construct in TAM, Cowen (2009) used more than 20 items to cover TAM constructs, while Jones and Seckman (2018) used 12 items. The initial number of items used in this research was around 37. After applying the above strategies, the final measurements scales consisted of 35 items (in both data collection tools; questionnaire and interview).

## 4.2 Results

### 4.2.1 Sociodemographic Profile of Participants

The total number of subjects that participated in this research was 342. The UAE MOHAP was the setting of interest as the technology under study has been implemented there since 2016. For quantitative methodology, the sample size calculated for this research = 385 and out of that, 330 participated (85.7%), while for the qualitative methodology, 12 participants were interviewed. All participants (342) completed the research and did not withdraw from it and provided usable responses and feedback. Figure 4.1 depicts the response rate in this research (for both; questionnaire and interview).

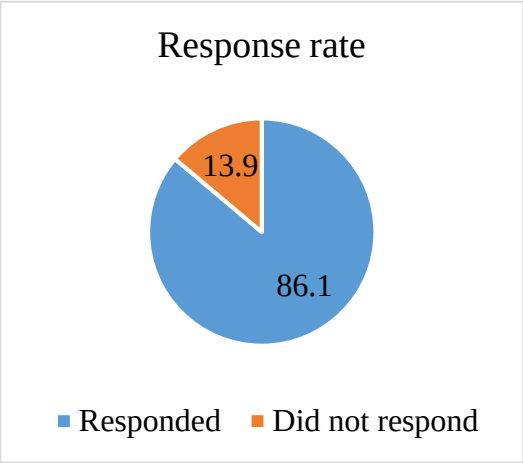



Figure 4.1: Response rate.

### 4.2.2 Quantitative Analysis

Data were cleaned, entered and analysed in SPSS® version 26.0 as well as checked for normal distribution. Descriptive analysis was done for the variables. Quantitative variables were presented in the form of mean $\pm$ and Standard Deviation (SD). Qualitative variables were presented in the form of frequency and percentages, such as gender, nationality, education level, emirates of the participants and for each question included in the questionnaire. Chi-square test was applied to determine the association/relationship between the qualitative outcome variables.

Univariate analysis of variance test was applied to compare the quantitative variables. Pearson's, Spearman rank correlation and simple linear regression tests were performed between the 5-point agreement scale–specific items and likelihood to accept telemedicine in the UAE. A p-value $\leq 0.05$ was considered as statistically significant. To assess the potential collinearity among variables using variance inflation factors (effect modifiers), multivariate logistic regression analysis was used to observe the significance.

We expanded research on the construct validity of the decisional balance scale for acceptance of telemedicine by testing its convergent and discriminant validity. Scale development was accomplished in five measurements. An overall reliability analysis was carried out on the perceived usefulness of telemedicine, perceived ease of use, attitude towards using, behavioural intention and usage of telemedicine values scale comprising of 19 items. Cronbach's alpha showed that the questionnaire reached high reliability, $\alpha = 0.93$, which means that the questionnaire is a well reliable measurement instrument and for each construct, Cronbach's alpha ($\alpha$) was established as depicted in table 4.1. Most items appeared to be worthy of retention, resulting in a decrease in the alpha if deleted. In Atkinson (2007) study, scales demonstrated internal consistency ($\alpha = \geq$

0.70), which what Jensen also used as minimum standard reliability (2002). This standard was as well applied in this research.

Table 4.1: Reliability analysis of TAM constructs.

| Construct | Items | Cronbach's alpha (α) |
|---|---|---|
| Perceived Usefulness (PU) | 3 | 0.89 |
| Perceived Ease of Use (PEOU) | 3 | 0.85 |
| Attitude towards using (A) | 4 | 0.70 |
| Behavioural Intention to use (BI) | 4 | 0.76 |
| Usage | 10 | 0.86 |

A total of 330 participants completed the questionnaire and were included in the research with the mean age of 37.56 $\pm$ 9.43 years, where the minimum age was 18 and the maximum recorded was 65 years. Among them, male were accounted to be 152 (46.1%) and females were 178 (53.9%). Almost both local and non-local nationalities participated equally in the questionnaire (49.1% vs 50.1%), respectively. Figure 4.2 demonstrates that most of the male participants (n= 38; 25.0%) belonged to the age group (33-37) years and likewise, the majority of participated females (n= 41; 23.0%) were from the age group (38-42) years.

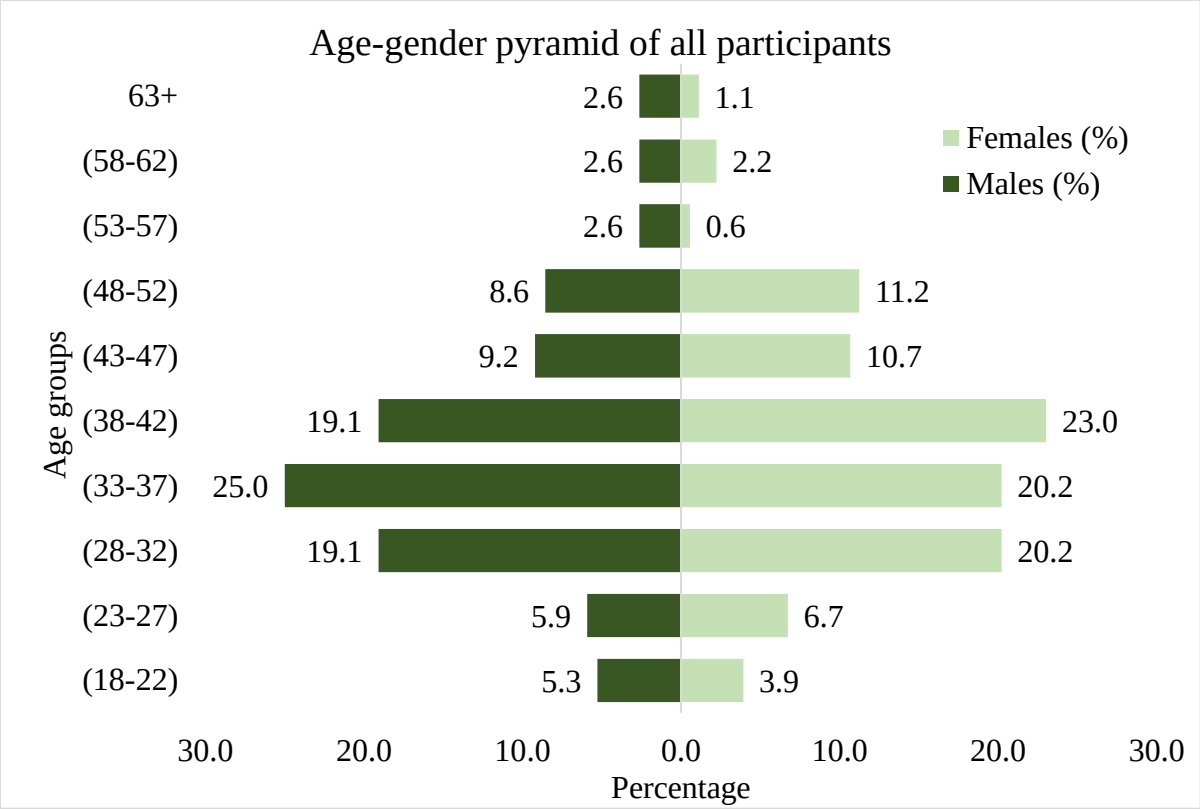



Figure 4.2: Questionnaire's population pyramid.

Figure 4.3 depicts the distribution of education level where (n= 215; 65.2%) of the participants were undergraduate, followed by (n= 85; 25.8%) post-graduate and the rest (n= 30; 9.1%) of the participants had education of school level.

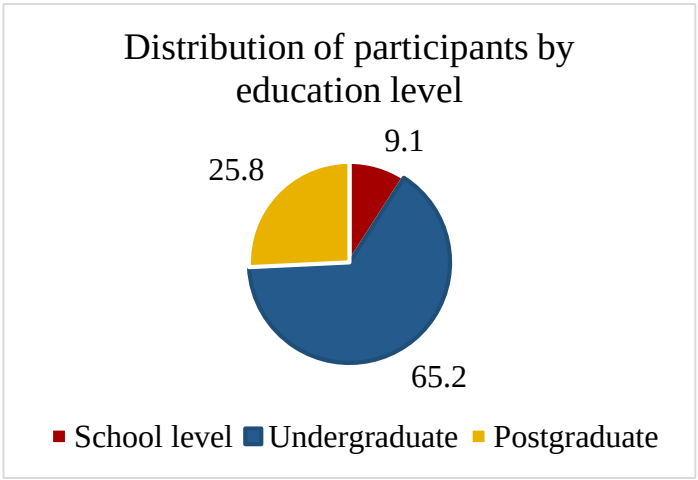



Figure 4.3: Participants education level.

Figure 4.4 depicts geographical location of the participants and as can be seen that participants from Dubai Emirate formed the majority of the sample (n= 136; 41.2%), followed by Sharjah Emirate(n= 78; 23.6%), Ajman (n= 43; 13.0%), Abu Dhabi (n= 34; 10.3%), Al-Fujairah (n= 16; 4.8%), Umm Al-Quwain (UAQ) (n= 13; 3.9%) and Ras Al-Khaimah (RAK) (n= 10; 3.0%).

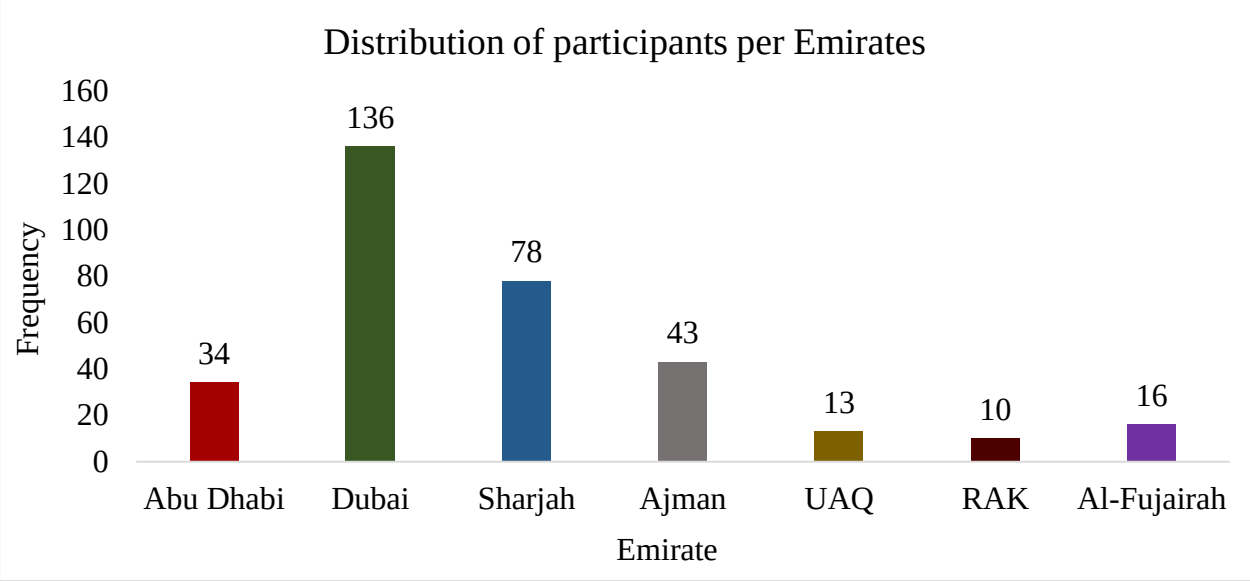



Figure 4.4: Participants distribution per Emirate.

#### 4.2.2.1 TAM Outcomes

Participants were arranged by likelihood to accept telemedicine technology in the UAE and clinical characteristics were evaluated. Appendix L: Statistical Results shows the mean and SD for general knowledge, demand, attitude, behaviour and usage of telemedicine for the overall sample and subsamples. The highest and lowest mean value for general knowledge of telemedicine was recorded among the participants for the evident usage of advanced technology in the UAE (4.04 $\pm$ 1.08) and for the response that telemedicine is a well-known concept (2.73 $\pm$ 1.14); respectively. The mean value for the demand of telemedicine among participants was documented slightly higher (3.71 $\pm$ 1.02). Scores for all questions for each perceived telemedicine attribute were be averaged to generate the precise mean score. So, in total; the mean score of general knowledge/ awareness of telemedicine was recorded high among all the participants (3.38 $\pm$ 0.87)

and when participants were asked about the perceived usefulness of this advanced technology, most of the participants agreed that it would be useful with a mean of (3.81 $\pm$ 0.82).

Similarly, about ease of use, the mean score of the participants was (3.56 $\pm$ 0.83) leading towards an agreement that telemedicine would be easy to use. The mean score for the question that telemedicine would be better than traditional medical care delivery was observed to be (3.05 $\pm$ 1.15) and the mean score (3.17 $\pm$ 1.99) was achieved from the participants that they will use telemedicine on a regular basis. About the actual usage of telemedicine, participants who responded that they will use this technology regularly were 26 (7.9%), often 88 (26.7%), rarely 72 (21.8%), not at all 64 (19.4%) and don't know 80 (24.2%).

For questions that participants had to respond based on agreement level (Likert scale), responses were pooled during analysis as the following:

- Strongly agree and agree = agreement.
- Strongly disagree and disagree = disagreement.
- Neutral response was kept as is.

**a. Awareness Level of Technology in the UAE**

About (n=266; 80%) of the participants agreed that advanced technology is evidently used in the UAE, while (n=34; 10.3%) had neutral response and (n= 30; 9.1%) disagreed with the statement as depicted in figure 4.5. Yet, figure 4.6 displays that less number of participants (n=97; 29.4%) agreed that telemedicine is a well-known concept while (n= 71; 21.5%) had neutral response and (n=162; 49.1%) disagreed with the statement.

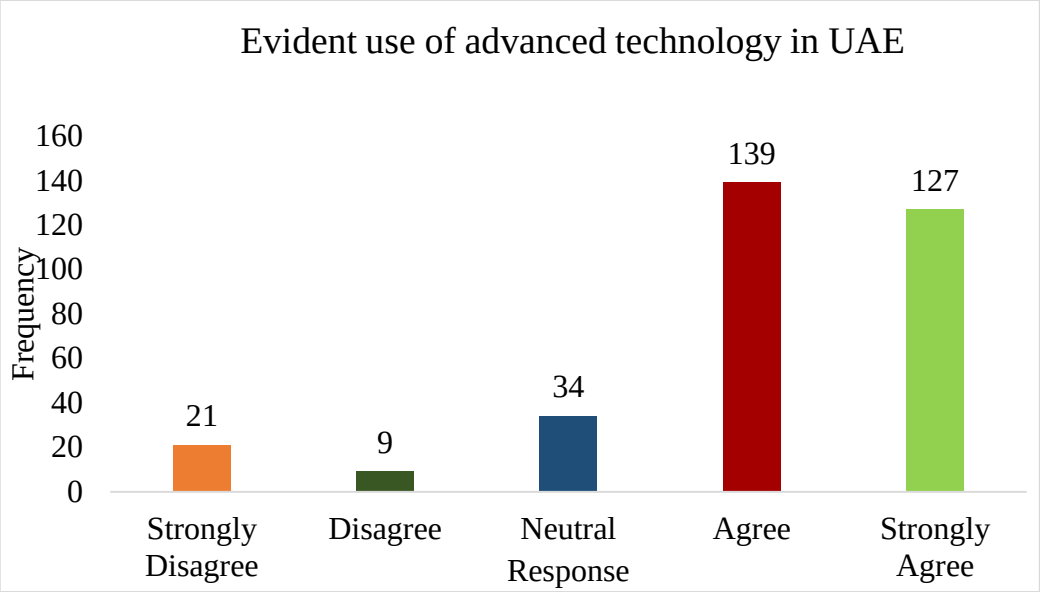



Figure 4.5: Evident use of advanced technology in the UAE.

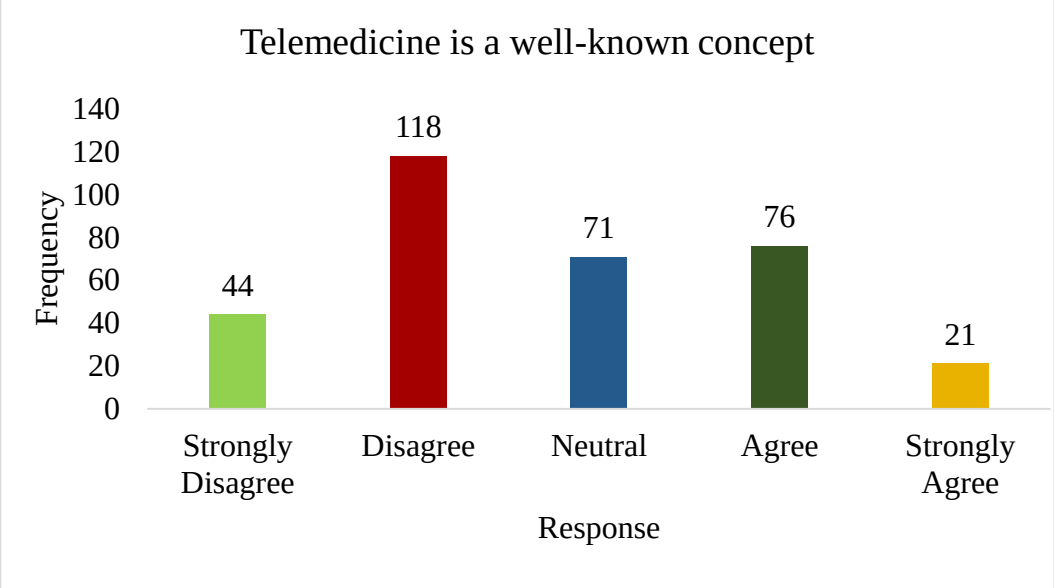



Figure 4.6: Telemedicine is a well-known concept.

**b. Demand of Telemedicine in the UAE**

Figure 4.7 demonstrates that a high percentage of participants stated that there is a need for telemedicine in the UAE and around (n=234; 71%) agreed with the statement, while (n= 54; 16.4%) had neutral response and only (n=42; 12.7%) disagreed with the need.

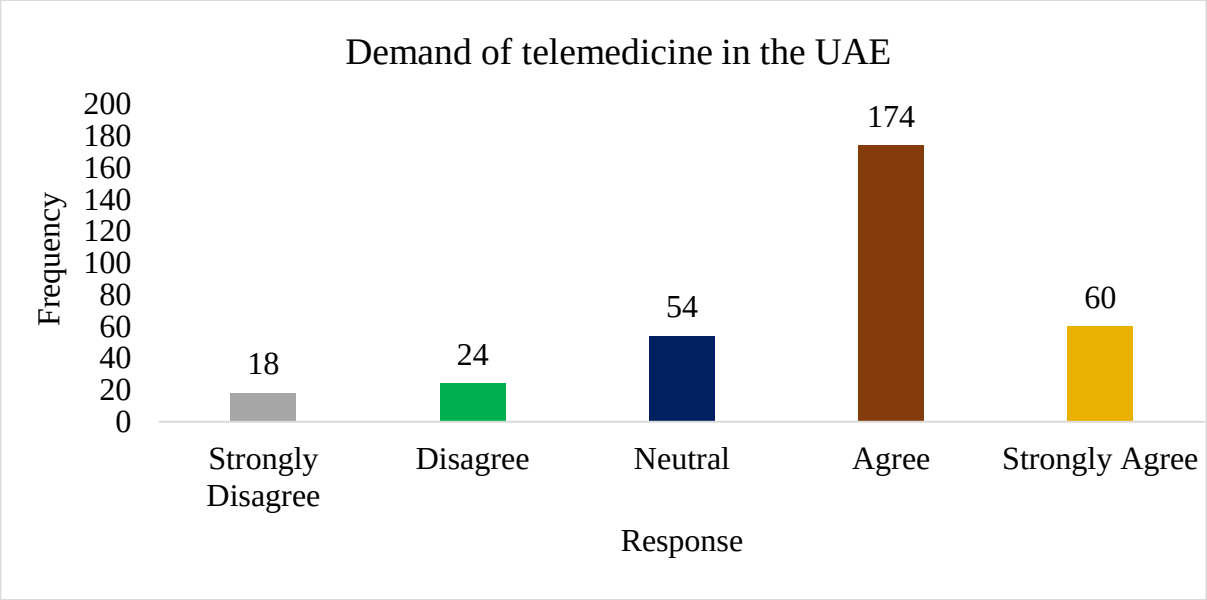



Figure 4.7: Telemedicine demand in the UAE.

**c. Perceived Usefulness (PU)**

Figure 4.8 reveals that a large number of responses (n= 247; 74.8%) was achieved in terms of agreement that telemedicine can help people in achieving tasks more quickly; however, (n= 53; 16.1%) responded neutral and only (n= 30; 9.1%) disagreed with the statement.

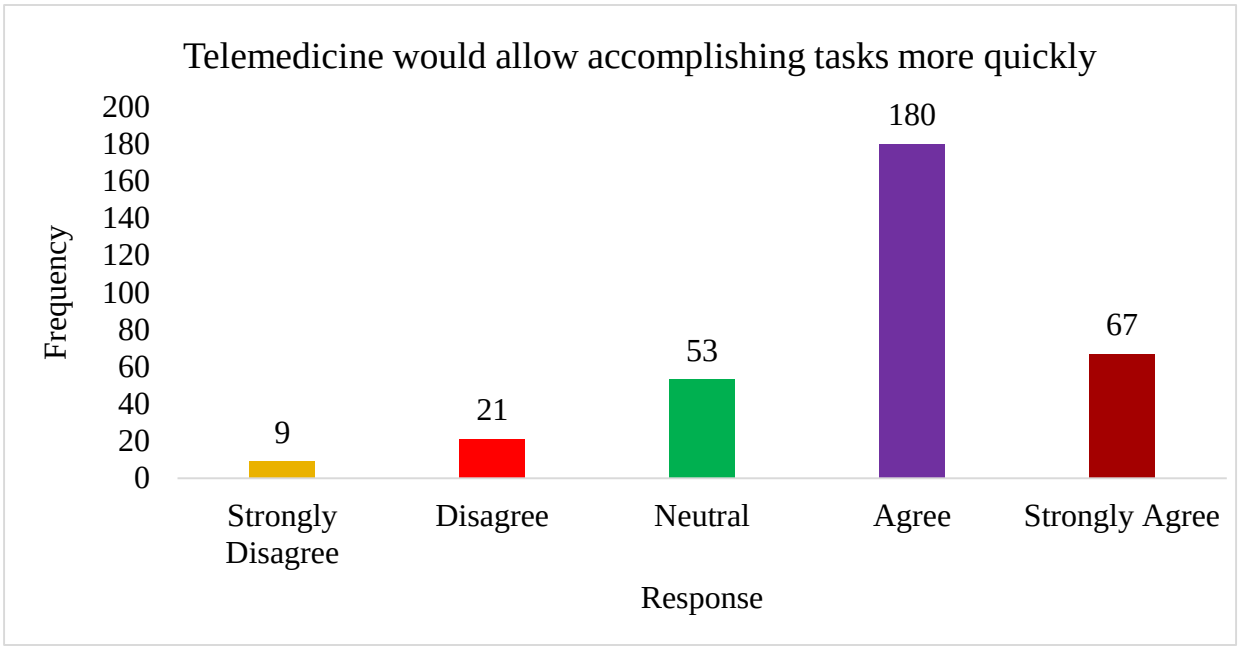



Figure 4.8: Telemedicine would accomplish tasks more quickly.

Figure 4.9 validates that (n= 219; 66.4%) of the participants agreed that using telemedicine would improve performance, while (n= 79; 23.9%) had neutral response and (n= 32; 9.7%) disagreed.

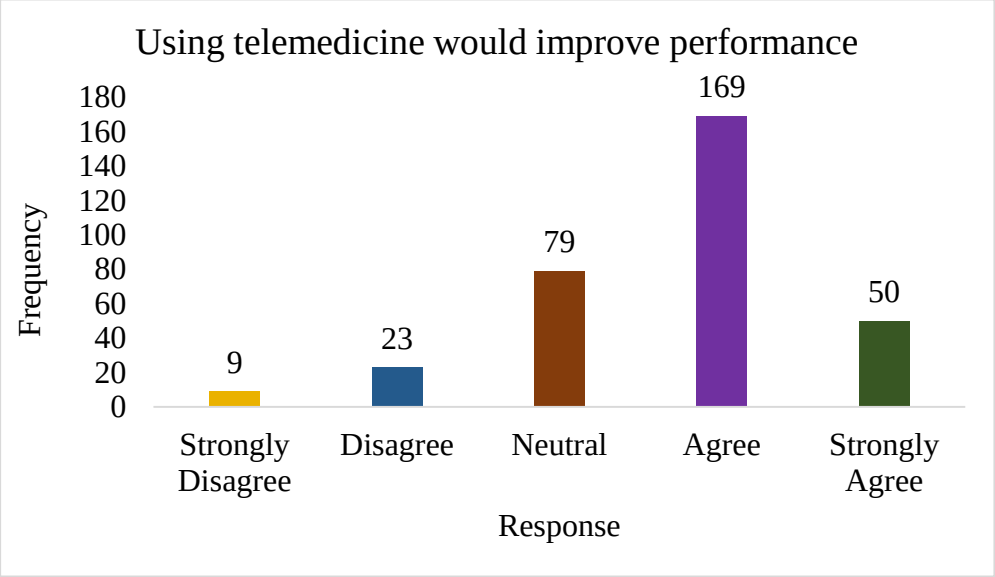



Figure 4.9: Telemedicine would improve performance.

Figure 4.10 confirms that telemedicine would be useful by (n=251; 76.1%) of the participants, (n= 57; 17.3%) was found with neutral response and very less responses (n= 22; 6.7%) was established for disagreement.

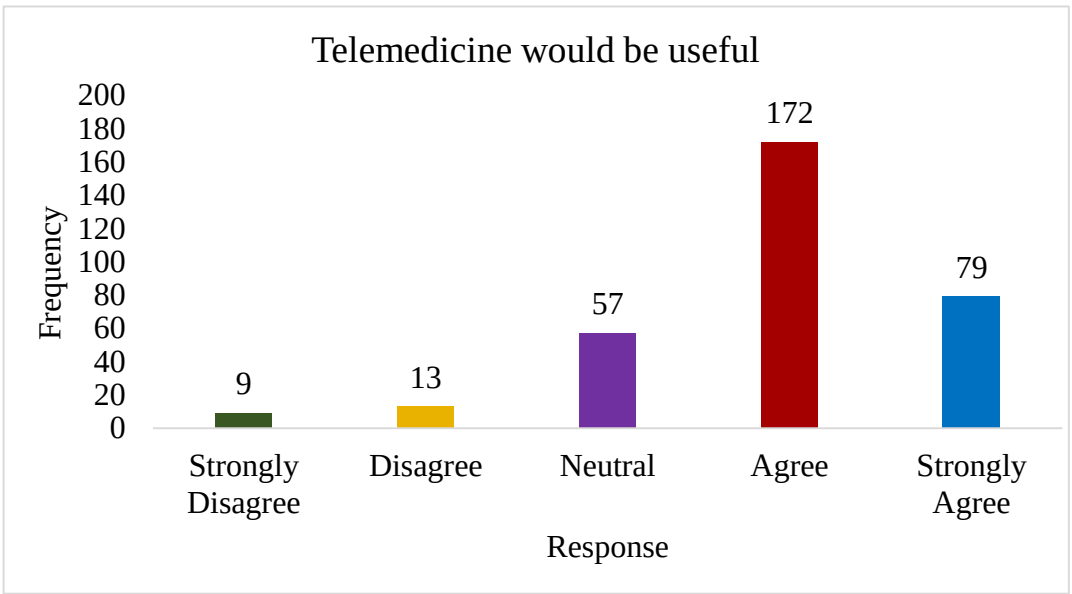



Figure 4.10: Telemedicine would be useful.

**d. Perceived Ease of Use (PEOU)**

Figure 4.11 indicates whether participants find telemedicine would be flexible to interact with or not and (n= 192; 58.2%) of the participants agreed, while (n= 97; 29.4%) had a neutral response and (n= 41; 12.4%) disagreed with the flexibility of interaction.

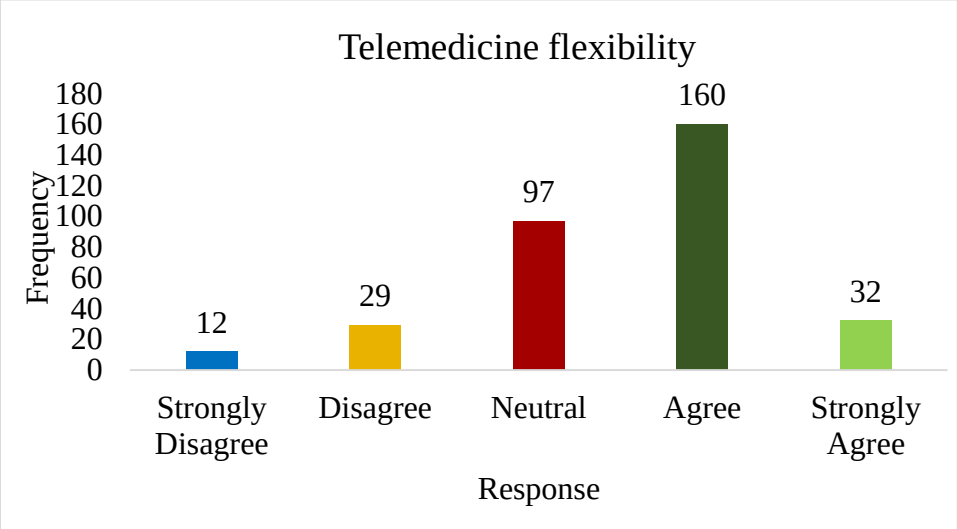



Figure 4.11: Telemedicine flexibility to interact with.

Figure 4.12 specifies that (n=212; 64.2%) participants agreed that becoming skilful at using telemedicine would be easy for them, followed by neutral (n= 77; 23.3%). However, (n= 41; 12.4%) disagreed with the statement.

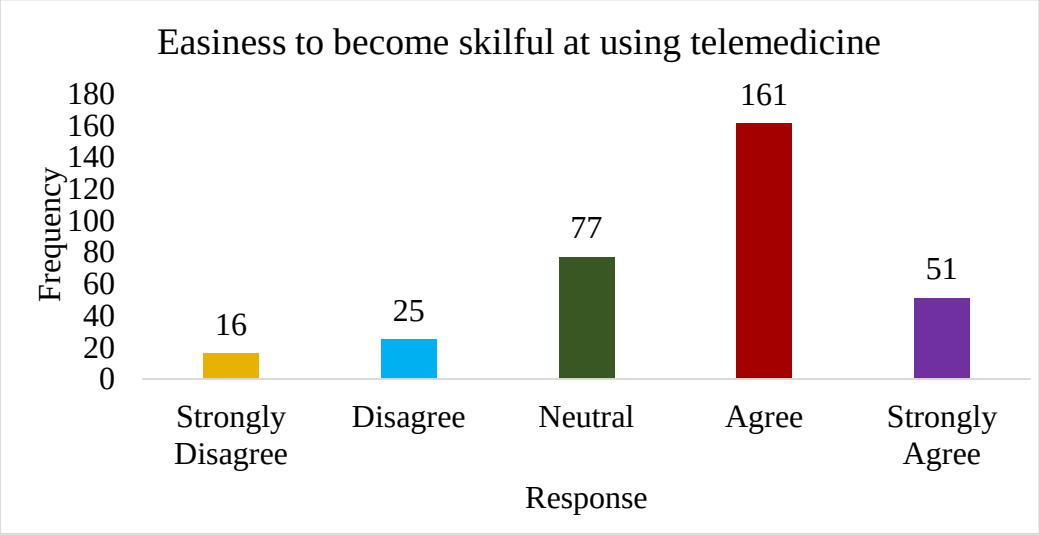



Figure 4.12: Easiness to become skilful at using telemedicine.

While, figure 4.13 presents an adequate number of agreement responses (n= 188; 57%) that telemedicine would be easy to use followed by neutral (n= 101; 30.6%) and disagreement (n= 41; 12.4%) with the ease of use.

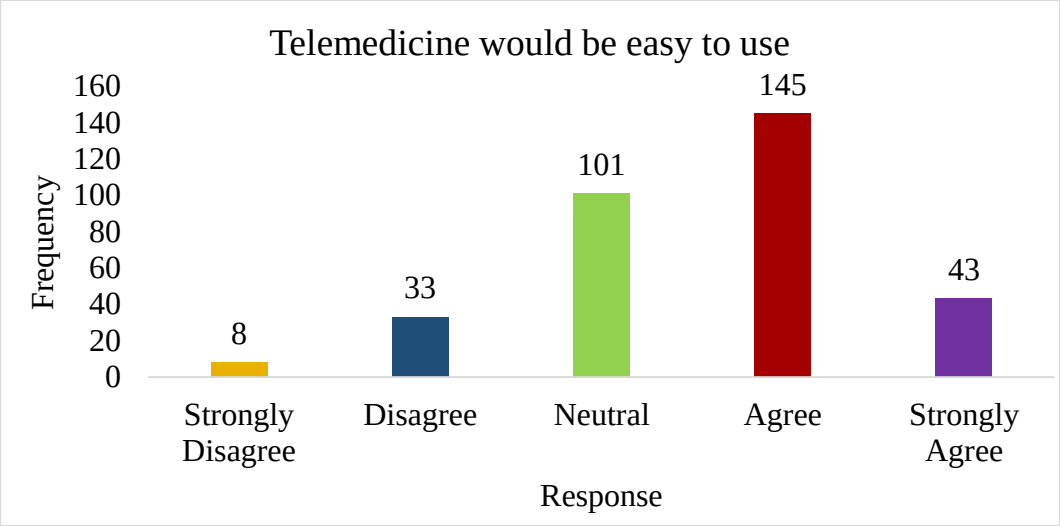
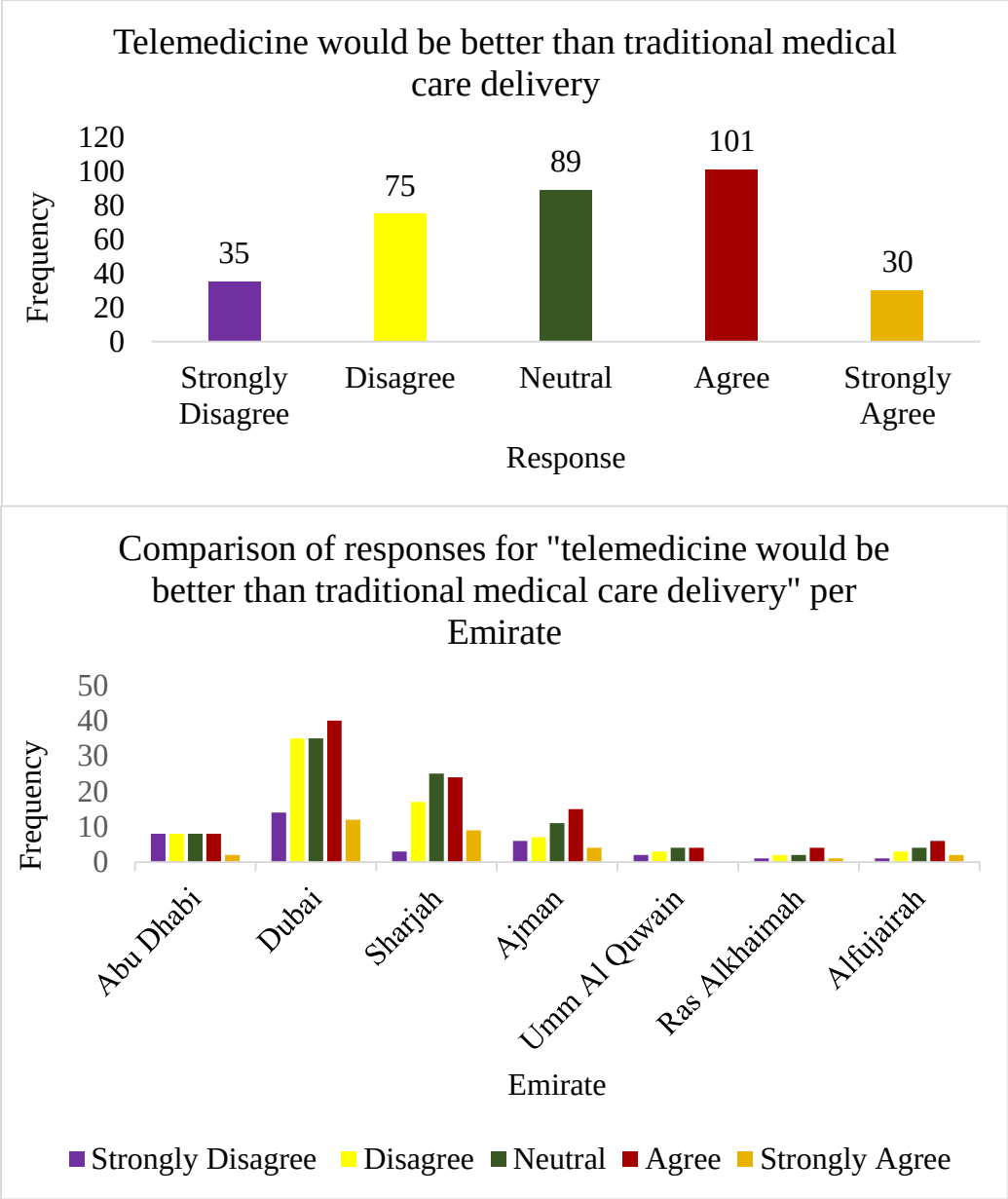



Figure 4.13: Easiness to use telemedicine.

**e. Attitude Towards Using(A)**

Figures 4.14 show participants' attitude towards telemedicine and when participants were asked whether telemedicine would be better than traditional medical care delivery, only (n= 131; 39.6%) agreed and (n= 89; 27.0%) had a neutral response, while (n= 110; 33.3%) responded disagree. Also, further analysis was done to compare whether telemedicine would be better than traditional medical care delivery per Emirate.




Figures 4.14: Medical practice.

**f. Behavioural Intention (BI)**

The below figure 4.15 illustrates the behavioural intention of the participants; either they will use telemedicine on regular basis or not and (n= 137; 68.5%) showed their positive interest followed by (n= 108; 32.7%) neutral and (n= 85; 25.7%) no interest / disagreed.

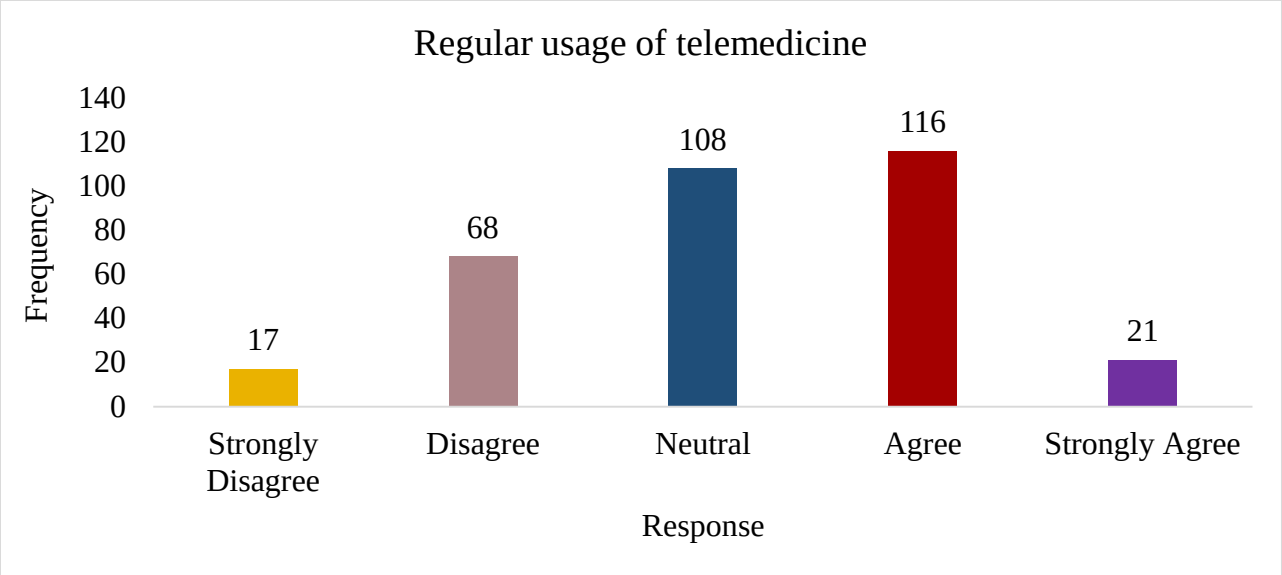



Figure 4.15: Regular usage of telemedicine.

**g. Actual/Expected Usage**

Here, participants were asked to respond based on their actual usage of telemedicine technology. If not, then respond based on their future expected usage. As shown in figure 4.16, more than a quarter of the participants (26.7%) stated that they often use telemedicine or will use it, followed by not sure (24.2%) if they will use the technology and then rarely usage by (21.8%).

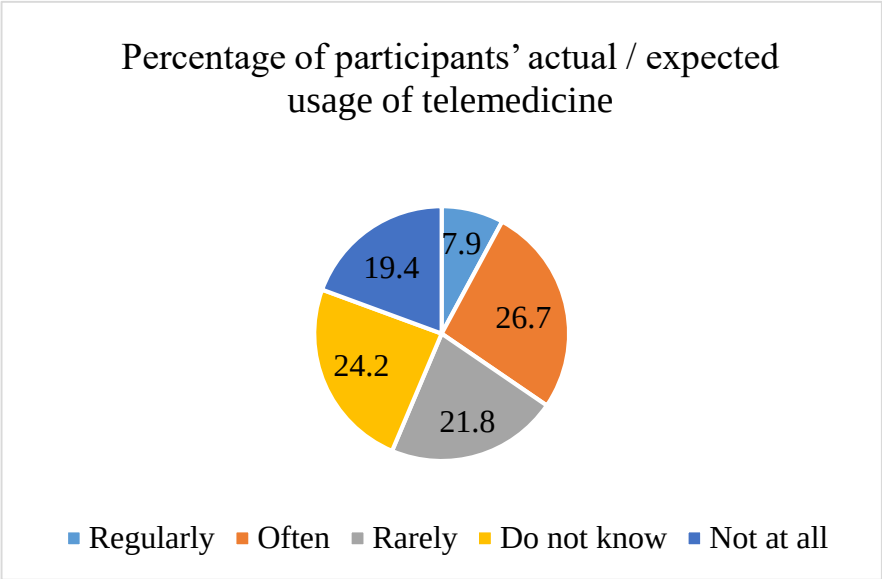



Figure 4.16: Telemedicine actual / expected usage.

For the below questions, participants were asked to choose from multiple choices available. Also, they had the option to add other responses not listed and choose more than one response.

Table 4.2: Distribution of statistics for the usage of telemedicine.

| Questions/Statements | N | % |
|---|---|---|
| Which of telemedicine's features you mostly used or will probably use? | | |
| Reports generation | 120 | 36.4 |
| Scheduler | 87 | 26.4 |
| Export/import files | 116 | 35.2 |
| Online-help | 162 | 49.1 |
| Other | 6 | 1.8 |
| What are most liked features of telemedicine? | | |
| Virtual communication | 135 | 40.9 |
| Sharing reports | 117 | 35.5 |
| Booking an appointment easily without visiting the hospital | 180 | 54.5 |
| Accessing personal medical record | 152 | 46.1 |
| Other | 8 | 2.4 |
| What are most disliked features of telemedicine? | | |
| Fear of sudden Internet disconnection | 163 | 40.9 |
| User-interface | 66 | 20.0 |
| Language | 94 | 28.5 |
| Technical skills required | 125 | 37.9 |
| Other | 17 | 5.2 |

As noticed from table 4.2, participants were inquired about the features of telemedicine that they used or will probably use in the future and the most common feature was the online help (49.1%) followed by report generation (36.4%), export/import files (35.2%) and scheduler (26.4%). Few participants (1.8%) did not choose any option and mentioned other responses (e.g. I did not use it and direct consultation and management of patients). Those who stated that they did

not use the technology yet did not know which features they would use in the future. Participants were also asked about the most liked features of telemedicine and the maximum number of responses was achieved in terms of booking an appointment easily without visiting the hospital (54.5%), followed by accessing personal medical record (46.1%), virtual communication (40.9%), sharing reports (35.5%) and few participants (2.4%) stated other responses (e.g. do not know and handling claims). Similarly, disliked features of telemedicine were as well observed and the most accounted one was fear of sudden Internet disconnection (49.4%) followed by technical skills required (37.9%), language (28.5%), user-interface (20.0%) and (5.2%) of the participants marked other responses for disliking the technology. For instance, improper diagnosis, lack of required skills from both physicians and technicians, technological miss-occurrences, problems if not properly used or executed, missing the human interaction and medical mistakes due to technology, difficulty in reading and assessing patients' body language and psychological status as well as if there are any problems with the application or the website (e.g. update files).

Furthermore, as part of evaluating participants' usage level, they were asked optionally to provide suggestions for future improvements of telemedicine technology and (n= 51; 15.5%) provided interesting suggestions, as demonstrated in figure 4.17. The suggestions were grouped under categories. For instance, (n=8) participants provided technical related suggestions and those were grouped under the [technical improvements] category.

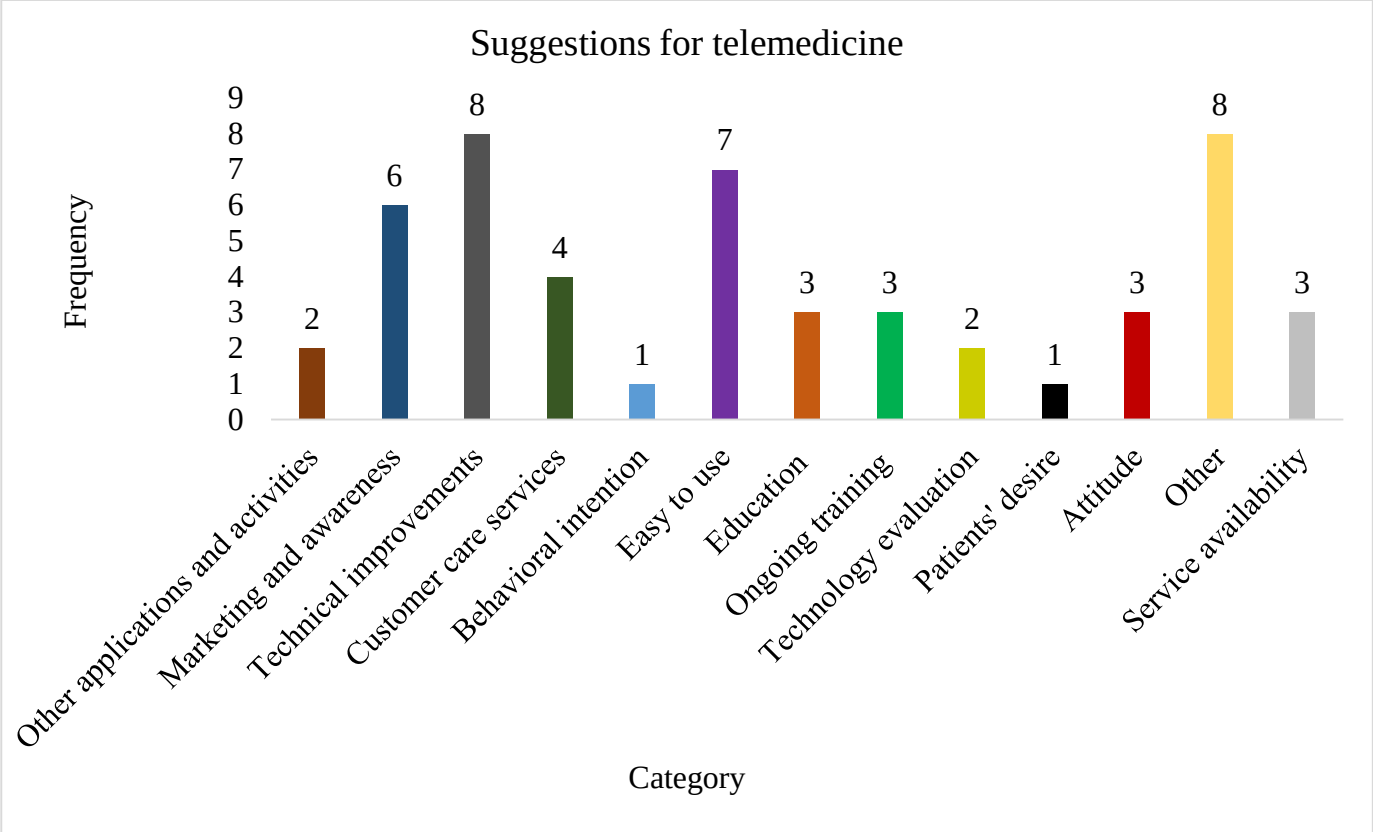



Figure 4.17: Suggestions for telemedicine improvements.

Below table 4.3 depicts further examples of what each category included.

Table 4.3: Examples of suggestions per category.

| Category | Examples |
|---|---|
| Other applications and activities | Care from home and specialists for the elderly. |
| Marketing and awareness | Proper marketing that reaches all possible users and needs more promotion because still people do not know about it. |
| Technical improvements | Accessibility on cloud, improve online services and features, mobile platform, better to acquire 5G Internet and ICT. |
| Customer care services | Quick response and professional care, as well as telemedicine must be placed under fully integrated technical support. |
| Behavioural intention | It will be appreciated if this technology saves our time. |

| | |
|---|---|
| Easy to use | Selection of languages to use, user-friendly, easiness and free access to the networks. |
| Education | Educating elderly people to use telemedicine and more lectures. |
| Ongoing training | More training. |
| Technology evaluation | Study telemedicine before implementation and trialability. |
| Patients' desire | Patients' desire to visit the hospital. |
| Attitude | It is a good idea; need to use it more, the sooner, the better, as well as seriousness and accountability while using telemedicine. |
| Other | International coordination for experts assistance, informed consent, choose famous and experienced doctors and they must review the patient's medical record before starting telemedicine session for fast treatment. |
| Service availability | Must be for everyone (all nationalities), in all hospitals and all Emirates. |

#### 4.2.2.2 Telemedicine Benefits and Challenges

Here, participants were asked to choose from multiple choices available and had the option to select more than one response as well as add other benefits and challenges not listed. Table 4.4 demonstrates the possible benefits and challenges of telemedicine technology within the UAE context.

Table 4.4: UAE telemedicine benefits and challenges.

| Telemedicine possible benefits | N | % |
|---|---|---|
| Improve access to healthcare services | 224 | 67.9 |
| Cost-effectiveness | 166 | 50.3 |
| Share knowledge | 154 | 46.7 |
| Reduce congestion to seek medical care | 165 | 50.0 |
| Other | 7 | 2.1 |

| | | |
|---|---|---|
| Telemedicine possible challenges | | |
| Reliability | 170 | 51.5 |
| Trustiness | 112 | 33.9 |
| Security | 175 | 53.0 |
| Variety of social backgrounds and values | 95 | 28.8 |
| Acceptance by the users | 126 | 38.2 |
| Increase workload on healthcare professionals | 68 | 20.6 |
| Other | 2 | 0.6 |

The most common benefit of telemedicine selected was to improve access to healthcare services (67.9%), followed by cost-effectiveness (50.3%) and reduce congestion to seek medical care (50.0%), which both were chosen almost equally. A few number of the participants stated other benefits (2.1%), such as connecting with other caregivers, which is part of sharing knowledge option and outsourcing doctors as telemedicine could lead to international telemedicine certification for doctors, which will reduce healthcare costs. Furthermore, improve convenience and customers' satisfaction, connecting with different healthcare professionals globally and save time.

On the other hand, for challenges, security (e.g. confidentiality, privacy…etc.) (53.0%) and reliability (e.g. system availability, human errors…etc.) (51.5%) were the most common challenges selected. Yet, other challenges were raised aside from those listed, such as availability to all possible users and not suitable for the older generation who do not have that much knowledge about technology.

#### 4.2.2.3Hypotheses Testing

Several hypotheses were tested in this research based on TAM and Rogers DOI Theory. Those hypotheses were also tested in previous works, but in different settings, as shown in appendix B: Previous Works' Hypotheses Testing and Outcomes.

**Hypothesis 1: Perceived usefulness and perceived ease of use of telemedicine**

$H_0$: There is no correlation between usefulness and ease of use of telemedicine.

$H_1$: There is a correlation between usefulness and ease of use of telemedicine.

Tables 4.5 demonstrate the association between the responses of usefulness and ease of use and 81.5% of the participants agreed that telemedicine would be a useful technology and easy to use, while 41.0% responded that though telemedicine would be useful, but it will not be easy to use. In comparison, a positive correlation was achieved between both variables r= 0.413. Thus, the association between usefulness and ease of use was statistically significant ($\chi^2$= 56.36, df= 1; P= 0.000).

Tables 4.5: Relationship between usefulness of telemedicine and ease of use.

| | | | Usefulness | | Total | P-value |
|---|---|---|---|---|---|---|
| | | | Yes | No | | |
| Ease of use | Yes | N | 128 | 29 | 157 | 0.000 |
| | | % within Ease of Use | 81.5% | 18.5% | 100.0% | |
| | No | N | 71 | 102 | 173 | |
| | | % within Ease of Use | 41.0% | 59.0% | 100.0% | |
| Total | | N | 199 | 131 | 330 | |
| | | % within Ease of Use | 60.3% | 39.7% | 100.0% | |

| Correlations | | | |
|---|---|---|---|
| | | Acceptance of Telemedicine in terms of Usefulness | Acceptance of telemedicine in terms of ease of use |
| Acceptance of Telemedicine in terms of usefulness | Pearson Correlation | 1 | .413** |
| | Sig. (2-tailed) | | .000 |
| | N | 330 | 330 |
| | Pearson Correlation | .413** | 1 |

| | | | |
|---|---|---|---|
| Acceptance of telemedicine in terms of ease of use | Sig. (2-tailed) | .000 | |
| | N | 330 | 330 |

**Correlation is significant at the 0.01 level (2-tailed).

| Chi-Square Tests | | | | | |
|---|---|---|---|---|---|
| | Value | df | Asymptotic Significance (2-sided) | Exact Sig. (2-sided) | Exact Sig. (1-sided) |
| Pearson Chi-Square | 56.363[a] | 1 | .000 | | |
| Continuity Correction[b] | 54.684 | 1 | .000 | | |
| Likelihood Ratio | 58.882 | 1 | .000 | | |
| Fisher's Exact Test | | | | .000 | .000 |
| Linear-by-Linear Association | 56.192 | 1 | .000 | | |
| N of Valid Cases | 330 | | | | |

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 62.32.

b. Computed only for a 2x2 table

**Hypothesis 2: Telemedicine acceptance and positive attitude**

$H_0$: There is no association between acceptance (usefulness and ease of use) of telemedicine with positive attitude.

$H_1$: There is an association between acceptance (usefulness and ease of use) of telemedicine with positive attitude.

Tables 4.6 show that out of 330 participants, 85 (58.2%) answered [yes] in terms of acceptance of telemedicine and had positive attitude towards using it, while 61 (41.8%) had negative attitude among participants who responded that they can accept telemedicine but didn't agree that it would be better than traditional medical care. The association between acceptance and positive attitude was statistically significant ($\chi^2$= 37.52, df= 1, p=0.000).

Tables 4.6: Association between acceptance and positive attitude towards using telemedicine.

| | | | Positive attitude | | Total | P-value |
|---|---|---|---|---|---|---|
| | | | Yes | No | | |
| Acceptance | Yes | N | 85 | 61 | 146 | 0.000 |
| | | % within Acceptance | 58.2% | 41.8% | 100.0% | |
| | No | N | 46 | 138 | 184 | |
| | | % within Acceptance | 16.0% | 84.0% | 100.0% | |
| Total | | N | 131 | 199 | 330 | |
| | | % within Acceptance | 39.7% | 60.3% | 100.0% | |

| Descriptive Statistics | | | |
|---|---|---|---|
| | Mean | Std. Deviation | N |
| Mean Acceptance of telemedicine in terms of usefulness + ease of use | 3.5645 | .83162 | 330 |
| Mean Attitude score | 3.0485 | 1.15016 | 330 |

| Correlations | | | |
|---|---|---|---|
| | | Mean Acceptance of telemedicine | Mean Attitude score |
| Pearson Correlation | Mean Acceptance score | 1.000 | .488 |
| | Mean Attitude score | .488 | 1.000 |
| Sig. (1-tailed) | Mean Acceptance score | . | .000 |
| | Mean Attitude score | .000 | . |
| N | Mean Acceptance score | 330 | 330 |
| | Mean Attitude score | 330 | 330 |

| Model Summary | | | | |
|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .488[a] | .238 | .236 | .72695 |

a. Predictors: (Constant), Mean Attitude score

b. Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use

| ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 54.200 | 1 | 54.200 | 102.561 | .000[b] |
| | Residual | 173.336 | 328 | .528 | | |
| | Total | 227.536 | 329 | | | |

a. Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use

b. Predictors: (Constant), Mean Attitude score

| Coefficients | | | | | | | |
|---|---|---|---|---|---|---|---|
| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | |
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 2.489 | .114 | | 21.925 | .000 | 2.265 | 2.712 |
| Mean Attitude score | .353 | .035 | .488 | 10.127 | .000 | .284 | .421 |

a. Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use

The findings showed quite a difference in the coefficients compared to the simple linear regression. In the above model summary table, it can be noticed that the R square was .238, which means that approximately 23.8% of the variance of mean acceptance score is accounted for by the model. The R is the correlation of the model between mean acceptance score with the mean attitude score and established with a moderate positive relationship (R= 0.488). From the ANOVA table, F-test can be seen and hence the model was statistically significant. Looking at the coefficients table, the constant or intercept term was 2.489, and this is the predicted value of acceptance score when assumption of attitude score equals zero. The t-test for mean attitude score equalled 10.127 and is statistically significant, meaning that the regression coefficient for attitude is significantly

different from zero. The coefficient for attitude was 0.353, meaning that for a one response increase in average respondents, it would be expected a 0.353 increase in mean acceptance.

**Hypothesis 3: Attitude's influence on behavioural intention towards using telemedicine.**

$H_0$: There is no correlation between attitude and behavioural intention towards using telemedicine.

$H_1$: There is a correlation between attitude and behavioural intention towards using telemedicine.

Tables 4.7 present positive correlation between attitude towards using telemedicine and behavioural intention among the research participants and results showed a statistically significant association between the two variables, which support the alternative hypotheses (r= .608, p=0.000).

Tables 4.7: Correlation between attitude and behavioural intention toward using telemedicine.

| Descriptive Statistics | | | |
|---|---|---|---|
| | Mean | Std. Deviation | N |
| Mean Behavioural Intention of telemedicine score | 3.17 | .996 | 330 |
| Mean Attitude Towards Using score | 3.05 | 1.150 | 330 |

| Correlations | | | |
|---|---|---|---|
| | | Behavioural Intention (BI) | Attitude Towards Using(A) |
| Pearson Correlation | Behavioural Intention (BI) | 1.000 | .608 |
| | Attitude Towards Using(A) | .608 | 1.000 |
| Sig. (1-tailed) | Behavioural Intention (BI) | . | .000 |
| | Attitude Towards Using(A) | .000 | . |
| N | Behavioural Intention (BI) | 330 | 330 |
| | Attitude Towards Using(A) | 330 | 330 |

**Hypothesis 4: Telemedicine acceptance and positive behavioural intention**

$H_0$: there is no association between acceptance (usefulness and ease of use) of telemedicine with positive behavioural intention.

$H_1$: there is an association between acceptance (usefulness and ease of use) of telemedicine with positive behavioural intention.

Tables 4.8 present the association between the acceptance of telemedicine and positive behavioural intention among participants and results showed maximum number of participants 103 (70.5%) were overwhelmingly agreed to accept telemedicine technology and they will use it on a regular basis, while only 43 (29.5%) exposed their negative behaviour towards regular practice. Statistically significant difference was stated between these two variables, which support the alternative hypothesis that there is an association between acceptance (usefulness and ease of use) of telemedicine with positive behavioural intention ($\chi^2$= 90.90, df= 1, p=0.000).

Tables 4.8: Association between acceptance of telemedicine and positive behavioural intention.

| | | | Behavioural Intention | | Total | P-value |
|---|---|---|---|---|---|---|
| | | | Yes | No | | |
| Acceptance | Yes | N | 103 | 43 | 146 | 0.000 |
| | | % within Acceptance | 70.5% | 29.5% | 100.0% | |
| | No | N | 34 | 150 | 184 | |
| | | % within Acceptance | 18.5% | 81.5% | 100.0% | |
| Total | | N | 137 | 193 | 330 | |
| | | % within Acceptance | 41.5% | 58.5% | 100.0% | |

| Descriptive Statistics | | | |
|---|---|---|---|
| | Mean | Std. Deviation | N |
| Mean Acceptance of telemedicine in terms of usefulness + ease of use | 3.5645 | .83162 | 330 |

| | | | |
|---|---|---|---|
| Mean Behavioural Intention score | 3.1697 | .99619 | 330 |

| Correlations | | | |
|---|---|---|---|
| | | Mean Acceptance score | Mean Behavioural Intention score |
| Pearson Correlation | Mean Acceptance score | 1.000 | .597 |
| | Mean Behavioural Intention score | .597 | 1.000 |
| Sig. (1-tailed) | Mean Acceptance score | . | .000 |
| | Mean Behavioural Intention score | .000 | . |
| N | Mean Acceptance score | 330 | 330 |
| | Mean Behavioural Intention score | 330 | 330 |

| Model Summary | | | | |
|---|---|---|---|---|
| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
| 1 | .597[a] | .356 | .354 | .66823 |

a. Predictors: (Constant), Mean Behavioural Intention score

b. Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use

| ANOVA [a] | | | | | | |
|---|---|---|---|---|---|---|
| Model | | Sum of Squares | df | Mean Square | F | Sig. |
| 1 | Regression | 81.072 | 1 | 81.072 | 181.558 | .000[b] |
| | Residual | 146.464 | 328 | .447 | | |
| | Total | 227.536 | 329 | | | |

a. Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use

b. Predictors: (Constant), Mean Behavioural Intention score

| Coefficients [a] | | | | | |
|---|---|---|---|---|---|
| Model | Unstandardized Coefficients | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B |

| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
|---|---|---|---|---|---|---|---|
| (Constant) | 1.985 | .123 | | 16.157 | .000 | 1.743 | 2.227 |
| Mean Behavioural Intention score | .498 | .037 | .597 | 13.474 | .000 | .426 | .571 |

a. Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use

In the above model summary table, the R square was .356, which means that approximately 35.6% of the variance of mean acceptance score is accounted for by the model. The R is the correlation of the model between mean acceptance score and mean behavioural intention score, which found with a strong positive relationship (e.g. R= 0.597). The coefficient table demonstrates a statistically significant association between both attributes.

**Hypothesis 5: Telemedicine acceptance and effective usage**

H0: There is no correlation between usefulness and ease of use of telemedicine with effective usage.

H1: There is a correlation between usefulness and ease of use of telemedicine with effective usage.

Tables 4.9 demonstrate the correlation between acceptance and actual effective usage of telemedicine and the results showed no relationship that if participants will find it useful and easy to use, they would agree to use the technology regularly or often (e.g. the correlation coefficient r= 0.049). Statistically insignificant value was perceived among both attributes P= 0.377.

Tables 4.9: Correlation between acceptance of telemedicine and effective usage.

| Correlations | | | |
|---|---|---|---|
| | | Usefulness + Ease of use | Effective usage |
| Acceptance of Telemedicine in terms of (Usefulness + Ease of use) | Pearson Correlation | 1 | .049 |
| | Sig. (2-tailed) | | .377 |
| | N | 330 | 330 |
| Effective usage (How many times you actually use or will use telemedicine?) | Pearson Correlation | .049 | 1 |
| | Sig. (2-tailed) | .377 | |
| | N | 330 | 330 |

| Descriptive Statistics | | | |
|---|---|---|---|
| Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use | | | |
| How many times you actually used or will use telemedicine? | Mean | Std. Deviation | N |
| Don't Know | 3.4880 | .81133 | 80 |
| Not at all | 3.1509 | .90653 | 64 |
| Rarely | 3.5131 | .69369 | 72 |
| Often | 3.9467 | .55351 | 88 |
| Regularly | 3.6673 | 1.23620 | 26 |
| Total | 3.5645 | .83162 | 330 |

| Parameter Estimates | | | | | | | |
|---|---|---|---|---|---|---|---|
| Dependent Variable: Mean Acceptance of telemedicine in terms of usefulness + ease of use | | | | | | | |
| Parameter | B | Std. Error | t | Sig. | 95% Confidence Interval | | Partial Eta Squared |
| | | | | | Lower Bound | Upper Bound | |
| Intercept | 3.667 | .155 | 23.672 | .000 | 3.363 | 3.972 | .633 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| How many times you actually used or will use telemedicine=0 | -.179 | .178 | -1.006 | .315 | -.530 | .172 | .003 |
| How many times you actually used or will use telemedicine=1 | -.516 | .184 | -2.811 | .005 | -.878 | -.155 | .024 |
| How many times you actually used or will use telemedicine=2 | -.154 | .181 | -.853 | .394 | -.510 | .201 | .002 |
| How many times you actually used or will use telemedicine=3 | .279 | .176 | 1.585 | .114 | -.067 | .626 | .008 |
| How many times you actually used or will use telemedicine=4 | 0[a] | . | . | . | . | . | . |

a. This parameter is set to zero because it is redundant.

The above model showed the significance between the mean acceptance score and each attribute of technology usage; separately. Results showed a statistically insignificant difference between the regular or often usage of telemedicine and acceptance. In contrast, the participants who responded not at all had a significant p-value < 0.05, which explained that if the participants would accept telemedicine even though they will not prefer to use it in a regular routine.

#### 4.2.2.4 DOI Theory and Other External Attributes

Cronbach's alpha (α) was measured for DOI Theory on a scale comprising of 9 items and the result indicated high reliability (α= 0.92). Table 4.10 depicts the responses related to DOI theory and most of the participants strongly agreed that the technology would require training for users (40%) and legal framework before implementation (32.1%). They responded that people will take interest when they see others using this advanced technology (23.6%). Also, (8.8%) of the participants disagreed that it would be easy to obtain related information via telemedicine and

some participants disagreed as well that telemedicine would change the work processes of an organization.

Table 4.10: Diffusion of innovations and external attributes.

| Attributes | Strongly Disagree (%) | Disagree (%) | Neutral (%) | Agree (%) | Strongly Agree (%) | Mean score |
|---|---|---|---|---|---|---|
| Awareness of new innovations (e.g. telemedicine) impacts its diffusion | 3.3 | 3.6 | 22.7 | 51.8 | 18.5 | 3.78 |
| Users' engagement in activities related to an innovation (e.g. telemedicine) leads to embrace it | 2.4 | 5.2 | 24.5 | 53.3 | 14.5 | 3.72 |
| The technology would require training for users | 3.3 | 3.0 | 10.9 | 42.7 | 40.0 | 4.13 |
| It would require a legal framework before implementation to guide the use of such system | 3.3 | 2.7 | 10.9 | 50.9 | 32.1 | 4.06 |
| Using telemedicine would meet needs in a better way | 3.0 | 3.6 | 25.2 | 54.2 | 13.9 | 3.72 |
| Telemedicine would change the work processes of an organization | 2.1 | 5.2 | 17.6 | 55.8 | 19.4 | 3.85 |
| Obtaining related information via telemedicine would be easy | 2.1 | 8.8 | 21.5 | 52.7 | 14.8 | 3.69 |
| Being personally able to try telemedicine is important to make decision about using it | 2.1 | 3.9 | 18.5 | 52.4 | 19.4 | 3.90 |
| Probably, people would be interested in telemedicine when they see others using it | 2.7 | 3.0 | 15.2 | 55.5 | 23.6 | 3.94 |

| | | | | | | |
|---|---|---|---|---|---|---|
| Telemedicine would be accepted in the UAE | 3.6 | 4.8 | 20.3 | 50.9 | 20.3 | 3.79 |

Table 4.11 demonstrates the multivariate model of the variables which can affect the relationship between acceptance and positive attitude, behaviour and usage of telemedicine. Results showed that effect modifiers like participants of age group (18-30) years had (2.167) probabilities of acceptance of telemedicine as a new technology and they were agreed to adopt it in future. For example, positive attitude (95 % CI, 0.803 – 5.844), positive behaviour (OR= 1.716; 95% CI: 0.583 – 5.051) and effective usage (OR= 1.885; 95% CI: 0.709 – 5.016).

**H6: Confounding variables and acceptance of telemedicine**

$H_0$: there is no association between the confounding variables and acceptance of telemedicine.

$H_1$: there is an association between the confounding variables and acceptance of telemedicine.

Statistically insignificant difference was observed between the age groups and acceptance towards different attributes. Conversely, male participants who agreed and strongly agreed to accept the technology had reduced probabilities of regular usage (OR = 0.853; 95% CI: 0.542 – 1.345). However, local participants had (1.379) probabilities of accepting telemedicine and positive attitude (95 % CI, 0.867 – 2.193), positive behaviour (OR: 1.301; 95 % CI: 0.780 – 2.170) and effective usage (OR: 1.359; 95 % CI: 0.861 – 2.145). Insignificant p-value revealed that male gender, local nationality and higher education level had no effect on the association between acceptance, attitude, behaviour and usage of telemedicine in UAE. Participants had greater probabilities for the confounding variable like diffusion of innovations and response if they were strongly agreed and agreed with the acceptance of telemedicine and positive attitude (OR = 4.805;

CI%: 2.855 – 8.085), regular use (OR = 3.851; 95% CI: 2.201 – 6.736), or the effective usage of telemedicine (OR = 5.743; 95% CI: 3.411 – 9.668). Statistically strong significant value was verified between diffusion of innovations attributes and acceptance (p =0.000).

Table 4.11: Characteristics associated with acceptance of telemedicine.

| Variables | Positive Attitude Odds ratio (95 % CI) | P-value | Positive Behaviour Intention Odds ratio (95 % CI) | P-value | Effective Usage Odds ratio (95 % CI) | P-value |
|---|---|---|---|---|---|---|
| Age (18-30) years | 2.167 (0.803 – 5.844) | 0.127 | 1.716 (0.583 – 5.051) | 0.327 | 1.885 (0.709 – 5.016) | 0.204 |
| Age (31-40) years | 1.866 (0.735 – 4.735) | 0.189 | 1.423 (0.517 – 3.916) | 0.494 | 1.522 (0.606 – 3.827) | 0.372 |
| Age (41-50) years | 1.426 (0.528 – 3.855) | 0.484 | 0.890 (0.300 – 2.645) | 0.834 | 1.138 (0.426 – 3.043) | 0.797 |
| Male Gender | 0.871 (0.548 – 1.385) | 0.559 | 0.959 (0.575 – 1.601) | 0.874 | 0.853 (0.542 – 1.345) | 0.853 |
| Local Nationality | 1.379 (0.867 – 2.193) | 0.174 | 1.301 (0.780 – 2.170) | 0.313 | 1.359 (0.861 – 2.145) | 0.187 |
| School level Education | 1.117 (0.462 – 2.704) | 0.805 | 1.573 (0.599 – 4.133) | 0.358 | 1.469 (0.611 – 3.534 | 0.391 |
| Undergraduate | 0.725 (0.423 – 1.242) | 0.242 | 0.805 (0.443 – 1.461) | 0.476 | 0.844 (0.500 – 1.427) | 0.527 |
| Diffusion of Innovations | 4.805 (2.855 – 8.085) | 0.000 | 3.851 (2.201 – 6.736) | 0.000 | 5.743 (3.411 – 9.668) | 0.000 |

On analysis as depicted in table 4.12, it was concluded that out of 330 participants, a significant number (n=216; 65.5%) considered telemedicine as a positive innovation and they are ready to accept and use this new convenient technology followed by (n=92; 27.9%) assumed it as a negative innovation and they would prefer traditional medical care delivery and (n=22; 6.7%) had neutral response.

Table 4.12: Overall perception of telemedicine in the UAE.

| Questions/Statements | N | % |
|---|---|---|
| Overall, how actually do you perceive telemedicine? | | |
| Positive Innovation | 216 | 65.5 |
| Neutral | 22 | 6.7 |
| Negative Innovation | 92 | 27.9 |

The below table 4.13 summarizes the outcomes of the tested hypotheses:

Table 4.13: Summary of hypotheses tested.

| Hypothesis | Specification | Result |
|---|---|---|
| H1 | There is a correlation between usefulness and ease of use of telemedicine. | Accepted (r = 0.413, p= 0.000) |
| H2 | There is an association between acceptance (usefulness and ease of use) of telemedicine with positive attitude. | Accepted (r = 0.488, p=0.000) |
| H3 | There is a correlation between attitude and behavioural intention towards using telemedicine. | Accepted (r= .608, p=0.000) |
| H4 | There is an association between acceptance (usefulness and ease of use) of telemedicine with positive behavioural intention. | Accepted (r = 0.597, p=0.001) |
| H5 | There is a correlation between usefulness and ease of use of telemedicine with effective usage. | Rejected (r= 0.049, p= 0. 377) |

| | | |
|---|---|---|
| H6 | There is an association between the confounding variables and acceptance of telemedicine. | Rejected ($p>0.05$) except for diffusion of innovations attributes which revealed a statistically strong significant association between diffusion of innovations attributes and acceptance ($p =0.000$). |

### 4.2.3 Qualitative Analysis

#### 4.2.3.1 Interviews Data Analysis and Interpretation

A sociotechnical analysis of telemedicine in the UAE was done by conducting as well interviews. Atlas.ti® software version 7.5.7 was used to analyse the qualitative data obtained through interviews sessions.

Thematic analysis "is a method to identify, analyse, interpret and report patterns (themes) within data" (Braun & Clarke 2006). In thematic analysis, coding is a necessary step. It is different from content analysis, where it relies on quantifying phrases and words in the content.

Thematic analysis is a straightforward approach, easy to conduct and does not require in-depth knowledge compared to other analysis methods, such as discourse analysis and content analysis (Braun & Clarke 2006). It can be a realist method as it reports experiences, the reality of participants and meanings or constructionst in which it examines the effects of discourses operating in a society related to events, meanings and experiences. Also, it can be a contextualist method, a hybrid between both realist and constructionst (Braun & Clarke 2006).

In this research, deductive thematic analysis (theoretical) was followed to identify themes and analyse qualitative data based on pre-existing concepts and theories, the researcher's knowledge in the area, and literature review. It requires engagement with literature before the

analysis phase starts. This approach follows coding of data based on the research questions rather than evolving of the research questions through the coding (known as inductive approach). This form of analysis provides more detailed analysis of needed data and less depth description of the data overall (Braun & Clarke 2006). Additionally, it is suitable when a researcher has an idea about possible responses that the participants will provide, which was the case in this research.

Interview questions were used as a guide to analyse the data as they were organized based on the research's questions. Thematic analysis involves several steps moving backwards and forwards (recursive process). Despite that Creswell (2014) steps for qualitative data analysis was followed; it was modified from step 3 onwards instead of having one direction; the process was iterative, as depicted in figure 4.18.

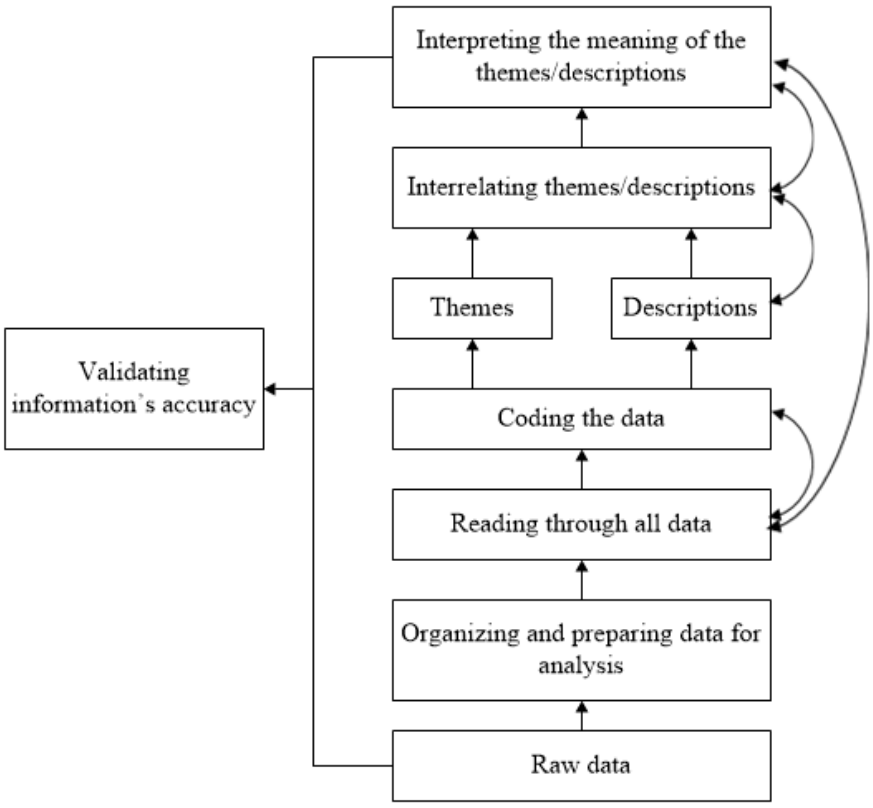



Figure 4.18: Qualitative data analysis process (Adapted from Creswell 2014, p.197).

Some aspects from Braun and Clarke (2006) six phases of thematic analysis, as depicted in table 4.14 was as well followed regardless of its order.

Table 4.14: Thematic analysis (Adapted from Braun & Clarke 2006, p.35).

| Phase | Description |
|---|---|
| 1. Familiarization with the data | It involves data transcription as needed, reading and re-reading data, as well as taking notes of initial data. |
| 2. Initial codes generation | Inserting codes in systematic style through the entire dataset and collating data relevant to each code. |
| 3. Searching for themes | Collating codes within potential themes and gathering data related to each potential themes. |
| 4. Reviewing themes | Checking themes work in relation to the coded extracts (level 1) and then the entire dataset (level 2). Also, producing a thematic map of the analysis. |
| 5. Themes definition and naming | Ongoing analysis to enhance specifics of themes and the overall story of the analysis tells, as well as generating clear definitions and names for each theme. |
| 6. Report generation | It includes selecting vivid and compelling extract examples, final analysis of chosen extracts, relating back the analysis to the research questions and literature as well as producing a scholarly report of the analysis. |

Braun and Clarke (2006) stated that qualitative analysis guidelines are similar somehow and they are not rules. Instead, it is about following the basic principles and be flexible to fit the research aims, questions and data (Patton 1990, cited in Braun & Clarke 2006). Below are descriptions of the steps followed in this research.

- Step 1: Raw data:

Qualitative data from interviews sessions were audio-recorded and, at the same time, by taking handwritten notes to avoid equipment failures (Creswell 2014). An interview protocol template was developed and used during interview sessions, as shown in appendix J: Interview

Protocol Template. Different transcription software for qualitative data are available and in this research, NCH Express Scribe Transcription Software® and IBM Watson Speech to Text™ (IBM 2019) were experimented with to test which one is more applicable and easy to use. Despite that NCH Express Scribe Transcription Software® was used to transcribe the interview sessions (audio), proofreading and editing the transcripts were required. The software has a high sensitivity to surrounding sounds and languages spoken.

Furthermore, self-intelligent verbatim transcription was done, where light editing to the transcripts was done to correct sentences, grammars and omit irrelevant words and pauses. Yet, this type of transcription is time-consuming and the transcriber needs to be familiar with the topic being transcribed to avoid omitting important data. Therefore, for the research purpose, intelligent verbatim transcription was the suitable one compared to other types, such as verbatim transcription where every spoken word, emotions expressed, mumbles and background noise need to be transcribed and this is a very tedious task and time-consuming which can be avoided; as applicable (Salonga 2019).

- Step 2: Data organization and preparation:

After completing the transcription step, data and information transcribed were organized. Arabic language transcripts were translated into English by the researcher herself as she has the linguistic skills for both Arabic (as a native language) and English (as a second language with IELTS score of 6.5). Those transcripts were then peer-reviewed by neutral certified researchers. Also, participants who had English language skills but preferred to speak in Arabic during the interviews were asked to review and verify the transcripts after translation while omitting the personal identifiers of interviewees.

Data were organized and prepared in folders according to the information's sources, such as Kalba Hospital interviews to facilitate analysis and interpretation.

- Step 3: Reading data:

This step involved reading through the data collected to get familiar with it before starting the coding step. Also, to evaluate whether it makes sense or not, reflect the research's purpose, cover research questions, what participants' general ideas were?…etc.

- Step 4: Data coding:

Creswell (2014) categorized coding qualitative data into 3 categories:

- Codes on topics that readers would expect finding it or based on the past literature and common sense.
- Codes that are unusual and would interest readers.
- Codes that are surprising and not expected at the beginning of a research.

There is an option to use predetermined codes based on theories being examined by "allowing codes to emerge during data analysis or using integration of predetermined and emerging codes" (Creswell 2014). In addition, a codebook was developed that contains predetermined themes, codes, descriptions and examples of quotes elucidating the codes as shown in appendix M: Qualitative Data Codebook.

Codes differ from themes which the second one are broader. Deductive open coding of the data based on predetermined themes and concepts from the literature was done. Atlas.ti® allows creating the needed codes and modify them at any time. These codes can then be selected from a [drop-down] list; no need to write them next to the sentences/paragraphs, which saves time and allows unifying codes names. However, there is In Vivo code in which phrases or sentence are taken straight from the transcript. There is no specific number of codes to apply. It depends on

data's richness, saturation and depth of analysis (Nation 2017). Appendix N: Atlas.ti® Screenshots illustrates open coding utilized in this research.

At the initial stage, open coding was done and going through the process till axial and selective coding. Open coding builds straight from the raw data. This ensures validity. Next, axial coding was done by conducting intense analysis around one category at a time and finding a relationship between categories and subcategories. For instance, the main category is acceptance of telemedicine and the subcategory related to acceptance was demographic factors that affect telemedicine acceptance. The last step was selective coding, in which data were coded systemically and concertedly for the main category. Selective coding was done by "delimits coding to only those codes that link to the core code(s)" (Strauss 1987). However, the process is time-consuming and involve tedious works going line-by-line, particularly if the qualitative data are huge.

The below network, as shown in figure 4.19 illustrates the relationship between the code family [Telemedicine in the UAE], related six codes and sub-codes.

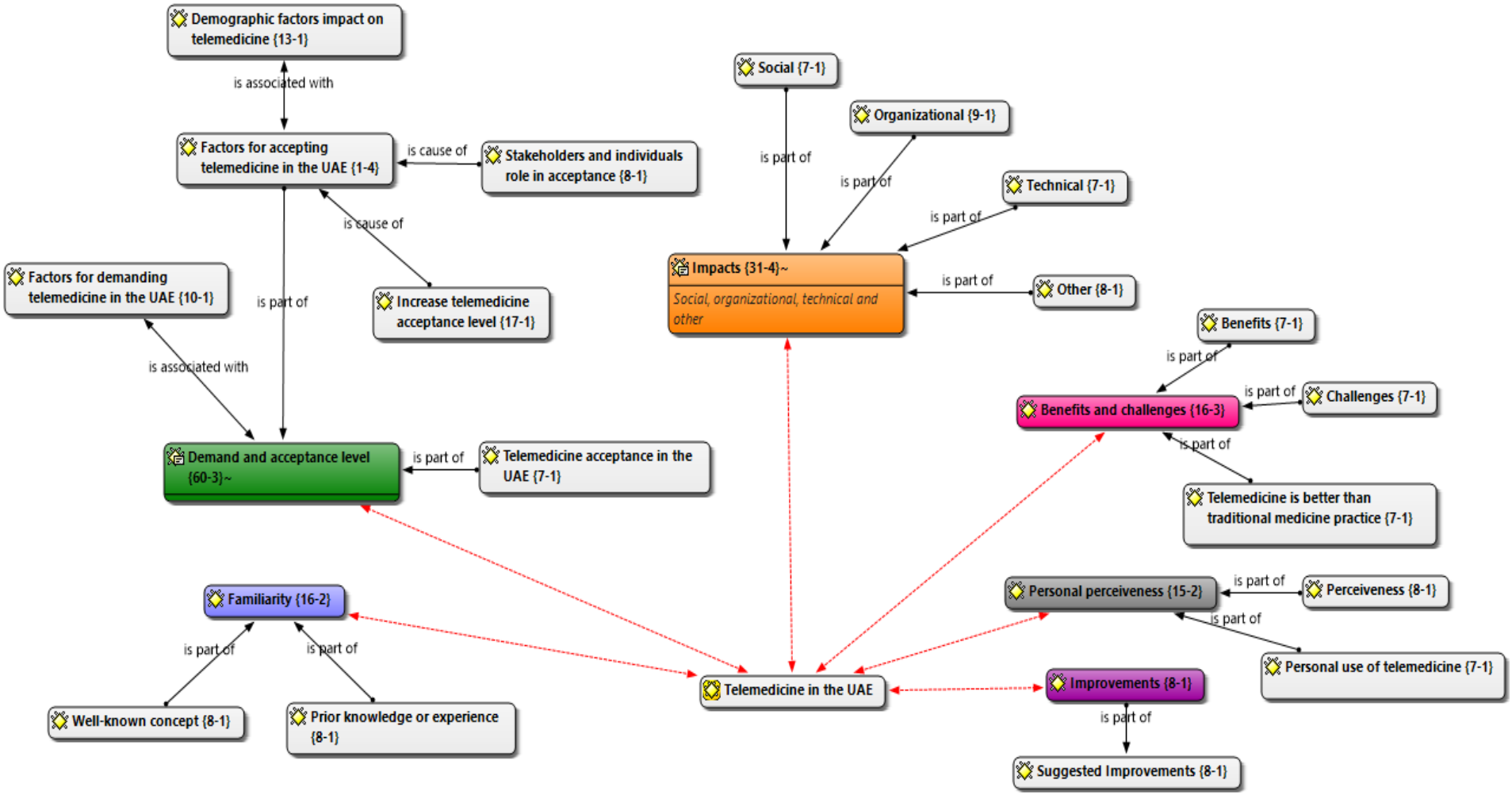



Figure 4.19: UAE telemedicine codes network.

Each main code was highlighted in a different colour to differentiate between them during analysis. The number next to the codes (on the left side) reflects the number of quotations and the number within brackets (on the right side) reflects how many sub-code is associated with it. For instance, familiarity with telemedicine included 16 quotations and 2 sub-codes, while impacts of telemedicine included 31 quotations and 4 sub-codes. Though, for the sub-codes, the number in the brackets (on the left side) means number of quotations, while on the (right side) means number of main and subcodes. Those valid and usable quotes were included. Total quotations used were around 146. Still, a separate network was created for each code, which included related inputs from the research participants. The inputs were grouped under specific categories and placed between square brackets to differentiate between various inputs, as shown in appendix N: Atlas.ti® Screenshots. Yet, quotes were rephrased and some of them were not added; as needed. For instance, code [Familiarity] included two sub-categories: well-known concept and prior knowledge or experience. This allowed analysing the data gathered during the interviews in easier way and group those related to the same theme in one place.

Demand and acceptance level code had the largest inputs as it was one of the main research questions and involved applying models. While future improvement of telemedicine code was the least responded to compared to other codes as the question was not mandatory to answer it.

All quotations for a specific code can be listed and navigated through in Atlas.ti® regardless of the number of documents that the code was used in it, as shown in appendix N: Atlas.ti® Screenshots.

- Step 5: Thematization and description

It involved sorting different codes under themes, analysing codes and combining them. Themes were created using questions from the interview to guide through predominant themes. Then, those themes were reviewed again for better analysis and interpretation as well as to avoid

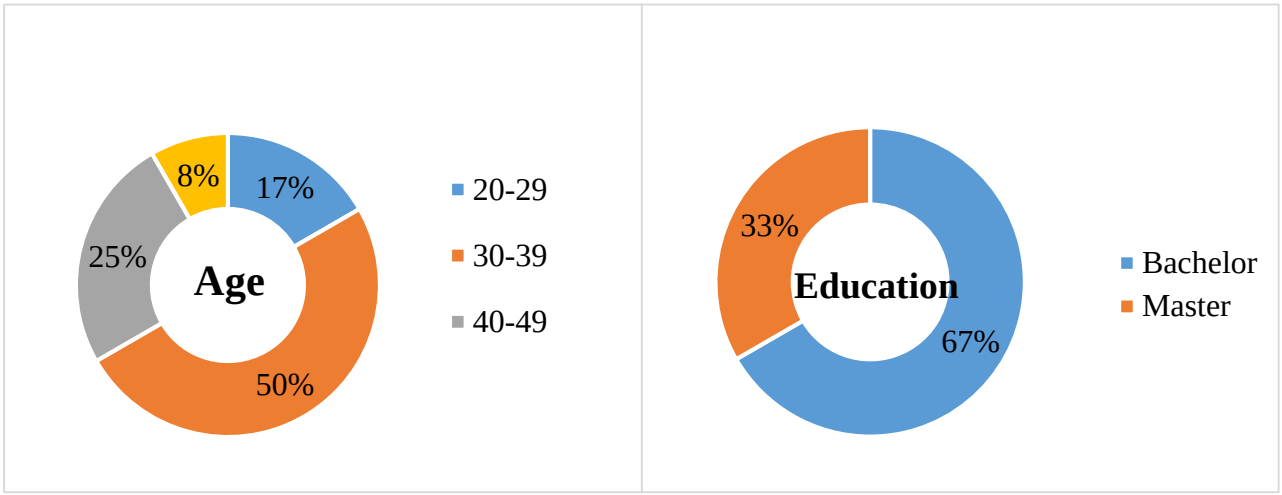
long and misunderstood analysis. This process was iteratively done to identify and interpret key themes and insights related to it. Themes were defined and illustrated in the codebook (appendix M: Qualitative Data Codebook). Participants' thoughts and inputs were analysed and linked to the themes listed. Detailed analysis of themes was done in the next step (interpretation), which what both Braun and Clarke (2006) and Creswell (2014) did as well.

- Step 6: Interpretation

According to Creswell (2014), this step involves interpretation of findings, comparisons between data/information obtained via interviews and literature or theories by either confirm past information, divert from it and/or suggest new findings that had not been foreseen earlier. Interpretation can convey personal meaning, research-based and/or actions.

**Interviewees' Sociodemographic Profile**

The interviewees' sociodemographic profile is characterized by having individuals from different backgrounds, age groups, genders, education, and occupation levels. The below figures 4.20 and 4.21 depicts interviewees distribution per age, education and occupation.




Figures 4.20: Interviewees' distribution per age and education.

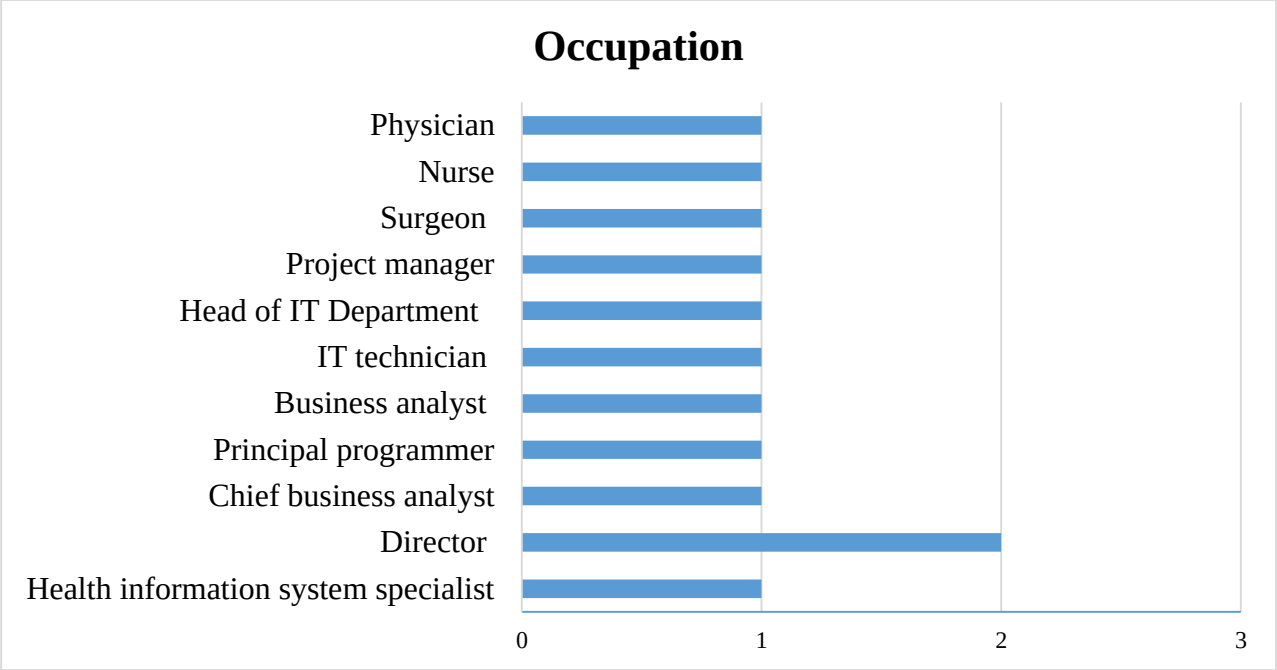



Figure 4.21: Interviewees distribution per occupation.

Most of the interviewees were in their thirties, with one of the interviewees preferred to no disclose her age. Also, more than half of the interviewees hold a bachelor degree in different majors, such as medicine and information technology. Their occupations were various, such as healthcare professionals, business analyst and directors.

**Themes Interpretation**

Below table 4.15 presents interviews data interpretation per themes.

Table 4.15: Interviews themes interpretation.

| Themes | Findings | Quotes samples |
|---|---|---|
| Familiarity with technologies | It consisted of two sub-categories and the interviewees responded well to this theme. Total quotes for this theme was around 16.<br>a. Well-known concept:<br>Responses related to this sub-category were various. Most interviewees agreed that telemedicine is known among those who work in the healthcare field but not among the public.<br>b. Prior knowledge or experience:<br>Most of the interviewees had prior knowledge about telemedicine. There were interviewees who did not try it before but had knowledge based on searches they did. Yet, three interviewees did not have any experience with telemedicine.<br>Results were compared between those who stated that telemedicine is a well-known concept and prior knowledge or experience. The analysis indicated rational findings. For instance, those who stated that telemedicine is a well-known concept; stated at the same time that they have prior knowledge or experience with the technology. | A chief business analyst stated that telemedicine is a "*new term, unknown by the public. It is still in premature phase".*<br><br>A business analyst stated that "*doubt anyone has experienced it in the UAE",* which is not the actual situation as telemedicine has been implemented in the country time ago regardless of the technology scale implemented (Al-Qirim 2007; Goldberg et al. 1994).<br><br>"*Tried it with one of my doctors about a medical concern and it was very effective and I did not have to go to emergency*". Another one said, "*do not have an idea if has been implemented currently or exists between physicians and public*", while another person stated that "*neither use it nor knew that it was implemented or it can be tried and contributed to it*". |

| | | |
|---|---|---|
| Demand and acceptance | It consisted of two sub-categories. The interviewees responded well to this theme. Total quotes for this theme was around 60.<br>a. Factors for demanding telemedicine in the UAE:<br>Responses were various; ranged from those who clearly stated that there is a need for telemedicine in the UAE to those who stated the contrary.<br>Other reasons discussed for demanding telemedicine in the UAE were shortage of specialists, increase treatment success rate, reduce costs related to seek care abroad and for emergency cases.<br>b. Factors for accepting telemedicine in the UAE:<br>It included sub-sections as the following:<br>i. Demographic factors:<br>There were interviewees who stated that elderly people might not accept telemedicine and almost all of the interviewees agreed that telemedicine would be more accepted among younger people. An interviewee stated that young people's education level plays a significant role in accepting telemedicine. However, there were interviewees who believed that elderly would be interested in the technology if people started using it noticeably and elderly sensed the technology's benefits.<br>On the other hand, the interviewees agreed that there is no difference between males or females. | A HIS specialist stated "*our country is not that big if we are going to use telemedicine; it will be more beneficial for people who cannot travel between the emirates. It will be demanding for them".* A director at MOHAP stated that *"there is a demand for workforce, and some specialities are not available in all regions, so we need to sort it out through telemedicine*". A principal programmer stated that "*with the evolution in the country, there is a need for telemedicine".*<br><br>"*As a start, I do not think elderly will accept the idea of having a video call or something with a doctor as they might think it will not be private or real*". Another one stated that "*elderly persons will never believe in this thing, they will believe it is just a video of someone talking to them, or maybe they can take it just as acceptance, but they won't believe it. For healthcare, believing is everything*". "*Acceptance of telemedicine among both genders is equal".* |

ii. Stakeholders and individuals role in acceptance:

Interviewees shared common thoughts about stakeholders and individuals role in telemedicine acceptance. For instance, marketing, promotion of the technology more in the community and encouraging each other. An IT technician stated that encouragement should be done via social media due to its great impact on people. One of the interviewees stated that if the technology to start, it must be started and accepted internally among healthcare professionals and centres, then moved externally to the public.

*"Everyone needs to talk about it, vendors need to advertise it and patients need to see how it will benefit them and healthcare professionals as well*".

*"The government has to accept that telemedicine is good enough".*

iii. Telemedicine acceptance in the UAE:

Interviewees agreed that telemedicine would be somehow accepted in the UAE. However, they had some concerns about that. For instance, to consider patients' desire to use it or not, enough awareness and take into consideration time factor to accept the technology. Another concern was the lack of trust in technologies by elderly people.

A HIS specialist stated: *"physicians have different understanding level that telemedicine is just like a normal consultation; just it is only via video call. For patients, they might be afraid at the beginning, but within time, they will get used to it".*

*"It can be accepted because the way UAE is moving; it is technically advanced. The country always open for innovative things, so UAE can have telemedicine as one of the key initiatives*".

"*It would be difficult for elderly to talk with a physician via machine or technology*".

iv. Increase telemedicine acceptance level:

Interviewees provided various thoughts to increase telemedicine acceptance level and some of these thoughts were common among them. For instance, they agreed upon advertisement, education, continuous training, policy and guidelines, healthcare professionals' acceptance, awareness and marketing. The most concurring recommendations among them were awareness and marketing.

Yet, some unique thoughts were provided as well, such as government support and trying telemedicine among one medical speciality, observing and experiencing the technology as it would build confidence in people to start using it. Furthermore, adding telemedicine in education curriculums, particularly in healthcare majors.

*"People might not know the concept of telemedicine, so they should first be aware of it and of course if they see that everywhere there is advertisement and marketing about it along with policies, they will feel that it is fine, wholesome and it is a complete package which is beneficial for them, so they will start accepting it*".

A principle programmer recommended: *"evaluate acceptance among healthcare professionals and then among the society per group (e.g. age group and geographical area), by starting with a certain group and see how to improve the technology before diffusion among all as urban people have a higher acceptance rate of a technology than rural people*".

*"Government has to create some policies, better insurance policies for telemedicine*".

| | | |
|---|---|---|
| Sociotechnical impacts of telemedicine | It consisted of four sub-categories and the interviewees responded well to this theme. Total quotes for this theme was around 31. Sociotechnical impacts analysis of telemedicine technology was done based on four dimensions:<br>a. Telemedicine social impacts:<br>Most of the interviewees agreed that the technology would have social impacts, such as reduce time and costs for patients and healthcare professionals. Also, access to all possible medicine and physicians by different social classes. Yet, two interviewees had contrary point of views related to costs. Overall, the impacts discussed were socially positive. | "*Instead of recruiting certain speciality in each area, we can utilize specialists across the country*".<br>"*Because a lot of assets won't be there, you will just need some technology and infrastructure to be built one time; then you can use it*".<br>An IT technician stated: "*it might charge for the devices and treatment if not covered by insurance*".<br>"*Telemedicine will help to cater each of these classes individually as telemedicine is kind of personal care so it can be personalized and socialized the way you want*". |
| | b. Telemedicine organizational impacts:<br>The majority of the interviewees agreed that the technology will add extra workloads on physicians and add some changes in the organization. However, some of them stated that the extra workloads and changes will be temporary. | An IT technician: "*it will add extra workload for IT people as it requires periodic maintenance*".<br>"*It will be a transition phase. As a start, there would be much load on employees*". |

| | | |
|---|---|---|
| | Two of the interviewees stated that there will be a need to hire specialized persons in telemedicine who are as well healthcare professionals. | |
| | Still, some of the interviewees believed that the technology will not add extra workloads or any major changes and one of the interviewees recommended to organize and schedule medical appointments appropriately that a physician is free during telemedicine sessions. Overall, the organizational impacts discussed might require taking it into consideration. | "*It would not add extra workloads on healthcare professionals. It will be the same as treating patient physically*".<br>"*As the medical appointments are scheduled according to the physician's timetable*". |
| | c. Telemedicine technical impacts:<br>Almost all of the interviewees agreed that telemedicine would have technical impacts related to costs, continuous updates, requiring robust infrastructure as well as advanced hardware and software. Overall, the technical impacts discussed were in somehow concerns and require paying attention to it as this technology is very complex and involves huge resources. | *"It will be costly, but like the way it will cost, it will benefit as well. So it will not be a waste of money*".<br>"M*oney needed to be invested for this, however later on, the maintenance cost will carry on*".<br>"*Infrastructure must be completed and a redundancy plan to be available as well as specialized personnel to handle technical problems*". |
| | d. Telemedicine other aspects:<br>The interviewees emphasised other aspects, such as the availability of legal framework and guidelines related to telemedicine technology, training, privacy measurements and hardware availability, and integrating telemedicine with patients' medical records. One of the interviewees suggested having video | "*Telemedicine will be like a video call and it won't be very complicated*". |

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| | training published for the users. Overall, other aspects discussed here were similar somehow to those discussed earlier but were raised again by the interviewees. | |
| Benefits and challenges | It consisted of three sub-categories and the interviewees responded well to this theme. Total quotes for this theme was around 16.<br>a. Benefits:<br>The interviewees stated different benefits of telemedicine, such as teleconsultation when patients can not travel or be transferred or to handle emergency cases, reducing costs related to transportation (e.g. petrol) and time, easy access to services and openness. One of the interviewees stated that it will impact general health in the country.<br>b. Challenges:<br>Various challenges were raised by the interviewees, such as acceptance, trustiness, budget allocation and high cost of the technology, skills required to use it, technical problems which would require 24/7 availability of support via call centre, confidentiality assurance, infrastructure, continuous maintenance and training required. | "*By still being in the UAE, you can still have access to the global in healthcare*".<br>"*We will have tons of records, so there is a probability to build a new technology on top of that like machine learning and you can expect the trend of health*".<br>"*Challenges are basically about changes*".<br>*"I know some people wouldn't trust anything they consider it as a social media, they will not see as a video call between a physician and a patient that is private, secured and whatever is said is right and real consultation*". |

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| | c. Medical practice:<br>Almost all of the interviewees agreed that telemedicine is not better than traditional medical practice and considered it as a supportive medicine practice and complement each other, but not replace it.<br>Yet, they stated that telemedicine can be better in certain situations, such as consultation.<br>An interviewee stated that it will be the same. | A chief business analyst: "*we can't get rid of the traditional medicine. Sometimes you need the clinical investigation and of course, it will be like the difference between primary, secondary and tertiary healthcare. It will be like a first step, no need to physically meet a doctor*" and "*not all cases are applicable for telemedicine*".<br>A Head of IT Department: "*especially for patients being treated at home*".<br>A business analyst: "*will be more or less the same because it is the physician's role to give the treatment and the physician is not changing. So the process might change, the process will be efficient, but the practice will still be the same*". |
| Personal perceiveness | It consisted of two sub-categories and the interviewees responded well to this theme. Total quotes for this theme was around 15.<br>a. Perceiveness<br>All of the interviewees agreed that telemedicine is a positive innovation, except for one interviewee who believed to be neutral and another interviewee who stated that telemedicine can be positive, neutral or negative. | "*It is a positive innovation because telemedicine is reducing time, cost and available 24/7 I believe, so is increasing my health and I feel comfortable about myself, I can complain any time and find the support any time, so it is helpful. However, it can be a neutral innovation if we used it out of its content and out of its benefits. Also, it can be a negative innovation if we misuse it*". |

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| | b. Personal use<br>Responses were optimistic as most of them agreed to use it due to its convenience and benefits, especially for consultation and follow-up. Yet, few interviewees were not sure if they will use it or not. | "*It depends on the situation and the technology's easiness*". |
| Telemedicine improvements | The interviewees were active and responded well to the question. The suggestions were interesting and plausible. For instance, simplicity, continuous provision and training, having a team responsible for the quality, conducting studies and surveys to compare telemedicine and traditional medicine practice. Furthermore, raising awareness in different ways, integrating telemedicine with pharmacies to dispense medications and bring in artificial intelligence | "*Doctors already fight against using systems in hospitals and will definitely be against using a complicated program*".<br>"*Mass-media and through influential individuals so that it would be diffused and well-known*".<br>"T*here are processing and behavioural understanding software that can understand the person's situation by recognizing his/her face and everything. So, these software will first help to understand the patient's situation; then, the AI will help provide the first level of diagnoses and then manual interpretations and interventions are always required*". |

#### 4.2.3.2 Case Study

The aim of conducting case study was to understand telemedicine technology while being in actual use. Hence, two sites (Al-Qassimi and Kalba Hospitals) were considered. Case study data were incorporated with the rest of the data collected during the research.

Multiple-case study was followed here since two sites were involved that implemented telemedicine technology and to report the findings, a comparative approach was used in which analysis of similarities and differences between two cases was done. Below table 4.16 depicts the findings from both sites.

Table 4.16: Case study findings.

| Location / Features | Kalba Hospital | Al-Qassimi Hospital |
|---|---|---|
| Geographical Location | East Coast of Sharjah Emirate | In the city of Sharjah Emirate. |
| Visit duration | Around 7 hours in the hospital. | Around 7 hours in the hospital. |
| Unite | Intensive Care Unit (ICU). | Intensive Care Unit (ICU). |
| Telemedicine application and characteristics | Video conference.<br>One computer on wheel with tele-ICU software installed on it.<br>A detachable camera is attached to the computer.<br>The software is English, can be connected over Wi-Fi and Ethernet cable with Internet Protocol version 4 (IPv4). | Video conference.<br>There was a command centre for tele-ICU, equipped with 4 monitors, each for a different purpose, such as monitoring patients in Kalba Hospital ICU, accessing patients Electronic Medical Records (EMR) and using telemedicine technology.<br>A detachable camera, printer, telephone…etc. |

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| | | The software is in English, can be connected over Wi-Fi and Ethernet cable with Internet Protocol version 4 (IPv4).<br>The system is installed on the PCs' desktop. |
| Data collection | The same methodology was applied in both sites. Audio-recorder was utilized and handwritten notes were taken. Reflective note type was followed to elicit the needed information, such as concerns, thoughts, clarifications…etc. Also, interviews were conducted with some of the hospitals' staffs and a questionnaire was administered among the hospitals' staffs and visitors, including patients. | |
| Participants | IT Department team.<br>Physicians.<br>An engineer from the vendor side<br>Visitors, including patients. | IT-technician.<br>Physician.<br>In-charge medical technician- registered ICU nurse.<br>Visitors, including patients |
| Administrative approvals | Granted from MOHAP Hospital Sector management and the hospital administration. | |
| Findings:<br><br>Similarities | The findings from both sites were almost the same as what the rest of the research's subjects provided.<br>Additional data related to telemedicine while being in actual use were noted and categorized as below.<br>o Philips is the system manufacturer.<br>o Technical support (e.g. system technical problems) is provided over the telephone, e-mail, or on-site depends on the issue being faced.<br>o Demand:<br>- There is a need for telemedicine to overcome the existing barriers in delivering healthcare services, such as the shortage of specialists. For instance, Kalba Hospital they do not have intensivists and it is located far away. | |

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| | ○ Perceived ease of use:<br>- The technology is easy, simple to use and does not require extensive training.<br>○ Usage:<br>- The technology is almost used daily.<br>○ Perceived usefulness:<br>- It enhances the work and managing cases, particularly where there is a lack of specialists to handle cases. Also, it did not change the workflow as a physician in Kalba Hospital stated, "*it is considered part of the treatment plan. We are within the patient's privacy right as Tele-ICU is used for medical care and between healthcare professionals not for publicity*". In addition, a nurse stated that *"the system did not add any burden or workload on the staff. It helped to improve the workflow and provide services where there is a shortage of specialized care"*.<br>○ Challenges:<br>- Recurrent Network disruption.<br>- Sometimes, low screen resolution.<br>- Sudden electricity shutdown and there is no UPS. MOHAP is in the process of placing UPS to avoid such circumstances.<br>○ Suggested improvements:<br>- Continuous maintenance.<br>- Incorporate other specialities. | |
| Differences | ○ No designated area for telemedicine.<br>○ Facing more network disruptions due to the hospital geographical location, surrounded by mountains. | ○ They have a designated command centre.<br>○ No telecommunication barriers.<br>○ It was not easy to reach healthcare professionals and patients compared to Kalba Hospital. |

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| | ○ More enthusiastic about the technology and the employees were very helpful. |

### 4.2.4 Comparison Between Quantitative and Qualitative Data

Here, a comparison between questionnaire and interviews findings was done as presented in table 4.17.

Table 4.17: Comparison between questionnaire and interviews findings.

| Characteristics | Findings |
|---|---|
| Sociodemographic characteristics | It was requested in both data collection tools (questionnaire and interview) to correlate the findings with participants' sociodemographic profile. Almost all participants provided their details, except for one participant who preferred to not disclose her age during the interview and her desire was respected. |
| Familiarity with telemedicine technology | The questionnaire and interview included questions about how telemedicine technology is well-known in the UAE. The responses from both tools were almost the same. Most of the participants agreed that telemedicine is not well-known in the country, particularly not among the public compared to healthcare professionals. |
| Demand level | The majority of the participants in both tools agreed that telemedicine is needed in the UAE to cover the shortage in specialities, reduce costs, distance, and meet society's demands. |
| Acceptance level | Sociodemographic attributes showed no association with the acceptance of telemedicine. Yet, interviewees' strongly believed that age impacts acceptance in which the younger generation would accept telemedicine better than the elderly. However, in terms of gender, quantitative and qualitative data indicated no association. Also, participants had a positive attitude towards telemedicine and behavioural intention to use the technology and stated how perceiving telemedicine's usefulness and ease of use would impact usage. Furthermore, some participants agreed that telemedicine will change an organisation's workflow and require some technical improvements. |

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| | Different factors that lead to increase telemedicine acceptance were measured and discussed, such as training, users' involvement and trialability. These factors were agreed upon by the research participants to increase acceptance. Additionally, participants agreed that telemedicine is not better than traditional medical practice and most of them stated that telemedicine is a supportive medical practice. |
| Benefits and challenges | Participants provided some common benefits and challenges of telemedicine. For instance, common benefits that were stated in both data collection tools: cost-effectiveness and easy access to healthcare services, while other benefits were stated separately in each data collection tool, such as improve convenience, customers' satisfaction and openness to the world.<br>On the other hand, some challenges discussed were as well common in both data collection tools, such as trustiness and acceptance. At the same time, there were other unique challenges addressed separately in each data collection tool, such as skills required to use it and increase workload on professionals. |
| Personal Perceiveness | Responses were almost similar in both data collections tools. Most of the participants agreed that telemedicine is a positive innovation, while a few participants stated that it is neutral or negative innovation. The neutral response might be because they still did not use the technology, so they could not respond positively or negatively. However, those who assumed it as a negative innovation preferred traditional medical care delivery. In addition, the majority of the participants stated that they will use telemedicine due to its convenience and benefits. Nevertheless, few participants stated that they will not use it or not sure. |
| Suggested improvements | Participants provided various suggestions for future improvements of the technology. There were common suggestions among participants in both data collection tools, such as continuous training, technology evaluation and awareness. Training and awareness were highly emphasized upon during the data collection. Still, other unique suggestions were raised separately, such as simplicity, bringing in artificial intelligence, selections of languages to use, and accessibility on cloud. |

Overall, the research hypotheses and findings reached and discussed reflect the conceptual framework presented in Chapter 2. For instance, telemedicine technology was evaluated covering certain sociotechnical aspects (social, organizational, technical and legal) within the UAE context. Each of these aspects was addressed and correlated with certain variables, as shown in the conceptual framework. Also, telemedicine demand and acceptance in the UAE were evaluated by applying TAM and DOI Theory and measuring the impact of certain variables (e.g. usefulness and easiness) via testing several hypotheses.

In addition, the research's findings led to several key observations. For instance, the findings of this research support that TAM and Rogers (DOI) Theory can be rationally used to explain technology's acceptance, perceptions, intentions and usage. Also, predicting usage before full deployment would enable identifying factors that are perceived less favourably and refine the technology; hence its acceptance and usage would be better; too. Furthermore, it would be interesting to conduct similar research on a longitudinal scale to evaluate the correlation between TAM constructs and Rogers DOI Theory attributes over time.

# CHAPTER 5: DISCUSSION

This chapter presents discussion of the research questions and related findings along with biases handled, validation techniques and ethical considerations applied.

Technological advancements have led decision-makers and those with interests in the healthcare field to look for new service delivery mechanisms. Virtual care is one of the trending options to provide healthcare services where beneficiaries are moved from traditional services encounters to technology-based self-services (Mutahar et al., 2017). Implementation and adoption of telemedicine in the region are unnecessary to replace in-person physician visits but are seen as an approach to save time and costs, reduce pressures on healthcare facilities and human resources, cover the shortage in medical care…etc.; when it is applicable.

Consequently, a sociotechnical analysis of telemedicine technology in the UAE was done in this research. It allows thinking broadly by deciding which technology to build, how it should be designed, and how it would fare once deployed and used (Coiera 2007).

## 5.1 Research Questions Discussion

This research aimed to evaluate telemedicine technology; sociotechnically in the UAE in terms of readiness, demand, acceptance by applying TAM and Rogers DOI Theory along with testing several hypotheses, benefits and challenges as illustrated in figure 2.16 (conceptual framework of telemedicine in the UAE).

### 5.1.1 Readiness Level to Implement Telemedicine in the UAE

To address the first research question related to the UAE readiness level to implement telemedicine, quantitative and qualitative measurements were followed. Several related topics were investigated and discussed as below.

### a. Current status of the UAE health informatics

UAE has witnessed significant expansion in its healthcare industry over the past decades. This expansion involved rapid growth in the health informatics field to meet the government's vision of providing world-class healthcare, responding to customers' needs and providing high-quality services. As a result, the government supports initiatives to implement advanced technologies and solutions in the healthcare industry ranging from simple mobile applications to comprehensive virtual care and robotics surgeries.

Although in the UAE there are several local healthcare authorities, private sector and federal health care organization (MOHAP); many initiatives are going on either on the local level or national level. For instance, DHA started several initiatives a few years ago to improve its healthcare system, such as: in 2015 launched its mobile app (Dubai Doctors), which allows users to find physicians in Dubai Emirate and locate where they work, qualifications, experiences...etc. Another initiative by MOHAP was (Wareed) electronic medical records. In 2015 the UAE Cabinet announced a new initiative, National Unified Medical Record (NUMR), which would allow having a single record per patient regardless of the healthcare institute providing the service.

To implement health informatics initiatives, UAE had to make major changes in infrastructure, technology availability and readiness, human resources, facilities…etc. These changes are still going on to facilitate the implementation of advanced technologies, such as fibre optics, 4G Internet and wireless devices. UAE ranked high in several international competitiveness reports (e.g. Global Competitiveness Index and ICT Development Index) in terms of different aspects, such as technological readiness and innovation, infrastructure quality, individuals using the Internet, ICT use and impact of ICT on access to essential services (TRA 2016). Thus, it is

evident that UAE is ready in terms of implementing health informatics initiatives. Still, there are areas for improvements as new technologies are emerging and have new requirements.

Overall, telemedicine implementation in the UAE is easy and possible since there are laws and regulations to guide the embracement of such technology. Different initiatives have been implemented that support telemedicine technology and infrastructure readiness.

**b. Requirements readiness for telemedicine implementation**

E-health readiness is defined as "the preparedness of communities or healthcare institutions for anticipated changes by a program related to ICT" (Khoja et al., 2007, cited in Buabbas 2013). Similar authors provided another definition of readiness as "the degree to which users, healthcare institutions and the healthcare system are prepared to engage and succeed with the implementation of e-health". Furthermore, there are several sociotechnical evaluation models for telemedicine, such as Guía de diseño, evaluación e implantación de servicios de salud basados en telemedicina "GDEISST"; in English [Guide for the design, evaluation and implementation of health services based on telemedicine], Wickramasinghe et al. (2005), Serrano and Yanes (2008), cited in PAHO (2016) and Model for Assessment of Telemedicine Applications (MAST) in Europe. These evaluation models cover similar dimensions, such as social, organizational and technical, which were considered in this research. Nevertheless, Wickramasinghe et al. (2005) framework, as depicted in figure 5.1 was applied here to assess UAE readiness for telemedicine. The framework consists of 4 prerequisites, 4 impacts and goals of the technology. Examining the prerequisites and impacts can help to assess UAE readiness for telemedicine.

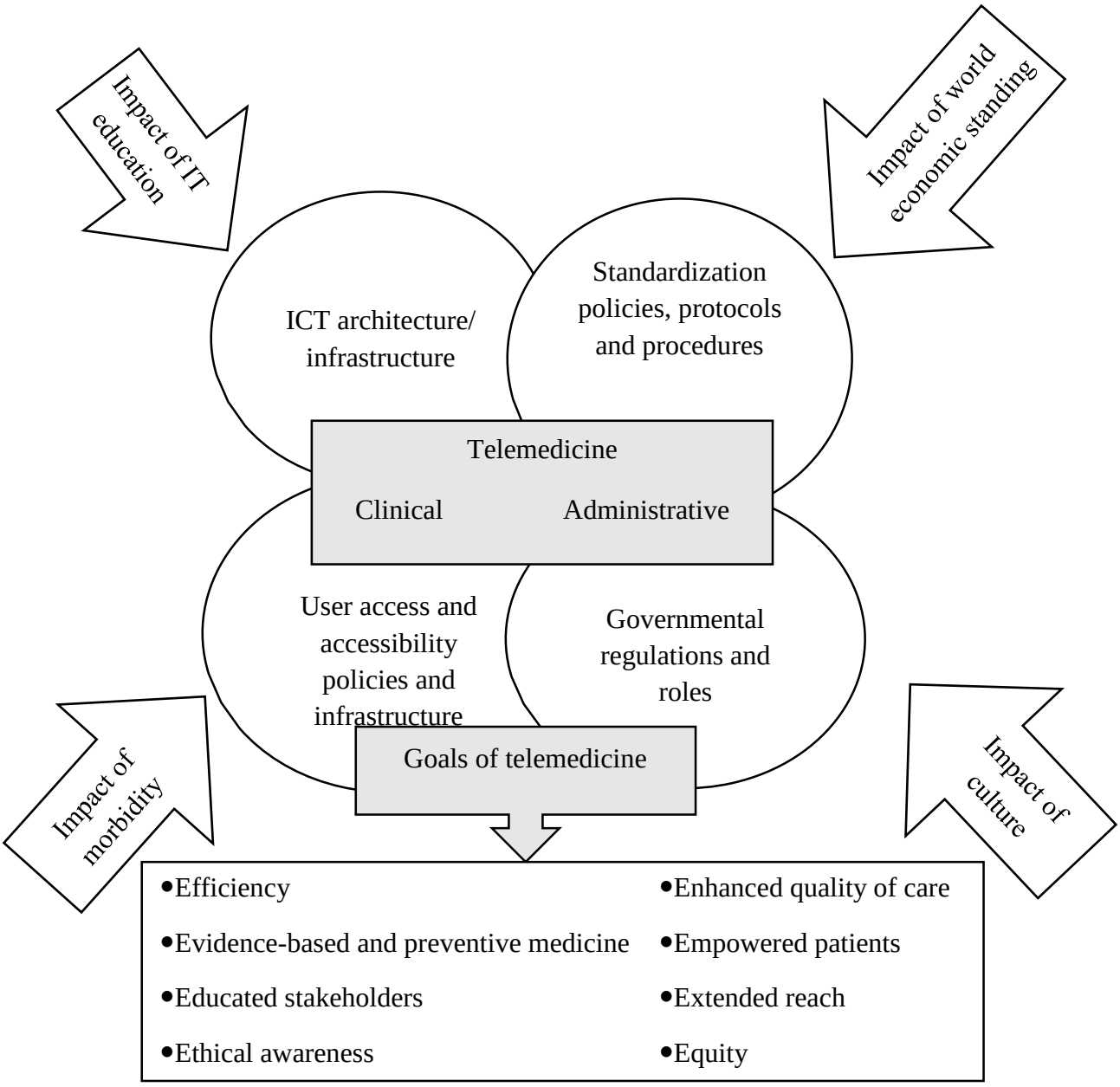


Figure 5.1: Telemedicine preparedness framework

(Adapted from Wickramasinghe et al. 2005, p. 326).

As can be seen from figure 5.1, the main readiness prerequisites are:

1- ICT architecture/ infrastructure:

For most telemedicine technologies, generic requirements should be available, particularly if to go with server-client architecture, such as fibre trunks, Integrated Services Digital Network

(ISDN), teleports, phone lines, electricity, reliable bandwidth and broadband access. Telecommunication is a core infrastructure for Internet access and thus for telemedicine. As mentioned above, UAE ranked top in different indicators related to households with Internet access, personal computers, availability of latest technologies, Internet bandwidth kb/s/user...etc.

2- Standardization policies, protocols and procedures:

To enable broad telemedicine coverage, significant amounts of documents exchanges and information flows need to be accommodated. Hence, standardization of policies, protocols and procedures is the key to this. Since in the UAE there are different healthcare systems, standardization among these authorities are of the essence and federal regulations need to be used as the base. In addition, as the Internet is the main component in technologies, standard protocols, such as HTTP and IP are to be used, which is the case in the UAE.

In the UAE, there are many initiatives taking place to standardize policies and protocols that would have a significant role in embracing technologies and reducing impediments. Also, there is a well-known non-profit organization: International Society for Telemedicine and eHealth (ISfTeH), which facilitates, supports, and promotes telemedicine and eHealth implementation in countries and provides access to recognized experts (ISfTeH 2019).

3- User access and accessibility policies and infrastructure:

In the UAE, the population has access to the Internet in their houses and most public areas in the urban have 24/7 Internet available. The challenge could be in rural areas where the terrain could hinder access and benefit from telemedicine technology. Furthermore, user infrastructure includes but not limited to PCs, Internet hosts, Internet Service Provider (ISP) and websites. However, to boost accessibility to telemedicine, the government need to financially support users' accessibility to telemedicine; for example, by including the service in insurance plans or put

policies in place to provide the service free of charges for a certain category of individuals, such as: elderly and people of determination. Another solution can be by collaborating companies to reduce costs of acquiring devices, subscription charges...etc as citizens may find these as disincentives to access the technology. Additionally, computer literacy is crucial and users need to have the knowledge to be familiar with computers, software products and the Internet, and benefits and possible usage of it.

4- Governmental regulations and roles:

The Healthcare field holds high sensitivity as it deals with human lives and confidential data. Hence, governments are incumbent to mandate regulations that facilitate utilizing technologies properly and maintaining consumers' rights (e.g. patients and physicians). For instance, place controls on accessing certain websites, particularly when access is done via organizations PCs, but to not at the same time hinder fulfilling the goals of advanced technologies initiatives. UAE Government has released a law [UAE Federal Law No. (2) of 2019 related to Using Information and Communication Technology in Healthcare] to guide the use of ICT in healthcare in addition to other existed federal laws and local regulations.

Additionally to Wickramasinghe et al. (2005) framework, the requirements readiness was evaluated sociotechnically as explained below. The covered dimensions share some similarities with the Wickramasinghe et al. (2005) framework as discussed below.

- Social:

Telemedicine needs to be ready socially by addressing, for example, culture, traditions, and literacy rate among targeted users and awareness (Alajlani & Clarke 2013). The technology should be aligned with the social needs, culture of the country, environment and economic

conditions where it will be applied. In this research, quantitative data indicated that (68.1%) of the participants agreed that using telemedicine would meet needs in a better way.

Before implementing technologies that involve drastic changes in routine service delivery, respect to local traditions, expectations, beliefs, and current healthcare services usage must be considered to avoid undermined telemedicine initiatives. Knowledge about social norms and cultures should guide the design and implantation of telemedicine technology (PAHO 2016). Furthermore, Abu-Shanab (2011) found that demographical and cultural differences were significant in affecting users' intention to use Internet Banking.

Buabbas study (2013) confirmed that telemedicine would not contradict Kuwait's culture and social norms and the technology could be used. Kuwait and UAE share some cultural similarities. By this, it is possible to say that culture would not hinder telemedicine's use in the UAE. Here, participants who completed the questionnaire indicated no effect of sociodemographic variables (e.g. age, gender and education level) on acceptance, attitude, behaviour and usage of telemedicine in the UAE. However, the research interviewees had different points of view as they strongly believed that age impacts acceptance of telemedicine in which the younger generation would accept telemedicine better than the elderly. Abu-Shanab (2011) study found education level as a technology adoption moderator in the banking field. In contrast, other studies found a contrary relationship between education and information technology acceptance as well as usage (e.g. González, Ramírez & Viadel 2015 and Cimperman, Brenčič & Trkman 2016).

The social impacts of telemedicine were measured in this research and participants had different perceptions. For instance, some participants agreed that the technology would have social

impacts, such as saving patients' time and costs to seek healthcare and improving access to healthcare by different social classes.

- Organizational:

Telemedicine needs to be ready organizationally by addressing several aspects. For instance, organizational process, workflow, acceptance, governance, structure, management and budget. However, in MOHAP, according to healthcare professionals interviewed and who were as well using the technology, "*telemedicine neither changed the workflow as it is considered part of the treatment plan nor add any burden or workload on the staff*". However, analysis of quantitative data in this research indicated that telemedicine would change the work processes of an organization, as stated by more than half of the participants (75.2%).

In terms of structure, user involvement shall be considered, redistribution of tasks and responsibilities of staff who will use telemedicine and traditional medical care as well as ensuring developing required skills through education and training to use telemedicine need to be considered.

Based on the literature reviewed, there were diverse findings about users' involvement in developing system. For example, Foster and Franz (1999), cited in Kujala (2003), found that users' self-perception of involvement had a moderate significant correlation with system acceptance, while analysts' perception of user involvement had strong significant correlation with acceptance which was supported as well by Zowghi (2018). Yet, users' involvement could cause some difficulties in lowering the degree of flexibility and overall success (Heinbokel et al. 1996, cited in Kujala 2003). In the current research, more than half of the participants (67.8%) supported that users' involvement impacts embracing telemedicine technology.

Organizational impacts of telemedicine were evaluated in this research and participants had different perceptions. For instance, ranged from adding extra workloads on healthcare professionals and changing processes to no significant changes. However, these different perceptions can be justified due to their involvement level in telemedicine technology (e.g., end-users, IT technicians and managers), usage behaviour, experience with advanced technologies…etc.

- Technical:

For telemedicine technology, requirements are beyond basics, for instance, higher bandwidth. Different departments within a healthcare organization, such as radiology, require higher bandwidth and larger data storage space to exchange and store various types of images (e.g. 3D images). Nowadays, with the availability of 5G network, telemedicine technology could be more enhanced. For instance, speed from 1.0 to 10.0 Gbps, multiplexing, bandwidth= 1000x bandwidth/unit area...etc. (Saravanan and Sudhakar 2017).

Also, electronic systems need to be smart and expert enough to handle diverse types of data, differentiate between them and respond accordingly. In addition, interoperability and technological issues, among others, need to be considered in telemedicine technology implementation. These issues include, but not limited to the following: Lack of matured infrastructures, insufficient testing and architectures of telemedicine including software, hardware, networks and communications. Furthermore, security, privacy and confidentiality, particularly in the case of international cooperation (PAHO 2016).

Since the technology is still new in the region and as the case in the UAE where healthcare is disseminated among different healthcare authorities, a collaboration between those authorities (e.g. DOH and DHA), Telecommunications Regulatory Authority (TRA), telecommunications

services providers, Ministry of Infrastructure Development and other entities needs to be well established to assess infrastructure readiness, integration of the technology which will serve as well the future national initiatives in the country (e.g. national unified medical record) and share related costs.

Additionally, telemedicine needs to be usable and scalable. It has to be user-friendly, comfortable to use, easy to learn and simple to maintain. Lack of these will limit the effective use of the technology and restrict benefits. Likewise, a backup plan and redundancy system should be built before the deployment of telemedicine and be part of telemedicine architecture to avoid sudden technical disruption and ensure business continuity and disaster recovery, otherwise affecting users' confidence in using the technology (PAHO 2016). In MOHAP, for instance, the current implemented telemedicine, according to one of the interviewees (a healthcare professional), lacks a backup system and there were situations where the technology went done (unscheduled downtime). Another interviewee (a principle programmer) stated, "*there must be a redundancy plan available as well as specialized personnel to handle technical problems*".

It is important to develop systems that can be customized and upgraded as cost-effectively as possible and with flexibility since healthcare and technologies are changing rapidly (PAHO 2016). In the current research, (58.2%) of the participants indicated that interacting with telemedicine would be flexible.

Technical impacts of telemedicine were measured in this research and participants had different perceptions. For instance, almost all the research interviewees agreed that telemedicine would have technical impacts related to costs, updates, maintenance, training, infrastructure, advanced hardware and software availability, safeguard measurements, and integration with existing electronic health systems. However, as stated by one of the interviewees, *"it will not be a*

*waste of money"*. The data collected via questionnaire indicated that (80%) of the participants agreed that there is an evident use of advanced technology in the UAE. Still, there are some possible technical challenges of telemedicine, such as security, reliability, skills required to use it and availability of a support team 24/7. Also, the participants listed some disliked features of telemedicine related to language, user interface and fear of sudden Internet disconnection.

- Legal:

Laws and regulations are essential in ICT. It is crucial to analyse the current status of regulations in the area where the technology is planned to be implemented and allow flexibility to amend the existing laws and regulations and establish new ones as needed (PAHO 2016). For laws and regulations to be effective and followed as intended, engagement of different and potential parties needs to be done. For instance, in telemedicine, each party (e.g. patient, physician and software engineer) has different perspectives and agenda. Addressing all these agenda would help in placing effective law and regulations.

Furthermore, local regulations need to be drawn based on federal laws. For instance, Dubai Emirate created their local telemedicine guidelines based on the Federal Law Decree No. (4) of 2016 related to medical liability. Lee, Stewart and Parvez (2014) stated the importance of having regulations in health informatics and frameworks for the security of data and information systems at the governmental level and how such a lack in these things would possibly limit up-taking technologies.

There are other aspects to consider related to telemedicine laws and regulations. For instance, parity law as what the US did in which the private sector in the country has to be part of providing telemedicine services and reimburse for it in the same way it would do for traditional medical care. Also, UAE issued a new federal law related to ICT (Using Information and

Communication Technology in Healthcare No. (2) of 2019), including data ownership, centralization, storage, privacy, confidentiality, protection...etc. International laws and regulations can be used to create more robust laws and regulations as there are many countries (e.g. US and European Union) that developed a long time ago laws and regulations related to telemedicine and still amending it to keep up with emerging changes.

Additionally, defining mandatory and preferable requirements in technologies. For instance, a redundancy system shall be mandatory available before deployment of the technology and ongoing training to use telemedicine, while having multiple platform types to use the technology, such as mobile App or web-based, can be optional.

The research quantitative findings indicated that most participants agreed that telemedicine would require a legal framework before implementation to guide the use of such technology. This was supported as well by the research interviewees who stated that "*legal framework is the most critical aspect because telemedicine can be operated from anywhere and it is really important to monitor from where it is getting operated*". In the UAE, legal bodies are working steadfastly to amend existing laws/regulations and create new ones to meet demands and technological advancements.

On the other hand, Wickramasinghe et al. (2005) presented the effect of several impacts on telehealth initiatives that were applied within the UAE telemedicine context as below:

- Impact of IT education: UAE population is well-educated, which drives competition and speeds up innovations, thus, adopting telemedicine for more effective and efficient services.
- Impact of world economic standing: UAE is keen on supporting IT health initiatives and allocating sufficient budgets as part of its governments' fiscal policies to transform the traditional healthcare system and enhance the country's economy and future growth.

- Impact of morbidity rate: a country's health status impacts the demand for telemedicine initiatives. UAE universal health coverage has reached a high level as per WHO (2017), so the country needs to focus now on how to further improve the health lifestyle of the population and ensure delivering healthcare to the entire population as much as possible, particularly during pandemics, such as COVID-19.
- Impact of culture: in each country, technologies are shaped and influenced by the nation's own culture, traditions, attitudes and expectations. Also, language presentation of health technologies as it mostly available in English which need to be addressed very well; particularly in countries, such as the UAE where the native language is Arabic; thus, the intended technology needs to be offered in different languages as well as supported by universal pictures and icons.

Overall, monitoring and evaluation of advanced technologies are essential to measure efficacy, level of acceptance and utility. The current status of the UAE related to health informatics and advanced technologies is evidently in a great position and ready to respond to society and healthcare demands. Integrating existed healthcare systems (MOHAP, DOH, DHA…etc.) under one centralized body would drastically improve the healthcare industry in the country.

**c. Telemedicine delivery mechanisms**

There are different telemedicine delivery mechanisms and there is no standard mechanism to provide telemedicine. It depends on the application used, the purpose of using it, intended users…etc. (ATA 2006).

Researchers differ in their description of telemedicine delivery mechanisms. Yet, they share the same aspects. For instance, PAHO (2016) classified telemedicine delivery mechanisms as store and forward, known as asynchronous, such as teledermatology. Asynchronous means

interaction between parties is not in real-time. Data are captured locally and stored temporarily for transmission at a later time, home monitoring programs and systems, and synchronous, such as video-conference. Synchronous means real-time interaction and exchange of health information via ICT. While, El-Mahalli, El-khafif and Al-Qahtani (2012) described the mechanisms as the following: patient-monitoring, such as home care, real-time interaction and store-and-forward non-interaction. On the other hand, ATA (2006) listed the below mechanisms:

- Networked programs: where healthcare institutes are linked with outlying clinics and centres in rural or suburban areas via either hub-and-spoke or integrated network systems. Dedicated high-speed lines or the Internet can be used for telecommunication.
- Web-based e-health patient service site: which is a web application component that uses a standardized format, such as XML, SOAP and HTTP to interact with other web applications over the Internet.
- Health provider to the home connections: where primary care providers, specialists and home health professionals with patients are connected over single line phone/video systems for clinical consultation. This might cover as well residential care centres.
- Direct patient to monitoring centre links: such as pacemaker and fetal monitoring, where patients can maintain an independent lifestyle.
- Point-to-point connections: using private networks between hospitals/clinics that provide speciality services to independent medical service providers in other ambulatory sites.

At UAE MOHAP, Synchronous telemedicine is used for Tele-ICU at both sites, Al-Qassimi and Kalba Hospitals. However, in settings where the full deployment of telemedicine is difficult due to different reason, such as lack of infrastructure readiness, Chatbot as another mean of delivering telemedicine service can be possible to go beyond routine applications of

telemedicine and extend service delivery. Chatbot does not require complicated infrastructure, networking and hardware. It can be as simple as using social media (e.g. Telegram), websites and mobile applications (e.g. Wysa).

**d. Barriers to implement telemedicine in the UAE**

There are some barriers that may hinder the implementation of telemedicine in the UAE. For instance, well-defined and integrated legislation specifically related to telemedicine on the national level for both; public and private sector. Although many laws and regulations are there, still there is a lack of awareness about it and more clarifications needed to ensure proper usability of the technology and for assurance purposes (M. Jones 2016). The defined law needs to clearly describe the reimbursement process and coverage of virtual health services (Kareem and Bajwa 2011). With a dispersed healthcare system, lack of agreed-upon governance is one of the highly likely factors that affect telemedicine technology. Ownership is another factor as there are different health organizations in the UAE; who would own the data? And how copyright is maintained when third party vendors are involved (Bhartiya & Mehrotra, 2014)?

Although large-scale technologies implementation is moving forward, still there are barriers in some geographical areas in the UAE; particularly in mountain areas where it would be challengeable in networking to connect devices and machines, exchanging information as well as processing and storing huge volume, velocity, variety and veracity of data…etc. So, fully matured development of technical information infrastructure is required for telemedicine propagation.

Furthermore, technology hardware and software-related aspects, such as availability of devices at patients' end. This causes a concern for patients in the first place and healthcare institutes since telemedicine technology requires certain equipment, software and applications, Internet…etc. Other barriers that might affect telemedicine implementation are the existence of

diverse information systems and many customized applications that create more challenges for integration. Additionally, despite many attempts to protect health data and ensure security, people are still reluctant and have fear when it comes to using information technologies. Also, adaptability with changes, diverse levels of competencies require different strategies to educate and train users, different interests and concerns, as well as lack of knowledge about the importance of different stages of software development and completing it carefully instead of going big-bang.

### 5.1.2 Demand and Acceptance Level of Telemedicine in the UAE

To address the second research question related to the demand and acceptance of telemedicine technology, quantitative and qualitative measurements were followed. Several related topics were investigated and discussed as below.

#### a. Demand for telemedicine in the UAE

Introduction of national e-health strategies and the adoption of advanced telecommunication technologies to improve the healthcare system and health outcomes of people are solutions that the UAE has already implemented.

In the UAE, the leading causes of death are cardiovascular diseases, cancer, and traffic accidents, which fall under non-communicable diseases and can be reduced through healthy lifestyle improvements and observations. This can be achieved somehow via telemedicine technology. Similarly, in emergency situations where reaching a healthcare facility on time is not possible and quick response could be a turning point between life and death, telemedicine could prove to be pivotal.

The current research findings indicated that there is a need for telemedicine technology in the UAE. The majority of the research participants supported this. For instance, participants who agreed for telemedicine demand justified it to the increased pressures on healthcare services, costs

of care and geographical barriers as well as to the technology's benefits in terms of covering lack of specialized workforce, keeping up with evolution happening in the country and increase the treatment success rate. Many previous works worldwide supported the need for telemedicine technology. Still, they emphasized upon implementing an effective technology that meets demands and usable (e.g. Al-Qirim 2007, Atac, Kurt & Yurfakul 2013 and Ward, Jaana & Natafgi 2015).

Overall, information about the need for telemedicine technology should be collected in a way that allows performing thorough analysis and establishing a solid base for taking the right decision whether to go with the technology or not.

**b. Telemedicine acceptance in the UAE**

Measurements of telemedicine acceptability need to be done considering different interests, concerns, and priorities, particularly for those going to use it. According to PAHO (2016), a questionnaire is a primary tool for evaluating telemedicine acceptability. Still, it is important to assess its validity and reliability to avoid low response rate and biases. In this research, TAM and Rogers DOI Theory were applied. Rogers DOI Theory attributes were included in the external variables as shown in figure 2.14 and analysed accordingly.

**Technology Acceptance Model (TAM) within UAE context**

TAM consists of several constructs, as depicted in figure 2.14. Those constructs were measured via a questionnaire developed based on previous works as explained in Chapter 3: Methodology. Further information about the questionnaire and questions' references are presented in appendix H: Questionnaire Items and References. Several hypotheses were tested related to TAM constructs and results were almost similar to previous works despite the contexts differences.

A reliability test was done to measure TAM constructs in the developed questionnaire. Results revealed high reliability, which means that the questions used to measure TAM constructs

were internally consistent and reliable. The Cronbach's Alpha (α) obtained for TAM constructs were almost equals to what was found in previous works, such as Davis (1989) and Jensen (2002). For instance, in this current research, Perceived Usefulness (PU) scored 0.89, which is the same as what Jensen (2002) study's obtained

Each construct of TAM was measured based on few statements and related hypotheses were tested as the following.

- Perceived Usefulness (PU)

  Related statements:

  - Telemedicine would allow accomplishing tasks more quickly.
  - Using telemedicine would improve performance.
  - Telemedicine would be useful.

- Perceived Ease of Use (PEOU)

  Related statements:

  - I would find telemedicine flexible to interact with.
  - It would be easy for me to become skillful at using telemedicine.
  - Telemedicine would be easy to use.

**Hypothesis 1: perceived usefulness and perceived ease of use**

A statistically significant association between usefulness and ease of use of telemedicine was observed and participants agreed that telemedicine would be a useful technology and easy to use. At the same time (41.0%) responded that although telemedicine would be useful, but it will not be easy to use. A positive correlation was achieved between both variables. This was found as well in other previous works, such as Davis (1989), Jensen (2002) and Cowen (2009).

- Attitude Towards Using (A)

Related statements:

- Telemedicine is a well-known concept.
- There is a need for telemedicine in the UAE.
- Telemedicine would be better than traditional medical care delivery.
- Using telemedicine would meet needs in a better way.

**Hypothesis 2: telemedicine acceptance and positive attitude**

A statistically significant association between acceptance (PU and PEOU) and positive attitude was perceived and there were participants who answered [yes] in terms of acceptance of telemedicine and had positive attitude towards using it, while (41.8%) had negative attitude among participants who responded that they can accept telemedicine but didn't agree that it would be better than traditional medical care. A moderate positive relationship was established between mean acceptance score with mean attitude score. This was supported as well by Liu (2014). Although Jensen (2002) found that PU was highly correlated with attitude, PEOU had an insignificant relationship that Davis, Bagozzi and Warshaw (1989) found.

**Hypothesis 3: attitude influences behavioural intention towards using telemedicine**

A statistically significant correlation was found between attitude and behavioural intention towards using telemedicine which means that attitude is a factor that contributes to the behavioural intention to use telemedicine. This was found as well in other previous works, such as Liu (2014) and Husseina (2017).

- Behavioural Intention (BI)

Related statements:

- Telemedicine would be easy to use.
- I will use telemedicine on a regular basis.

- Using telemedicine would meet needs in a better way.
- Being personally able to try telemedicine is important to make decision about using it.

**Hypothesis 4: telemedicine acceptance and positive behavioural intention**

Although most of the participants agreed to accept telemedicine technology and showed positive behavioural intention to use it on a regular basis, there was a small percentage of them (29.3%) who showed negative behaviour towards regular usage of the technology.

A statistically significant association between acceptance (PU and PEOU) of telemedicine with positive behavioural intention was found. This was supported as well by Mutahar et al. (2017). Yet, Liu (2014) and Cowen (2009) found a significant relationship between PU and BI but not between PEOU and BI.

- Usage

Although self-reported times estimates are not necessarily prices, it can be accurate as a relative indicant of the amount of time spent on job activities" (Hartley et al. 1977; cited in Davis 1993). Here, participants were asked to respond based on their actual usage of telemedicine technology. If not, then to respond based on their future expected usage and when they were asked about [How many times you actually use or will use telemedicine?], (often) was the most response received (26.7%), followed by do not know (24.2%).

Usage was measured by addressing the following statements:

- How many times you actually use or will use telemedicine?
- Awareness of new innovations (e.g. telemedicine) impacts its diffusion.
- Users' engagement in activities related to an innovation (e.g. telemedicine) leads to embracing it.
- The technology would require training for users.

- It would require a legal framework before implementation to guide the use of such system.
- Using telemedicine would meet needs in a better way.
- Telemedicine would change the work processes of an organization.
- Obtaining related information via telemedicine would be easy.
- Being personally able to try telemedicine is important to make decision about using it.
- Probably, people would be interested in telemedicine when they see others using it.

**Hypothesis 5: telemedicine acceptance and effective usage**

Results showed no correlation between acceptance (PU and PEOU) of telemedicine and effective usage, which means that no relationship if participants will find it useful and easy to use would agree to use the technology regularly or often. Statistically insignificant value was perceived among both attributes. Interestingly, when each attribute of technology usage was analysed separately, participants who responded not at all had a significant p-value ($< 0.05$) which means that if the participants would accept telemedicine even though they will not prefer to use it in a regular routine. Lee and Kim (2009) reached similar results. Yet, Davis (1989) and Isaac et al. (2016) found that usage is correlated with PU and PEOU. The contradiction could be justified because the technology under evaluation (telemedicine) is still new and not many people experienced it compared to technology or service was evaluated in previous works (e.g. Internet).

Although TAM was extended (known as TAM2) and the latter model included other constructs, according to Venkatesh and Davis (2000), TAM2 effects can be noticeable in certain environments (mandatory settings).

**Rogers Diffusion of Innovations Theory (DOI) and external attributes**

Davis (1989) encouraged to include external factors in TAM as the original model did not examine the impact of these factors on behavioural intention and actual usage.

**Hypothesis 6: confounding variables and acceptance of telemedicine**

As indicated earlier, an insignificant p-value was obtained that male gender, local nationality and higher education level had no effect on the association between acceptance, attitude, behaviour and usage of telemedicine in UAE. However, qualitative data collected via interviewees indicated that age impacts acceptance, but not gender. There were previous works that supported sociodemographic variables impact on acceptance (e.g. Abu-Shanab 2011) and other works that contradicted it (e.g. Casas 2010 and González, Ramírez & Viadel 2015). Yet, this does not imply wrong or inaccurate results; rather, it can be justified to research setting differences, participants involved, sense of comfort at the time of collecting data…etc.

The external variables in this research included as well Rogers DOI Theory attributes of innovation as described below in table 5.1. These attributes were evaluated to measure their effect on acceptance within the UAE context. The findings revealed an overall statistically strong significant association between diffusion of innovations attributes and acceptance (p =0.000). Mutahar et al. (2017) explained that TAM core constructs (PU and PEOU) are similar to DOI attributes (relative advantage and complexity).

Table 5.1: Evaluation of DOI attributes and effect on acceptance within UAE context.

| Innovation attributes | Findings |
|---|---|
| Relative advantage | According to the research's participants, one of the main benefits of telemedicine technology is to improve access to healthcare services as it allows receiving specialized care with less effort to visit healthcare institutes, reduces |

| | |
|---|---|
| | waiting time and timely response. This is important mainly for people living in rural areas who are in the distance from specialized care. The nature of telemedicine frees users from being in fixed locations. Overall, the findings confirmed the usefulness of telemedicine. |
| Compatibility | Telemedicine technology connects its users (e.g. patients and healthcare professionals) and allows them to communicate and receive services. A range of applications and devices are available which provide users' various options based on their needs (e.g. teleconsultation and patient online portal).<br>Also, the research findings indicated that telemedicine would meet needs better, which was supported by (68.1%) of the participants. |
| Complexity | The research's findings indicated different perceptions of whether telemedicine would be better than traditional medical care delivery. For instance, (39.6%) agreed on that, followed by disagreed (33.3%) and neutral (27.0%). The interviewees as well confirmed this difference that telemedicine is a supportive medical practice and complements each other, but not to replace traditional medical care delivery.<br>Furthermore, ease of use perception was evaluated and results indicated that telemedicine would be easy to use by (57%) of the participants. However, the technology would require developing new skills, training and support to effectively use it, which were supported by both quantitative and qualitative data. Yet, (64.2%) participants agreed about the easiness of becoming skilful at using telemedicine. For developing required skills, usually younger generation would develop it faster than elderly as per the research's interviewees. Also, data gathered from site visits to MOHAP hospitals indicated that the implemented technology is easy, simple to use and does not require extensive training. |
| Trialability | Telemedicine so far is an optional service in the UAE; in which a person can either use it or not and he/she can use it for some time then discontinue using it. By this, the person would have the chance for trial use or observing another person using it (e.g. a relative). |

| | |
|---|---|
| | Participants were asked whether being personally able to try telemedicine is important to make decision about using it and (71.8%) of the participants confirmed that. One of the interviewees stated that "*I tried it with one of my doctors about a medical concern and it was very effective"* and another one stated that experiencing the technology would build confidence in people to start using it, hence, increase telemedicine acceptance level. Buabbas (2013) emphasized upon trialability of a technology. |
| Observability | Telemedicine might not be easily observed and communicated to others, and its results might not be easily visible. It requires time to notice the outcomes. Participants were asked whether people would be interested in telemedicine when they see others using it and (79.1%) agreed about it. Also, interviewees stated that to increase telemedicine acceptance level, telemedicine needs to be observed by people. |

As one of the research's purposes was to apply TAM in investigating telemedicine by examining the relationships between TAM constructs, the results revealed that participants intention to use telemedicine is primarily determined by the technology usefulness and ease of use as well as other external factors, such as innovation complexity which is consistent with previous works (e.g. Davis 1989 and Liu 2014). In addition, Isaac et al. (2016) reached similar inferences that there is an association between DOI Theory's attributes and TAM constructs.

Safi, Thiessen and Schmailzl (2018) found that DOI attributes affect technology diffusion but have no strong effect to predict acceptance, which contradicts what has been found in this current research. However, they stated that accepting a technology would take time and individuals' acceptance behaviour change at a different rate. According to Bowonder, Bansal and Giridhar (2005), diffusion of telemedicine is still low due to trust and reputation of it and to have sustainable telemedicine. The following critical success factors need to be considered carefully:

technological efficiency (connectivity), behavioural acceptability (trust) and economic sustainability (low cost).

Overall, results indicated that telemedicine would be accepted well in the UAE and participants justified that by supporting the statement of evident use of advanced technology in the country and UAE is one of the top countries that adopt technologies as well as is technically advanced, which was supported as well in international competitiveness reports as indicated earlier. Also, as stated by an interviewee, the UAE is always open to innovations. Though, participants had some concerns about acceptance of telemedicine in the UAE, such as consideration of patients' desire whether they want to use it or not and time factor in accepting the technology, which Rogers (2003) emphasized upon it. To increase telemedicine acceptance in the country and anywhere, certain factors need to be considered, which were as well emphasized upon by different researchers. These factors are explained next.

**Increase telemedicine acceptance level**

To increase technology acceptance level in general and telemedicine in particular, the research participants provided other factors and feasible solutions aside from TAM constructs which showed its impact on acceptance as shown in the below figure 5.2. Some of those were consistent with previous works, such as Bowonder, Bansal and Giridhar (2005), Kujala (2003) as well as Alajlani and Clarke (2013).

| | |
|---|---|
| Stakeholders and individuals role in acceptance | Users' engagement in activities related to telemedicine, such as during planning and testing phases, more promotion of the technology in the community, encouraging each other to use it, encouragement via social media, observability and trialability. |
| Awareness and marketing | People might know the concept of telemedicine in general, but did not try it or do not know how it works and what its benefits.<br>Also, advertisement and marketing about the technology and people should be well aware that there are policies, so they would feel more comfortable and confident in using it. Awareness of telemedicine benefits and challenges would be very useful to increase acceptance. |
| Government support | The government has to accept that telemedicine is good enough and provide full support. If people notice support from higher authorities and influential bodies, they would highly likely embrace the technology. |
| Legal framework and guidelines | Amendments to existed policies and regulations and develop new ones to keep up with changes and demands. Policy reserves the rights and responsibilities of customers and gives them the comfort to use it.<br>Furthermore, better insurance coverage and reimbursement policies related to telemedicine. |
| Security, privacy and confidentiality | All these need to be well defined and related measurements are in place and effective before deployment of telemedicine. Also, customers need to know about it, so they feel safe and comfortable using it. |
| Education and training | Adding telemedicine in education curriculums; particularly in healthcare majors. In addition, different types of training need to be available, such as: manuals and video-based trainings. There should be continuous trainings, particularly that technologies involve updates and upgrades from time to time. |

Figure 5.2: Factors and solutions to increase telemedicine acceptance level.

One of the interviewees stated the importance of accepting the technology by healthcare professionals and its impact on patients' acceptance. Safi, Thiessen and Schmailzl (2018) and Buabbas (2013) supported such factor that confident healthcare professionals conveying their positive attitudes about an innovative technology to their patients is a way to improve acceptance. Yet, individuals could link physical attendance of healthcare professionals to their satisfactions with medical encounters, level of assurance related to conveying appropriate information and measuring the reactions and activities of healthcare professionals (George, Hamilton and Baker 2012)

According to PAHO (2016), implementing updates based on feedbacks received and continuous system monitoring make it possible to detect threats, risks and identify inconsistencies at the right time. Additionally, it stated that the costs of telemedicine to be extended to other sectors (public and private).

The World Health Organization WHO (2019) emphasized upon providing adequate training for health workers to boost their motivation towards transition to digital health and use technology easily, the importance of privacy policies to protect individuals, governance and coordination to ensure integration of these tools across healthcare systems as well as stability of infrastructure.

**c. Personal perceiveness**

In this research, despite that no relationship between acceptance and actual usage was found, participants were asked to rate telemedicine as if it is positive innovation or neutral or negative and whether they will personally use it or not. Findings revealed that telemedicine as overall is a positive innovation (65.5%), yet, can be negative if misused. Although participants showed positive interest in personal usage of telemedicine (68.5%), they did not fully agree that telemedicine is better than traditional medical care delivery, but it can be supportive to it. WHO released its first guidelines on digital health interventions in 2019, which stated and supported the research findings that telemedicine is a valuable complement to traditional medical practice and does not replace it entirely. Wang et al. (2019) supported that; wherein some situations, telemedicine might not be proper and traditional medical care is required and patients' desire to be considered whether to go with online services or offline.

**d. Telemedicine Improvements**

Although the related question was optional, participants were very interested in the technology and provided feasible suggestions for future improvements of telemedicine technology. The responses were categorized based on commonality among them. For instance, technical improvements (e.g. accessibility on cloud, mobile platform and better to acquire 5G Internet), others (e.g. international coordination for experts assistance and doctors must review patients' medical records before starting telemedicine session for prompt treatment) and easy to use (e.g. selection of languages to use, easiness and free access to the networks) were the most stated ones.

As one of the interviewees stated, to improve telemedicine, simplicity is needed. Sha (2001) stated that complexity is a primary cause of software errors. Telemedicine is not a homogenous technology; it includes diverse systems, hardware, applications, and software that need to work and interact smoothly. This does not mean to avoid building a comprehensive technology that might entail complexity, but rather to hide complexity behind a friendly interface that is enough to use and for mass acceptance.

Some of the suggested improvements are already in place in the UAE. For instance, mobile platform, which Abu Dhabi Telemedicine Center and DHA provide their telemedicine service via App Store and Google Play as well as international coordination with experts, which is available in Abu Dhabi Telemedicine Center. This may imply that people still not adequately aware of telemedicine technology scope, available features and related initiatives.

Overall, the results confirmed what has been found in other previous works that users' perception is significantly associated with their intention to use telemedicine. The findings here

were more or less similar to what has been found in previous works, such as Liu (2014) and Mutahar et al. (2017).

### 5.1.3 Possible Benefits and Challenges of Telemedicine in the UAE

To address the third research question related to telemedicine technology's possible benefits and challenges, quantitative and qualitative measurements were followed. The research's participants shared almost similar benefits and challenges of telemedicine technology as stated in previous works (e.g. George, Hamilton and Baker 2012, Al-Qirim 2007 and Tithecott & Sochacki 2015). The most common benefits of telemedicine selected here were improve access to healthcare services, followed by cost-effectiveness and reduce congestion to seek medical care, as shown earlier in table 4.4. Other benefits were stated in addition to those listed, such as improve convenience, customers' satisfaction, globalization and potentials for implementing other new technologies that include machine learning and Artificial Intelligence (AI). Aside from its health-related benefits, telemedicine socially reduces disruptions for patients as it allows receiving care within one's comfortable environment. To realize technologies' benefits, optimized use is paramount (Jones and Seckman 2018).

As Al-Qirim (2007) stated, positive views related to telemedicine represent a good foundation to adopt large-scale telemedicine in the UAE as well as on the national level. In the UAE, large-scale telemedicine technology is in the process of implementation and the findings obtained in this research support Al-Qirim's conclusion.

On the other hand, there were some challenges highlighted by the research participants and almost similar to what has been found in previous works (e.g. Krebs and Duncan 2015, Ekeland, Bowes & Flottorp 2010 and Atac, Kurt & Yurfakul 2013). For instance, security, reliability and acceptance by the users were the most common challenges selected, as shown in table 4.4. Yet,

other challenges were raised additional to those listed, such as availability to all possible users and might not be suitable for the older generation who do not have that much knowledge about technology, infrastructure and continuous maintenance requirements.

According to George, Hamilton and Baker (2012), telemedicine poses possible risks, such as devices and machines shutdown, unscheduled downtime and identity theft. Some would argue that privacy is part of security, yet, privacy can also be a challenge when authorized users access patients' medical records and breach their privacy either deliberately or not, such as; lack of understanding of privacy principles or technical problems.

These challenges might impact telemedicine technology acceptance and effective usage. Also, as indicated earlier, how individuals perceive technology as useful to them has a significant effect on acceptance.

Overall, these perceived benefits and challenges are not necessarily the only or exact perceptions about telemedicine but represent the community's perceptions and beliefs related to this type of technology. The benefits of telemedicine are substantial. With more scientific research, the discussed challenges in this research would most probably be reduced or eliminated.

### 5.2 Telemedicine's Future

Telemedicine's future is promising and bright. It is expected to see more control from patients and families over their health through telemedicine. The technology is expected to be more prominent in healthcare in the coming years (Wainstein 2018).

As one of the research interviewees stated that with telemedicine, there will be an option to bring in AI that can understand a person's situation by recognizing his/her facial expression and then analyse is he/she actually facing a problem and the technology will help to provide the first level of diagnosis and interpretation. According to Wainstein (2018), telemedicine trends will

shape the healthcare industry's future in terms of the collection and analytics of patients' data during telemedicine sessions, where big data analytics would play an important role in analysis and predictions. Also, mobility, where interactions with healthcare professionals occur through mobile devices and this is evident with the availability of smart devices and medical applications among the populations. Furthermore, better opportunities for investments, such as collaboration with international medical institutes and sharing funds to support telemedicine. Additionally, more customized and personalized healthcare applications with the flexibility to control information exchanged between parties and enabled convenient interactions.

Yet, to keep up with the way technologies are progressing, barriers that might hinder telemedicine technology need to be eliminated or minimized as much as possible.

### 5.3 Research Biases and Validation

There are many types of biases and errors that may occur in research. Some of them can be avoided with proper research design and sampling (e.g. sampling and selection biases), while others are difficult to prevent but can be minimized (e.g. mood bias and evaluation apprehension) (Bowling 2009). In this research, biases were avoided and minimized as much as possible by choosing the appropriate sampling method based on scientific and statistical calculations as described in chapter 3: methodology. Also, the participants were well informed about the research and voluntariness to participate as well as data were collected according to the research participants' convenience.

On the other hand, in mixed research design, the validity and reliability of qualitative data are not the same as for quantitative data and need to be established separately (Creswell 2014). Hence, in this research, the following were applied.

- Reliability (Cronbach's Alpha): all measurements scales showed good reliability with Cronbach (α) coefficient exceeding ≥0.70, which is consistent with previous works in the same field of health informatics and technologies (e.g. Venkatesh & Davis 2000 and Atkinson 2007). A reliability coefficient = 0.70 means that 70% of the measured variance is reliable and 30% is due to random error. In this research, Cronbach's alpha= 0.70 was used as a minimum acceptance level (Nunnally 1994; Streiner and Norman 2003).
- Qualitative reliability: here, transcripts were ensured to not contain notable mistakes made during transcription and data were compared with codes constantly as well as drifting in the definition of codes were avoided (Creswell 2014).
- Validity:
  - Face validity: in this research, face validity was maintained by ensuring that the data collection instruments were well presented and relevant to the research aims and objectives via conducting pilot phase (Bowling 2009).
  - Content validity: it was ensured through examining the data collection instruments by subject matter experts (e.g. biostatisticians and software engineers) for its logic, comprehensiveness and measuring what it intended to measure via conducting pilot phase.
  - Internal validity: here, the instruments were tested among members of the population before starting the actual data collection phase and correlation was measured between independent and dependent variables as explained in chapter 4: results and analysis (Boussabaine 2016; Patino & Ferreira 2018).

- External validity: here, the research results can be generalized due to the research's scope, population involved and sampling methodology (Boussabaine 2016; Patino & Ferreira 2018).
- Qualitative validity: here, interview, documents and case study were used. Also, member-checking was done by taking the final report or part of it or particular descriptions back to the participants for their feedback about its accuracy, trustworthiness, credibility and authenticity, as well as comparing between participants' inputs and the researcher's interpretations. Furthermore, presentation of negative information was done as a discussion of converse information adds to the research's credibility.

- Triangulation: mixed methods (quantitative and qualitative methods) were applied to support the research and validate findings.

According to Bowling (2009), developing new scales and testing them for reliability and validity requires a lengthy time, efforts and resources. To avoid these burdens as much as possible, Bowling suggested using existed scales which was as well recommended by other researchers, such as Jensen (2002). This suggestion was followed in this research when data collection tools were developed.

### 5.4 Research Ethical Considerations

There are different standards for research ethics that have been placed by various professional associations, such as The American Sociological Association Code of Ethics and Good Clinical Practice (GCP) by the US National Institutes of Health, which the researcher completed the GCP Course.

As this research covered telemedicine technology in the UAE led by MOHAP and the researcher is a member in the Health Information Systems Department that is co-handling telemedicine, ethical and micro-political implications had to be considered, such as: avoiding biases and influences of own values and believes.

In addition, interaction with human being requires proper ethical considerations during research phases: prior conducting the research (e.g. defining the protocols of dealing with raw data and obtaining required approvals), throughout the research (e.g. Informed consent form and voluntariness to participate) and in writing the final report (e.g. aliases/pseudonyms to maintain privacy and data ownership). Further details of the research ethics phases followed here are described in appendix O: Research Ethics Phases.

# CHAPTER 6: CONCLUSION

This chapter presents a summary of the research's key points, recommendations, contribution to knowledge, research implications and limitations, as well as future works.

Cross-sectional research was conducted to investigate telemedicine technology in the UAE by addressing the readiness level of implementing telemedicine in the UAE, demand and acceptance level, as well as possible benefits and challenges of the technology. Such technology still requires ongoing and proper sociotechnical evaluation related to different aspects, for example, designing, development, and implementation. Also, several research questions were addressed and answered related to telemedicine in the UAE from a sociotechnical perspective as the following.

Question one: What is the readiness level of implementing telemedicine in the UAE? The readiness level was evaluated from sociotechnical perspectives along with addressing possible delivery mechanisms of telemedicine and possible barriers that may hinder telemedicine implementation in the country. The findings indicated that UAE is socially, organizationally, technically and legally ready for telemedicine technology with some enhancements to be made.

Question two: What is the demand and how to measure the acceptance level of telemedicine in the UAE? Certain determinants identified in the conceptual framework; figure 2.16 were covered to address this question. Also, TAM and Rogers DOI Theory were applied along with testing several hypotheses related to telemedicine acceptance and correlation with different variables, such as attitude and usage. Findings indicated a need for telemedicine in the UAE and most of the tested hypotheses were accepted, such as the correlation between usefulness and ease of use of telemedicine. Additionally, most participants agreed that telemedicine is a positive

innovation and suggested various improvements, such as accessibility on the cloud and acquiring 5G Internet.

Question three: What are possible benefits and challenges of telemedicine in the region? Examples of telemedicine benefits raised in this research were improving access to healthcare services and cost-effectiveness, while challenges were reliability and security.

Embracing telemedicine in the UAE can positively contribute to achieving the aim of UAE as being one of the leading medical tourism destinations as patients who come to UAE for medical care can continue having the same care virtually once they return home.

### 6.1 Recommendations

From this research, different recommendations emerged that can serve various parties, such as:

- Harmonization between different standards to exchange data and information is crucial for interoperability purposes. Despite that many interoperability standards exist, they still need to be re-adjusted from time to time, particularly when systems of systems are involved.
- Existed telemedicine services in the UAE need to be unified and integrated under one unified national program.
- Involving a representative sample of potential users through technology simulation to evaluate the technology in terms of requirements, concerns, usefulness, ease of use…etc.
- As an enhancement component, adding Clinical Decision Support System (CDSS) in telemedicine technology that can support diagnosis and treatment plan based on the medical knowledge database and in case of new diseases not in the database, then sent

an alert to a healthcare professional for the expertise and update the knowledge database according to the healthcare professional's response and knowledge.

- A redundancy system should be part of the technology architecture.
- Benchmark with other existed telemedicine programs to learn lessons and avoid repeating similar mistakes.
- The findings in the research suggested that differences in attitude towards telemedicine would require tailoring approaches for introducing, marketing and deploying the technology among the disparate population.
- Telemedicine should be used in pandemics situations (e.g. COVID-19) to fight diseases' spread and reduce the burden on healthcare.

## 6.2 Contribution to Knowledge

To the best of the researcher's knowledge, this research can be said as the first research in the UAE and one of the few in the region that examined telemedicine based on sociotechnical analysis and at the same time applied TAM and Rogers DOI Theory on diverse categories of subjects. Most of previous works in the computer science field focused on software, systems and programs. This research covered as well other angles besides technical, such as: social and legal. In addition, it provides worthy contributions by enabling healthcare organizations in identifying the current status of demanding telemedicine in the UAE and its level of acceptance. Other countries may also apply similar methodology and measurements used in this research to evaluate their technologies, not only telemedicine.

Furthermore, enabling MOHAP and other interested parties to identify their hardware and software readiness as well as capability to implement and use telemedicine and other technologies in healthcare. Another contribution is that this research evaluated perspectives and acceptance of

potential users of telemedicine (e.g. IT developers, technical engineers and decision-makers), identified various ranges of users' needs, preference and attitude towards telemedicine technology, as well as how to integrate these factors into the technology's stages as earlier as possible. The information and analysis in this research provide great advantages in terms of making more informed decisions, learning lessons and minimizing productivity paradox's risks. Also, other parties can benefit from it, such as vendors, researchers, local healthcare authorities and private sectors to benchmark and focus on primary determinants (e.g. system's usefulness) to accept and use technology.

The research can be used as a base for other research in computer science to pay attention to other areas, such as telemedicine interoperability, software engineering, systems re-engineering to optimize its usage, systems of systems…etc. Hence, this research would contribute to the knowledge in health informatics and computer science.

### 6.3 Research Implications

Truth that this research covered MOHAP only and there are other local healthcare authorities and private sector in the country, the research's findings can be generalized and relied on, as MOHAP is the federal healthcare entity in the UAE. Also, research methodology followed, diversity of participants involved and data collection strategies all allowed ensuring research validity.

Furthermore, the applied TAM and Rogers (DOI) Theory provided a rationale for the flow of causation from external factors through perceptions to attitude and eventually usage.

The results of this research can be added to the body of research literature on technology evaluation and acceptance as well as can be useful for the healthcare sector and governmental-related authorities to strategically manage the healthcare system.

The research's findings have implications for improving users' acceptance by identifying variables to focus on (e.g. perceived usefulness) as users might be willing to embrace complex systems to access functionalities that facilitate their activities. Also, forecasting users' acceptance as early as possible before full deployment of technology takes place as it can reduce risks related to technology rejection, greater flexibility to modify a technology design, and better prioritise and refine ideas for developers.

To reach sustainable progress in the computer science field, systematic investigations about users' behaviour and examining alternative theories and models need to be ongoing as users' reactions to technologies and innovations are multifaceted and not easy to predict.

### 6.4 Limitations

This research has few limitations and faced challenges that the researcher tried the best to minimize and/or overcome it. For instance, the research is a cross-sectional one which is useful for such context as here; however, it is highly likely that people attitude and acceptance towards a technology change over time and after a period of exposure to the technology.

Although Rogers (DOI) Theory was applied in this research, it was not fully applied as it is a lengthy theory that needs to be conducted over time to thoroughly study telemedicine diffusion in a certain setting which can help to investigate behaviour changes, perceptions towards an innovation, patterns in adoption…etc. Also, a large number of the research's subjects did not have hands-on experience with telemedicine but had knowledge or heard about it, which resulted in a lack of actual usage. Their feedback was almost based on the introductory video demo presented to them before data collection started, the researcher's verbal introduction, and/or searches they did before participation. This might have an impact on the participants' perceptions, attitude and reactions towards telemedicine. However, participants were asked to respond based on their

expected future usage if they have not used telemedicine. Availability of a trial version of telemedicine for the participants to use during the research would have improved their exposure to telemedicine, hence better perceptions.

Additionally, self-reported usage compared to actual usage was not done due to challenges in obtaining the actual system usage behaviour data. Such data would support the research findings, particularly for those in both case studies.

As a case study, only MOHAP was included in this research. Other local healthcare authorities and the private sector were not included and yet implemented telemedicine technology.

However, the above discussed limitations should not have a high impact on the research's validity due to the research's structure, management and techniques employed.

### 6.5 Future Works

The research findings indicated a strong interest in telemedicine that would improve the healthcare system but requires modifications to be substantially accepted and avoid discontinuing usage. For instance, further empirical studies need to be conducted to measure telemedicine technology impacts on patients' health outcomes and expenditures over time, such as in the event of pandemics (e.g. COVID-19).

To elicit more reliable information about usage behaviour and acceptance of technology (e.g. telemedicine), follow-up analysis after a period of exposure should be done as perception and attitude towards technology are highly likely to change.

Also, apply a combination of models (e.g. TAM and Task-Technology Fit "TTF") to understand and identify common factors and underlying determinants of behavioural intentions and then compare the results of the models used.

Furthermore, as known in the computer science world, technology acceptance is a prevalent issue. Although many researchers applied TAM to evaluate technology acceptance, there is still a need for further tests to be done and other models and theories to develop, modify, retest…etc.

Due to access restriction to the back-end of telemedicine technology to compare the research results with actual usage behaviour, it is highly encouraged as future work to investigate this and compare findings between intention to use and actual usage behaviour.

Finally, address telemedicine interoperability and integration that works properly with all enterprises.

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# APPENDICES

## Appendix A: UAE Population Distribution

| Total population distribution | | | |
|---|---|---|---|
| Gender | Male | Female | Total |
| | 6806044 (72%) | 2594102 (28%) | 9400146 |
| Geographical location | Urban | Rural | Total |
| | 8107437 | 1292708 | 9400145 |
| Age group | Gender | | |
| | Male | Female | Total |
| 0-4 | 233278 | 223783 | 457061 |
| 5-9 | 237429 | 226869 | 464298 |
| 10-14 | 193913 | 191108 | 385021 |
| 15-19 | 224244 | 174664 | 398908 |
| 20-24 | 478827 | 191558 | 670385 |
| 25-29 | 954071 | 264912 | 1218983 |
| 30-34 | 1150573 | 339811 | 1490384 |
| 35-39 | 1030012 | 322734 | 1352746 |
| 40-44 | 890354 | 251327 | 1141681 |
| 45-49 | 632130 | 172111 | 804241 |
| 50-54 | 395124 | 109154 | 504278 |
| 55-59 | 226547 | 61782 | 288329 |
| 60-64 | 86250 | 30058 | 116308 |
| 65-69 | 33245 | 16717 | 49962 |
| 70-74 | 22963 | 8679 | 31642 |
| 75-79 | 10400 | 4143 | 14543 |
| 80+ | 6684 | 4692 | 11376 |
| Total | 9400146 | | |

(Adapted from The World Bank 2018).

The above data are estimations done by the World Bank. It can be noticed that there is a small difference in the total population per gender and age groups in the totals compared to the total population per geographical location. However, this was verified by calculating age groups separately and then again calculating gender separately; it gave the same total population = 9400146.

**Appendix B: Previous Works' Hypotheses Testing and Outcomes**

| Study | Author (s) and year | Hypotheses and outcomes |
|---|---|---|
| An analysis of technology acceptance model: exploring user acceptance and intention of taxi-hailing app in Shanghai | Liu (2014) | Perceived usefulness had the strongest impact on behavioural intention, followed by influence on attitude towards using taxi-hailing app.<br>Perceived ease of use had a moderate effect on users' attitude towards using the app.<br>Perceived ease of use had a strong influence on perceived usefulness.<br>Attitude had an influence on behavioural intention toward using the app. |
| The influence of perceived usefulness, perceived ease of use, and subjective norm on the use of computed radiography systems: a pilot study. | Cowen (2009) | No significant relationship existed between subjective norm and perceived usefulness as well as between subjective norm and behavioural intention to use technology.<br>A very significant relationship existed between perceived ease of use and perceived usefulness.<br>A significant relationship existed between perceived usefulness and behavioural intention to use technology.<br>No significant relationship existed between perceived ease of use and behavioural intention to use technology. |
| Integration of innovation diffusion theory and technology acceptance model to understand mobile banking acceptance | Mutahar et al. (2017) | Compatibility had a positive effect on perceived usefulness and remarkably predicted perceived usefulness.<br>Compatibility had a positive effect on perceived ease of use and significantly predicted perceived ease of use. |

| | | |
|---|---|---|
| in Yemen: the moderating effect of income. | | Trialability had a significant positive effect on perceived usefulness.<br>Trialability had a significant positive effect on perceived ease of use.<br>Observability did not predict perceived usefulness and perceived ease of use.<br>Perceived usefulness had a positive effect on the intention to use mobile banking services and greatly predicted intention to use.<br>Perceived ease of use had a significant effect on the intention to use mobile banking services.<br>Perceived ease of use positively affected perceived usefulness and was a significant antecedent of perceived usefulness and intention to use. |
| An evaluation of GeoBEST contingency beddown planning software using the technology acceptance model. | Jensen (2002) | Perceived usefulness had a strong effect on behavioural intention, while attitude had a slightly smaller effect.<br>Perceived usefulness was highly correlated with attitude, but perceived ease of use had an insignificant relationship. This was found as well by Davis, Bagozzi and Warshaw (1989).<br>There was a strong relationship between perceived usefulness and perceived ease of use. |
| User acceptance of information technology: system characteristics, user perceptions and behavioural impact. | Davis (1993) | Attitude toward using had a significant positive effect on actual system usage.<br>Perceived usefulness had a significant positive effect on attitude toward using, controlling for perceived ease of use. |

| | | |
|---|---|---|
| | | Perceived ease of use had a small effect on attitude toward using, controlling for perceived usefulness.<br>Perceived ease of use had a strong effect on perceived usefulness. |
| Perceived usefulness, perceived ease of use, and user acceptance of information technology. | Davis (1989) | Case study 1:<br>The effect of usefulness on usage was significant when ease of use was controlled, while the effect of ease of use on usage was not significant when usefulness was controlled.<br>Case study 2:<br>Usage was correlated with usefulness as well as with ease of use, but the significance of usefulness- use correlation was greater than ease of use-use correlation.<br>Ease of use was correlated with usefulness.<br>Overall, usefulness had a significantly greater correlation with usage behaviour than ease of use. Also, usefulness and ease of use can be effected by external factors. |

**Appendix C: ATA Guidelines**

1. Administrative guidelines:
    - Organizations
        - When providing telemedicine services, organizations and healthcare professionals shall comply with local and federal legislation, accreditations, ethical requirements, and regulations to support decision-making and consent.
        - Mechanisms shall ensure that patients and healthcare professionals are aware of their rights and responsibilities to access and provide healthcare via telemedicine.
        - Organizations shall respect in-person requests by patients.
        - Integrating telemedicine with existing operational procedures to obtain consents (e.g. treatment) from patients shall be done and provide information in a language that can be easy to understand by patients, especially technical information (e.g. encryption and potential technical failures).
    - Healthcare professionals
        - Professionals shall perform care consistent with law, licensing, regulation, credentialing…etc.
        - Professionals shall have the necessary education, training, licensure and continuous professional development.
2. Clinical guidelines:
        - Healthcare professionals shall be acquainted with the use of devices and software employed in delivering healthcare via telemedicine.
        - Organizations and healthcare professionals shall consider patients' expectations about additional contact between the patient and professional.

- Professionals shall be culturally competent when delivering services by considering different aspects, such as the population's culture, background, age, gender and language.
- Implementing verification protocols either the patient is in the healthcare institution or a remote location. For instance, both parties shall follow the placed verification protocols, such as licensure information and providing a government issued identification card.

3. Technical guidelines:
    - Communication modes and applications
        - Appropriate verification, confidentiality as well as security measures shall be taken.
        - Machines that include social media functions to notify users about anyone on the contact list log-in should not be used.
    - Devices and equipment
        - Both parties should use high quality devices and equipment (e.g. camera and data transmission equipment). Also, device management software should consistently oversee applications, devices, security, and data configuration.
        - Organizations shall have strategies in place for the safe use of telemedicine equipment and addressing environmental elements.
        - Organizations shall comply with relevant laws and regulations related to technology. For instance, in the United Arab Emirates (UAE), there is a law about information technology in health "Federal Law No. (2)for 2019

regarding the Use of Information Technology and Communications in the Fields of Health".

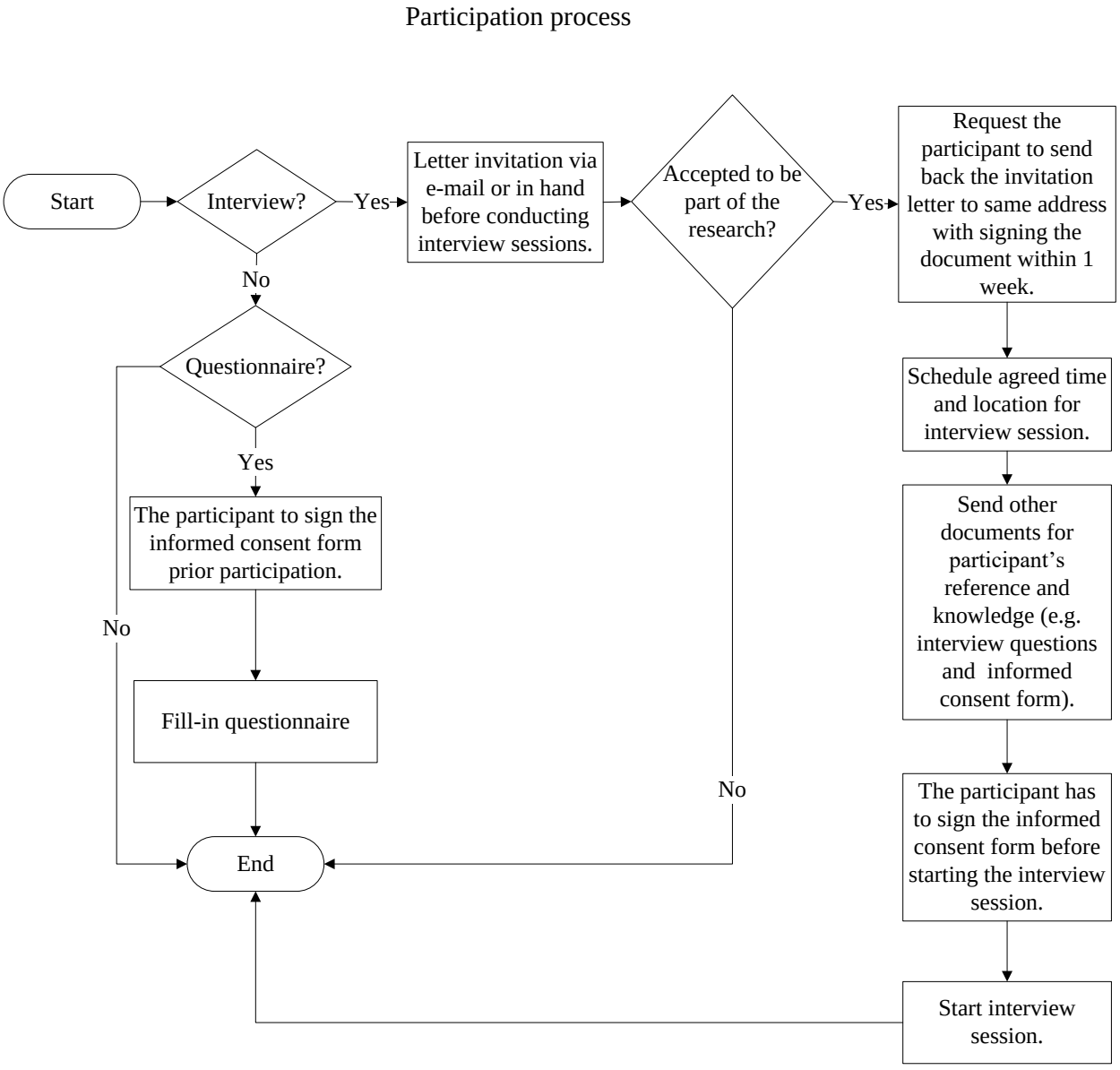
- Organizations shall do ongoing maintenance.

- Connectivity
  - Video conferencing service should be provided at a "bandwidth of at least 500Kbps in each of downlink and uplink directions. Also, a minimum of 640X480 resolution at 30 frames/second" (ATA 2014).
  - Healthcare professionals/organizations may recommend certain software/hardware to the patient; where it is practical.
  - Either/both parties may conduct a pre-test of the connection (e.g. bandwidth test) before starting the telemedicine session to ensure the quality of the session.
  - Organizations shall have reliable, redundant systems that ensure the availability of data transmission infrastructure.
- Privacy
  - Encryption mechanisms that meet recognized standards shall be used when audio, video and data are transmitted.
  - IT professionals should be aware of up-to-date technology security measure available and help in educating patients about privacy and security.
  - Passphrases or equivalent security features shall be used before related devices can be accessed. When applicable, multi-factor authentication should be used. Additionally, the inactivity timeout function should be

utilized to access devices after the time-out threshold is exceeded (not more than 15 minutes).

- Remote disable of devices or wiping contents option should be available in the event of device lost or stolen.
- The software shall not allow the running of more than one session by a single user per time. If an attempt to open another session, the software shall either exist the first session or block the second session from being opened.
- Storage/backup of confidential personal health information and data shall only be on secure data storage locations. Cloud services that are not able to achieve compliance shall not be sued. If data are stored on either parties' computer hard drive, whole disk encryption should be used.

## Appendix D: Research Participation Process



**Appendix E: Informed Consent Form – English**

**Telemedicine Technology in the United Arab Emirates (UAE)**

Date (dd/mm/yyyy):

My name is Shaikha Abdulkarim Abdool, a PhD student at the British University in Dubai. I'm conducting a research about telemedicine technology in the United Arab Emirates (UAE).

It is important that you read and understand the following explanation of all information related to the research. Take your time to discuss and ask questions as needed with the researcher.

The purpose of this research is to get more information about telemedicine technology in the country from adults (males and females) in the UAE's community. This will help in evaluating telemedicine technology from a sociotechnical perspective as well as readiness level to implement this technology in the country. Also, evaluate demand and acceptance level for this technology. The results of this research will allow better understanding of the need for telemedicine technology along with acceptance factors.

In total, approximately 385 participants will be involved in this research from different parts of the community.

You have been selected randomly to participate in this research and information will be collected through interviews and/or questionnaires. No medical tests or experiments will be done. In case of interview, it will approximately take 30 minutes per sessions. The interview session will be one-to-one, audio-recorded and then transcribed as well as shared with you for modification; if needed. The recording of the session will be done where it is convenient to you and I (the researcher) and

the academic supervisor only if needed will access the recorded session. After completing this research which could take maximum three years, the recorded sessions will be destroyed by completely deleting it without keeping copies of it. While, filling in the questionnaire, it will approximately take 15 minutes.

As a participant, you understand that confidentiality and privacy will be maintained and the researcher will not disclose any real identifications in the final report. However, for the purpose of research analysis, it is possible for other involved academics in this research besides the researcher to get access to the transcripts only.

For research publication, direct quotations and summary of interview contents will be anonymous, so they can not be identified by other individuals. The researcher may contact you again only if it is required to complete missing information or clarify matters related to the research.

No benefits or payments are expected to be received for participating in this research. You have the right to ask questions and contact the researcher for further enquiries or concerns related to this research.

All personal information collected and obtained from you will be kept strictly confidential and anonymous and will be used by the researcher for scientific purpose.

By signing this form, you thereby volunteer to participate in this research and you have the right to withdraw from the research at any time without any risks or penalty.

| | | |
|---|---|---|
| Participant's Name: | Participants' Signature: | Date (dd/mm/yyyy): |
| Researcher's Name: | Researcher's Signature: | Date (dd/mm/yyyy): |

Contact Details:

Name of the researcher: Shaikha Abdulkarim Abdool

Address: P.O.Box: 378, Ajman – UAE

Tel: 00971503071177

E-mail: 2015146060@student.buid.ac.ae

For ethical concerns/complaints related to this research, you may contact Mrs. Yusra Abdulrahman from Dubai Research Ethics Committee at 0097147078538 and email: Yusra.swaidal@moh.gov.ae

## Appendix E.1: Informed Consent Form – Arabic

**إستمارة الموافقة المسبقة**

**تقنية التطبيب عن بعد في دولة الإمارات العربية المتحدة**

التاريخ (اليوم / الشهر / السنة):

إسمي شيخة عبدالكريم عبدول، طالبة دكتوارة في الجامعة البريطانية – دبي. أقوم بإجراء دراسة بحثية عن تقنية التطبيب عن بعد في دولة الإمارات العربية المتحدة.

من المهم أن تقرأ و تفهم جميع المعلومات عن الدراسة. خذ الوقت الكافي لطرح ما تحتاج من أسئلة للباحث.

إن الهدف من هذه الدراسة هو الحصول على المزيد من المعلومات عن تقنية التطبيب عن بعد في الدولة من قبل الذكور و الإناث البالغيين في مجتمع دولة الإمارات العربية المتحدة، و هذا سيساعد على تقييم تقنية التطبيب عن بعد من منظور إجتماعي تقني و مدى جاهزية تطبيق التقنية في الدولة. و كذلك، تقييم مستوى الحاجة و القبول لهذه التقنية. ستسمح نتائج هذه الدراسة بفهم أفضل لمدى الحاجة لتقنية التطبيب عن بعد و عوامل القبول.

إجمالاً، سيشارك في هذه الدراسة حوالي 385 مشترك من مختلف شرائح المجتمع.

تم إختيارك بشكل عشوائي في هذه الدراسة و سيتم جمع المعلومات عن طريق إجراء مقابلات و/أو تعبئة إستبيانات. لن يتم إجراء أي تحاليل أو تجارب طبية. في حالة إجراء مقابلة، قد تستغرق حوالي 30 دقيقة للجلسة الواحدة. جلسة المقابلة ستكون شخص-إلى-شخص و مسجلة، و من ثم التدوين و سيتم مشاركة نسخة من المدونة مع المشارك لتعديل الأخطاء، إن وجدت. سيتم تسجيل المقابلة في المكان الذي يناسبك و سأكون الشخص المخول بالإستماع للتسجيل و المرشد الإكاديمي فقط إذا دعت الحاجة و بعد الإنتهاء الكامل من الدراسة و التي قد تستغرق أقصى حد 3 سنوات، سيتم التخلص من السجلات بحذفها تماماً دون الإبقاء على أية نسخ. بينما في حالة تعبئة الإستبيان، قد يستغرق حوالي 15 دقيقة.

كمشارك، تتفهم بأنه سيتم الحفاظ على السرية و الخصوصية و الباحث لن يكشف عن أسماء و هويات حقيقية قي أي تقرير. لكن، لتحليل البحث، من الممكن الوصول إلى النصوص المدونة فقط من قبل الباحث و الزملاء الأكاديميين الآخرين الذين قد يتعاونون في هذا البحث.

لنشر هذا البحث، الإقتباس المباشر و ملخص محتويات المقابلة ستكون مجهولة الهوية حتى لا يتم التعرف عليها من قبل أفراد آخرين. قد يقوم الباحث بالإتصال بك مرة أخرى فقط إذا كان من الضروري إكمال بعض المعلومات المفقودة أو إستيضاح أمور ذات علاقة بالبحث.

من الغير متوقع تلقي منافع أو مدفوعات جرّاء المشاركة في هذه الدراسة .لديك الحق بطرح أسئلة و التواصل مع الباحث لإستفسارات أضافية أو مخاوف متعلقة بهذه الدراسة.

جميع المعلومات الشخصية التي سنجمعها و نحصل عليها منك ستبقى سرية للغاية و مجهولة الهوية و ستسخدم من قبل الباحث و لأغراض بحثية فقط.

من خلال توقيعك لهذه الإستمارة، ستتطوع بالمشاركة في هذه الدراسة و هي إختيارية و لك الحق بالإنسحاب من هذه الدراسة في أي وقت دون مخاطر أو جزاء.

| | | |
|---|---|---|
| إسم المشارك: | توقيع المشارك: | التاريخ (يوم/شهر/سنة): |
| إسم الباحث: شيخة عبدالكريم عبدول | توقيع الباحث: | التاريخ (يوم/شهر/سنة): |


تفاصيل التواصل:

إسم الباحث: شيخة عبدالكريم عبدول

العنوان: صندوق البريد: 378 - عجمان - الإمارات العربية المتحدة

الهاتف: 00971503071177

البريد الإلكتروني: 2015146060@student.buid.ac.ae

للإستفسارات و الشكاوى المتعلقة بأخلاقيات هذه الدراسة، يمكنك التواصل مع السيدة / يسرى عبدالرحمن من لجنة أخلاقيات البحث في دبي على رقم الهاتف: 0097147078538 و البريد الإلكتروني: Yusra.swaidal@moh.gov.ae

**Appendix F: Invitation Letter to Participate in the Research – English**

**Telemedicine in Practice: A Sociotechnical Analysis**

Date (dd/mm/yyyy):

Dear [Insert Name],

My name is Shaikha Abdool, a PhD student at the British University in Dubai (BUiD) and conducting research about telemedicine in the United Arab Emirates (UAE). The research purpose is to explore and analyse telemedicine in the country from sociotechnical perspectives. Hence, I would like to invite you to be part of the research and is completely voluntary. There will be a face-to-face interview that would take approximately (30 minutes) in length and the location will be agreed upon as convenient. Answering question is without boundaries and you may decline or withdraw from the research without any terms and conditions.

Topics will be discussed during the interview:

- ☐ What is the readiness level to implement telemedicine in the UAE?
- ☐ How is telemedicine well known in the UAE by healthcare professionals and the public?
- ☐ What are the factors for demanding and accepting telemedicine in the country?
- ☐ What are possible benefits and challenges of telemedicine in the country?

Based on your approval, the interview will be audio-taped for future referencing during the research. The recording of the session will be done where it is convenient to you and I (the researcher) and the academic supervisor only if needed will access the recorded session. After completing this research which could take maximum three years, the recorded sessions will be

destroyed by completely deleting it without keeping copies of it. Transcribed and analysed data will be shared with you before publication. Your anonymity will be maintained

Your participation is very appreciated and valuable to the research. This will add more value to the field of computer science and health informatics as well as serve UAE and its society regarding telemedicine.

Kindly let me know your decision and you may contact me for further enquires via: 2015146060@student.buid.ac.ae

*Thank you and regards,*

Shaikha Abdool

**Appendix F.1: Invitation Letter to Participate in the Research - Arabic**

**رسالة دعوة للمشاركة في الدراسة**

**التطبيب عن بعد في الممارسة العملية: تحليل إجتماعي-تقني**

التاريخ: اليوم/الشهر/السنة

عزيزي/تي (إسم المشارك)،

إسمي شيخة عبدالكريم عبدول، طالبة دكتوراة في الجامعة البريطانية – دبي و أقوم ببحث عن التطبيب عن بعد في دولة الإمارات العربية المتحدة. الهدف من هذا البحث التحري وتحليل تقنية التطبيب عن بعد في الدولة من منظور إجتماعي-تقني. لذلك، أرغب بدعوتك اتكون جزء من هذا البحث و هي إختيارية بالكامل. ستكون هناك مقابلة وجهاً لوجه و قد تستغرق حوالي 30 دقيقة. مكان المقابلة سيتم الإتفاق عليها حسب الملائمة. الرد على الأسئلة من غير قيود و لك الحق بالرفض أو الإنسحاب من البحث دون أية شروط أو أحكام.

المواضيع التي ستتم مناقشتها خلال المقابلة:

- ☐ ما هي مستوى الجاهزية لتطبيق التطبيب عن بعد في دولة الإمارات العربية المتحدة؟
- ☐ ما مدى شهرة التطبيب عن بعد في دولة الإمارات العربية المتحدة من قبل مهنيين الرعاية الصحية و المرضى؟
- ☐ ما هي عوامل الطلب و قبول التطبيب عن بعد في الدولة؟
- ☐ ما هي الفوائد و التحديات المحتملة للتطبيب عن بعد في الدولة؟

بناءً على موافقتك، سيتم تسجيل المقابلة (صوتياً) كمرجع خلال البحث. سيتم تسجيل المقابلة في المكان الذي يناسبك و سأكون الشخص المخول بالإستماع للتسجيل و المرشد الإكاديمي فقط إذا دعت الحاجة و بعد الإنتهاء الكامل من البحث و الذي قد يستغرق أقصى حد 3 سنوات، سيتم التخلص من السجلات بحذفها تماماً دون الإبقاء على أية نسخ. البيانات المدونة و المحللة سيتم مشاركتها معك قبل النشر مع إبقاء هويتك مجهولة.

مشاركتك محل تقدير كبير و ذو قيمة للدارسة و التي ستضيف المزيد من القيمة لمجال علم الحاسوب و المعلوماتية الصحية و كذك لخدمة دولة الإمارات العربية المتحدة و مجتمعها بما يتعلق بالتطبيب عن بعد.

لطفاً، أعلمني بقرارك و لمزيد من الإستفسار؛ بإمكانك التواصل معي عن طريق: 2015146060@student.buid.ac.ae

شكراً لك و مع التحيات،

شيخة عبدول

**Appendix G: Telemedicine in the UAE Questionnaire – English**

**Telemedicine in the United Arab Emirates (UAE)**

(All information will be kept confidential)

This questionnaire is designed by a PhD student at the British University in Dubai (BUiD). Data collected from the questionnaire will be used to conduct thorough research about telemedicine in the UAE.

Telemedicine can be defined as providing healthcare remotely without physical attendance to the healthcare facility; when it is applicable. It could be between different healthcare professionals or a patient and healthcare professionals…etc. The aim of the research is to evaluate the readiness level of implementing telemedicine, the demands and acceptance of this technology in the UAE and possible benefits along with challenges from sociotechnical aspects.

Participation in this questionnaire is appreciated, which should only take approximately 15 minutes. Your feedback is important to the success of this research.

Participation is completely voluntary and responses will be dealt with confidentiality and respect. There are no right or wrong answers and no real identifications will be disclosed. The results obtained will be used solely for research purposes.

For enquires and concerns:

Researcher's name: Shaikha Abdool

Address: P.O. Box: 378- Ajman- United Arab Emirates

Contact Number: 00971503071177

E-mail: 2015146060@student.buid.ac.ae

**Instructions:**

- Participants shall only complete the questionnaire once, regardless of the version completed (Arabic or English or paper-based or online).
- Select answers from available options and write down when it is applicable. All questions shall be answered unless stated "Optional".

---

- Name (*Optional*): …….
- Gender: ☐Male ☐Female
- Age (*Please Specify*):……..…
- Nationality: ☐Local ☐Non-Local
- Education: ☐School Level ☐Undergraduate ☐Postgraduate
- City/Emirate (*Please Specify*):…….…….……
- Job Title (*Please Specify*):……...…….…...
- Contact Number:…….…….…....
- E-mail Address (*Optional*):..……...……

| No. | Question | Strongly Disagree (SD) | Disagree (D) | Neutral (N) | Agee (A) | Strongly Agree (SA) |
|---|---|---|---|---|---|---|
| **General** | | | | | | |
| 1. | There is an evident use of advanced technology in the UAE. | | | | | |
| 2. | Telemedicine is a well-known concept. | | | | | |
| **Demand** | | **SD** | **D** | **N** | **A** | **SA** |
| 3. | There is a need for telemedicine in the UAE. | | | | | |
| **Acceptance** | | **SD** | **D** | **N** | **A** | **SA** |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Perceived Usefulness (PU)** | 4. | Telemedicine would allow accomplishing tasks more quickly. | | | | | |
| | 5. | Using telemedicine would improve performance. | | | | | |
| | 6. | Telemedicine would be useful. | | | | | |
| **Perceived Ease of Use (PEOU)** | 7. | I would find telemedicine flexible to interact with. | | | | | |
| | 8. | It would be easy for me to become skilful at using telemedicine. | | | | | |
| | 9. | Telemedicine would be easy to use. | | | | | |
| **Attitude Towards Using(AT)** | | | **SD** | **D** | **N** | **A** | **SA** |
| 10. | Telemedicine would be better than traditional medical care delivery. | | | | | | |
| Behavioural Intention (BI) | | | **SD** | **D** | **N** | **A** | **SA** |
| 11. | I will use telemedicine on a regular basis. | | | | | | |

**Usage** *(Please respond based on your actual usage of telemedicine technology. If not, respond based on your future expected usage).*

12. How many times you actually use or will use telemedicine?

☐Regularly ☐Often ☐Rarely ☐Do not know ☐Not at all

*13.* Which of telemedicine's features you mostly used or will probably use *(you may select more than one option):*

☐Reports generation ☐Scheduler ☐Export/import files

☐Online-help ☐Other (*Please Specify*):…….…….

14. What are most liked features of telemedicine? *(you may select more than one option):*

☐Virtual communication ☐Sharing reports

☐Booking an appointment easily without visiting the hospital ☐Accessing personal medical record

☐Other (*Please Specify*):……..……

15. What are most disliked features of telemedicine? *(you may select more than one option):*

☐Fear of sudden Internet disconnection ☐ User-interface ☐ Language

☐Technical skills required ☐Other (*Please Specify*):…….……..……

16. What suggestions do you have for future improvement of telemedicine? (*Please Specify*):

| No. | Question | Strongly Disagree (SD) | Disagree (D) | Neutral (N) | Agee (A) | Strongly Agree (SA) |
|---|---|---|---|---|---|---|
| **Diffusion of Innovations (DOI) and External Attributes** | | | | | | |
| 17. | Awareness of new innovations (e.g. telemedicine) impacts its diffusion. | | | | | |
| 18. | Users' engagement in activities related to an innovation (e.g. telemedicine) leads to embracing it. | | | | | |
| 19. | The technology would require training for users. | | | | | |
| 20. | It would require a legal framework before implementation to guide the use of such system. | | | | | |
| 21. | Using telemedicine would meet needs in a better way. | | | | | |
| 22. | Telemedicine would change the work processes of an organization. | | | | | |
| 23. | Obtaining related information via telemedicine would be easy. | | | | | |
| 24. | Being personally able to try telemedicine is important to make decision about using it. | | | | | |
| 25. | Probably, people would be interested in telemedicine when they see others using it | | | | | |
| **Overall** | | **SD** | **D** | **N** | **A** | **SA** |
| 26. | Telemedicine would be accepted in the UAE. | | | | | |

27. Telemedicine has possible benefits *(you may select more than one option):*

☐Improve access to healthcare services.

☐Cost-effectiveness (e.g. save money for transportation, seeking medical care…etc.).

☐Share knowledge.

☐Reduce congestion to seek medical care (e.g. Transportation).

☐Other (*Please Specify*):……..….

28. Telemedicine has possible challenges *(you may select more than one option):*

☐Reliability (e.g. system availability, human errors…etc.).

☐Trustiness.

☐Security (e.g. confidentiality, privacy…etc.).

☐Variety of social backgrounds and values.

☐Acceptance by the users (e.g. healthcare providers and patients).

☐Increase workload on healthcare professionals.

☐Other (*Please Specify*): ……..…….

29. Overall, how do you actually perceive telemedicine?

☐Positive innovation ☐Neutral ☐Negative innovation

| **Further Comments and Recommendations (***Optional***):** |
| --- |
| |

**End of questionnaire**

**Thank you for your cooperation**

## Appendix G.1: Telemedicine in the UAE Questionnaire – Arabic

**إستبيان التطبيب عن بعد في دولة الإمارات العربية المتحدة**

(جميع المعلومات سرية)

هذا الإستبيان تم إنشاؤه من قبل طالب دكتوراة في الجامعة البريطانية – دبي. سيتم إستخدام المعلومات المجمعة من خلال هذ الإستبيان في إجراء بحث متعمق عن تقنية التطبيب عن بعد في دولة الإمارات العربية المتحدة.

يُعرّف التطبيب عن بعد كالتالي: تزويد الرعاية الصحية عن بعد دون التواجد الفعلي في نفس المكان أو المنشأة الصحية ؛ عندما يكون ذلك قابلاً للتطبيق. قد يكون ذلك بين محتلف مهنيين الرعاية الصحية أو بين مهني رعاية صحية و مريض...إلخ.

الهدف من هذا البحث هو تقييم مستوى الجاهزية لتطبيق تقنية التطبيب عن بعد و كذلك الحاجة و القبول لهذه التقنية في دولة الإمارات العربية المتحدة و الفوائد و التحديات المحتملة من نواحي إجتماعية – تقنية.

مشاركتك في هذا الإستبيان محل تقدير و الذي قد يستغرق حوالي 15 دقيقة. ملاحظاتك و آراؤك مهمة في نجاح هذا البحث. لك الحرية الكاملة للمشاركة في هذا البحث و سيتم التعامل مع الإجابات بسرية و إحترام. ليس هناك إجابات صحيحة أو خاطئة و لن يتم الكشف عن أو نشر بيانات شخصية. النتائج التي تم جمعها ستسخدم فقط لأغراض البحث.

للتواصل و الإستفسار:

إسم الباحث: شيخة عبدالكريم عبدول

العنوان: صندوق البريد: 378 - عجمان – الإمارات العربية المتحدة

الهاتف: 00971503071177

البريد الإلكتروني: 2015146060@student.buid.ac.ae

**إرشادات:**

- يجب على المشاركين تعبئة الإستبيان مرة واحدة فقط ؛ بغض النظر عن الإصدار الذي تم تعبئته (باللغة العربية أو الإنجليزية أو النسخة الورقية أو الإلكترونية).
- إختار الإجابة من الخيارات المتوفرة و الكتابة حسب الحاجة. يجب الإجابة على جميع الأسئلة؛ ما عدا في الحالات المذكورة (إختياري).

---

- الإسم *(إختياري)*:.....
- الجنس: ☐ذكر ☐أنثى
- العمر*(يرجى التحديد)*:.....
- الجنسية: ☐موطن ☐غير مواطن
- التعليم: ☐شهادة مدرسية ☐جامعي ☐دراسات عليا
- المدينة/الإمارة *(يرجى التحديد)*:.....
- المسمى الوظيفي *(يرجى التحديد)*:.....
- رقم التواصل:.....
- البريد الإلكتروني *(إختياري)*:.....

| الرقم التسلسلي | الأسئلة | غير موافق بشدة | غير موافق | محايد | موافق | موافق بشدة |
|---|---|---|---|---|---|---|
| **عـام** | | | | | | |
| .1 | هناك إستخدام ملحوظ للتقنيات المتطورة في دولة الإمارات العربية المتحدة. | | | | | |
| .2 | تقنية التطبيب عن بعد مفهوم معروف. | | | | | |
| **الحاجة للتقنية** | | **غير موافق بشدة** | **غير موافق** | **محايد** | **موافق** | **موافق بشدة** |
| .3 | هناك حاجة لتقنية التطبيب عن بعد في الإمارات العربية المتحدة. | | | | | |

| القبول | | غير موافق بشدة | غير موافق | محايد | موافق | موافق بشدة |
|---|---|---|---|---|---|---|
| **الفائدة المتصورة** | 4. سيسمح التطبيب عن بعد إنجاز المهام بسرعة أكبر. | | | | | |
| | 5. إستخدام التطبيب عن بعد من شأنه تحسين الأداء. | | | | | |
| | 6. قد يكون التطبيب عن بعد مفيد. | | | | | |
| **سهولة الإستخدام المتصورة** | 7. التفاعل مع تقنية التطبيب عن بعد مرن. | | | | | |
| | 8. من السهل بالنسبة لي أن أصبح ماهراً في إستخدام التطبيب عن بعد. | | | | | |
| | 9. قد يكون من السهل إستخدام تقنية التطبيب عن بعد. | | | | | |
| **الموقف إتجاه إستخدام تقنية التطبيب عن بعد** | | **غير موافق بشدة** | **غير موافق** | **محايد** | **موافق** | **موافق بشدة** |
| 10. | سيكون التطبيب عن بعد أفضل من تقديم الرعاية الطبية التقليدية. | | | | | |
| **النية السلوكية** | | **غير موافق بشدة** | **غير موافق** | **محايد** | **موافق** | **موافق بشدة** |
| 11. | سوف أستخدم التطبيب عن بعد بشكل منتظم. | | | | | |

**الإستخدام** *(يرجى الإجابة بناءً على إستخدامك الفعلي لتقنية التطبيب عن بعد. إذا لم يكن الأمر كذلك ، أجب بناءً على إستخدامك المتوقع في المستقبل).*

12. كم عدد المرات التي إستخدمت فعلياً هذه التقنية أو سوف تستخدمها؟

☐بانتظام ☐غالباً ☐ نادراً ☐لا أعلم ☐ليس على الإطلاق

13. أي من الميزات التطبيب عن بُعد التي تستخدمها في الغالب أو ستستخدمها على الأرجح *(يمكنك إختيار أكثر من إجابة):*

☐ إصدار تقارير ☐جدولة ☐ تحميل و تنزيل الملفات ☐المساعدة عبر الإنترنت

☐أخرى *(يرجى التحديد):* .....

14. ما هي أكثر الميزات التي تعجبك في تقنية التطبيب عن بُعد؟ *(يمكنك إختيار أكثر من إجابة):*

☐التواصل الإفتراضي ☐مشاركة التقارير ☐حجز موعد بسهولة دون زيارة الفعلية للمستشفى

☐الوصول إلى السجل الطبي الشخصي ☐أخرى *(يرجى التحديد):*.....

15. ما هي أكثر الميزات التي لا تعجبك في تقنية التطبيب عن بعد؟ *(يمكنك إختيار أكثر من إجابة):*

☐الخوف من الإنقطاع المفاجئ للإنترنت ☐واجهة المستخدم ☐اللغة ☐المهارات التقنية المطلوبة

☐أخرى *(يرجى التحديد):*.....

16. ما هي الإقتراحات التي لديك للتحسينات المستقبلية للتطبيب عن بعد؟ *(يرجى التحديد):*

| الرقم التسلسلي | الأسئلة | غير موافق بشدة | غير موافق | محايد | موافق | موافق بشدة |
|---|---|---|---|---|---|---|
| **إنتشار الإبتكار و العوامل الخارجية** | | | | | | |
| 17. | يؤثر الوعي بالإبتكارات الجديدة (مثل التطبيب عن بُعد) على انتشاره. | | | | | |
| 18. | يؤدي مشاركة المستخدمين في الأنشطة المتعلقة بالإبتكار (مثل التطبيب عن بُعد) إلى تبنيه. | | | | | |
| 19. | ستطلب هذه التقنية تدريب المستخدمين. | | | | | |
| 20. | التطبيب عن بعد سيتطلب إطار قانوني قبل التطبيق لإرشاد المستخدمين. | | | | | |
| 21. | إستخدام التطبيب عن بعد من شأنه تلبية الإحتياجات بطريقة أفضل. | | | | | |
| 22. | سوف يغير التطبيب عن بعد أساليب عمل المؤسسة. | | | | | |
| 23. | سيكون الحصول على المعلومات ذات الصلة عبر التطبيب عن بعد أمراً سهلاً. | | | | | |
| 24. | التمكن شخصياً بتجربة تقنية التطبيب عن بعد هو مهم لإتخاذ القرار بشأن إستخدامه. | | | | | |
| 25. | على الأرجح ، سيكون الناس مهتمين بالتطبيب عن بعد عندما يرون الآخرين يستخدمونه. | | | | | |
| **بشكل عام** | | **غير موافق بشدة** | **غير موافق** | **محايد** | **موافق** | **موافق بشدة** |
| 26. | سيكون التطبيب عن بعد مقبولاً في دولة الإمارات العربية المتحدة. | | | | | |

27. من الفوائد المحتملة للتطبيب عن بعد *(يمكنك إختيار أكثر من إجابة):*

☐تحسين الوصول إلى خدمات الرعاية الصحية.

☐الفعالية من حيث التكلفة (مثال: توفير نفقات النقل، البحث عن الرعاية الصحية،...إلخ).

☐تبادل المعرفة.

☐التقليل من الإزدحام لطلب الرعاية الصحية (مثال: النقل).

☐أخرى (*يرجى التحديد*):.....

28. من التحديات المحتملة لتقنية التطبيب عن بعد *(يمكنك إختيار أكثر من إجابة):*

☐إمكانية الإعتماد (مثال: توافر النظام، الأخطاء البشرية،...إلخ).

☐الثقة.

☐الأمن (مثال: السرية، الخصوصية...إلخ).

☐تنوع الخلفيات الإجتماعية و القيم.

☐قبول المستخدمين (المهنيين في الرعاية الصحية و المرضى).

☐زيادة عبء العمل على المهنيين في الرعاية الصحية.

☐أخرى *(يرجى التحديد)*:.....

29. بشكل عام، كيف ترى تقنية التطبيب عن بعد؟

☐إبتكار إيجابي ☐محايد ☐إبتكار سلبي

| **للملاحظات و المقترحات** *(إختياري)*: |
| --- |
| |

**نهاية الإستبيان**

**شكراً لتعاونك**

**Appendix H: Questionnaire Items and References**

| Item | Question/statement | Examples of source |
|---|---|---|
| General | - There is evident use of advanced technology in the UAE.<br>- Telemedicine is a well-known concept. | Rogers (2003) |
| Demand | - There is a need for telemedicine in the UAE. | Rogers (2003) |
| Perceived Usefulness (PU) | - Telemedicine would allow accomplishing tasks more quickly.<br>- Using telemedicine would improve performance.<br>- Telemedicine would be useful. | Cowen (2009)<br>Davis (1989)<br>Davis (1993)<br>Jensen (2002)<br>Mutahar et al. (2017) |
| Perceived Ease of Use (PEOU) | - I would find telemedicine flexible to interact with.<br>- It would be easy for me to become skillful at using telemedicine.<br>- Telemedicine would be easy to use. | Cowen (2009)<br>Davis (1989)<br>Davis (1993)<br>Jensen (2002)<br>Mutahar et al. (2017) |
| Attitude Towards Using(A) | - Telemedicine would be better than traditional medical care delivery. | Atkinson (2007) |
| Behavioural Intention (BI) | - I will use telemedicine on a regular basis. | Davis (1989)<br>Mutahar et al. (2017) |
| Usage | - How many times you actually use or will use telemedicine<br>- Which of telemedicine's features you mostly used or will probably use<br>- What are most liked features of telemedicine?<br>- What are most disliked features of telemedicine?<br>- What suggestions do you have for future improvement of telemedicine? | Davis (1989)<br>Jensen (2002) |

| | | |
|---|---|---|
| Diffusion of Innovations (DOI) and External Attributes | - Awareness of new innovations (e.g. telemedicine) impacts its diffusion.<br>- Users' engagement in activities related to an innovation (e.g. telemedicine) leads to embracing it.<br>- The technology would require training for users.<br>- It would require a legal framework before implementation to guide the use of such system.<br>- Using telemedicine would meet needs in a better way.<br>- Telemedicine would change the work processes of an organization.<br>- Obtaining related information via telemedicine would be easy.<br>- Being personally able to try telemedicine is important to make decision about using it.<br>- Probably, people would be interested in telemedicine when they see others using it | Atkinson (2007)<br>Rogers (2003) |
| Overall | Telemedicine would be accepted in the UAE. | Rogers (2003) |
| Benefits and Challenges | - Telemedicine has possible benefits.<br>- Telemedicine has possible challenges. | Al-Qirim (2007)<br>European Commission International Society and Media (2009) |
| Technology Perceiveness | - How do you actually perceive telemedicine? | (Rogers 2003) |

**Appendix I: Interview Questions – English**

1. How is telemedicine well known in the UAE by healthcare professionals and the public?

    1.1 Do you have any prior knowledge or experience related to telemedicine? (If yes, please explain).

2. What are the factors for demanding and accepting telemedicine in the country?

    2.1 Is there a need for telemedicine in the UAE? Why?

    2.2 To what extent do you believe that age and gender would impact acceptance of such technology?

        2.2.1 Do you think that young people would embrace this technology faster than elderly people? If yes, explain more about it.

        2.2.2 What is the role of individuals and stakeholders, such as patients and healthcare professionals, in telemedicine acceptance?

    2.3 What are the social impacts of telemedicine? Such as social acceptance, healthcare costs, meet society demands…etc.

    2.4 What are the organizational impacts of telemedicine? Such as changing the workflows, roles and responsibilities, extra workload…etc.

    2.5 What are the technical impacts of telemedicine? Such as infrastructure, continuous maintenance…etc.

    2.6 Are there other aspects to be considered related to telemedicine, such as hardware and software requirements and costs of acquiring it, training users, legal framework…etc.

    2.7 How to increase telemedicine acceptance level?

2.8 To what level do you expect telemedicine would be accepted in the country?

3. What are possible benefits and challenges of telemedicine in the country?

    3.1 Is telemedicine better than traditional medical practice? (Please explain).

    3.2 How would awareness of telemedicine's benefits and challenges be useful?

4. How do you actually perceive telemedicine?

    Positive innovation neutral negative innovation

    4.1 Would you personally use telemedicine? Why?

5. Do you have suggestions for future improvement of telemedicine?

6. Would you like to share any comments, opinions or have any questions?

Thank you for your time and cooperation

## Appendix I.1: Interview Questions – Arabic

**أسئلة المقابلة**

1. ما مدى معرفة المهنيين في الرعاية الصحية و الجمهور بتقنية التطبيب عن بعد في دولة الإمارات العربية المتحدة؟

1.1 هل لديك أي معرفة أو خبرة سابقة تتعلق التطبيب عن بعد؟ (إذا كانت الإجابة بنعم، يرجى التوضيح).

2. ما هي عوامل الحاجة إلى تقنية التطبيب عن بعد و قبولها في الدولة؟

2.1 هل هناك حاجة إلى تقنية التطبيب عن بعد؟ و لماذا؟

2.2 إلى أي مدى تعتقد بأن العمر و الجنس (ذكر /أنثى) يؤثران على قبول هذه التقنية؟

2.2.1 هل تعتقد بأن فئة الشباب سيتبنون هذه التقنية أسرع من كبار السن؟ فسر بشكل أكثر؟

2.2.2 ما هو دور الأفراد و أصحاب المصحلة مثل المرضى و المهنيين في الرعاية الصحية في قبول تقنية التطبيب عن بعد؟

2.3 ما هي التأثيرات الإجتماعية لتقنية التطبيب عن بعد ، مثلاً: القبول الإجتماعي، تكاليف الرعاية الصحية، مواكبة متطلبات المجتمع...إلخ؟

2.4 ما هي التأثيرات المؤسسية لتقنية التطبيب عن بعد ، مثلاً: تغيير الإجراءات، المهام و المسؤوليات، زيادة ضغوطات العمل ...إلخ؟

2.5 ما هي التأثيرات التقنية للتطبيب عن بعد ، مثلاً: البنية التحتية، الصيانة المستمرة... إلخ؟

2.6 هل هناك جوانب أخرى يجب مراعاتها متعلقة بتقنية التطبيب عن بعد، مثلاً: متطلبات البرمجيات و المعدات، تكاليف الحصول عليها، تدريب المستخدمين، الإطار القانوني...إلخ.

2.7 كيف يمكن زيادة مستوى قبول تقنية التطبيب عن بعد؟

2.8 إلى أي مدى تتوقع قبول تقنية التطبيب عن بعد في الدولة؟

3. ما هي الفوائد و التحديات المحتملة لتقنية التطبيب عن بعد في الدولة؟

3.1 هل التطبيب عن بعد أفضل من الطريقة التقليدية في ممارسة الطب؟ (يرجى التوضيح).

3.2 كيف من الممكن الوعي بفوائد و تحديات تقنية التطبيب عن بعد أن تكون مفيدة؟

4. ماهي نظرتك لتقنية التطبيب عن بعد؟ ( إبتكار إيجابي محايد إبتكار سلبي)

4.1 شخصياً، هل ستسخدم تقنية التطبيب عن بعد؟ لماذا؟

5. هل لديك مقترحات للتطوير المستقبلي لتقنية التطبيب عن بعد؟ (إذا كانت الإجابة بنعم، يرجى التوضيح).

6. هل ترغب بإضافة تعليقات، ملاحظات أو إستفسارات؟

شكراً لوقتك و تعاونك

## Appendix J: Interview Protocol Template – English

### Introduction

Good morning /afternoon.

My name is Shaikha Abdool, a PhD student at the British University in Dubai (BUiD). Thank you for participating in the research about telemedicine in the United Arab Emirates (UAE). Telemedicine can be defined as providing healthcare remotely where patients and physicians are located in different places via telecommunication technologies; when it is applicable. The aim of the research is to explore telemedicine in the UAE from different angles: social, organizational, financial, technical and legal aspects, as well as possible benefits along with challenges.

Participating in this interview is appreciated and completely voluntary, which should only take around 30 minutes. Your feedback is important to the success of this research and will be dealt with confidentiality and respect. The results obtained will be used merely for research purposes.

The first part of the interview will be related to some demographical information about you and then will proceed to other parts related to telemedicine. There are no correct or wrong answers. You are more than welcome to express your experiences, knowledge and thought about telemedicine.

<u>Further Notes</u>:

1. Before starting the session, may I tape-record the session solely for research purposes. The purpose of recording the session is to get much information when analyzing the findings and produce reliable interpretations. No real identifications will be disclosed or shared with other parties.
2. There might be future interviews if needed.

3. Kindly, would you sign this consent form?
4. Once you sign the form, we shall turn the recorder on and start the session.

| | | |
|---|---|---|
| Research: Telemedicine in practice: a sociotechnical analysis | Interviewer: Shaikha Abdulkarim Abdool | |
| Date (dd/mm/yyyy): | Time of Interview: | Place: |

| | | |
|---|---|---|
| Interviewee: | Age: | Gender |
| Education: | Job/Position | |

| Interview Questions | Feedback |
|---|---|
| | |
| | |
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| | |

Thank you for your participation. You might be reached out again for further clarification as needed and if it suits you.

## Appendix J.1: Interview Protocol Template – Arabic

**قالب محضر جلسة مقابلة**

**المقدمة**

صباح الخير/مساء الخير.

إسمي شيخة عبدالكريم عبدول، طالبة دكتوراة في الجامعة البريطانية – دبي. أشكرك لمشاركتك في هذا البحث عن التطبيب عن بعد في دولة الإمارات العربية المتحدة.

يُعرّف التطبيب عن بعد بتزويد الرعاية الصحية عن بعد حيث تكون الأطراف (مثال: المرضى و الأطباء) متواجدون في أماكن مختلفة عن طريق تكنولوجيا الإتصالات، متى ما أمكن. الهدف من هذه الدراسة هو إستطلاع تقنية التطبيب عن بعد في دولة الإمارات العربية المتحدة من نواحي مختلفة: إجتماعية، مؤسسية، مالية، تفنية و قانونية. كذلك، الفوائد و التحديات المحتملة.

لك الحرية التامة للمشاركة في هذه المقابلة و الذي قد تستغرق حوالي 30 دقيقة. ملاحظاتك و آراؤك مهمة في نجاح هذا البحث و التي سيتم التعامل معها بسرية و إحترام. النتائج المحصول عليها ستسخدم بحتاً لأغراض البحث.

القسم الأول من المقابلة ستكون عن بعض البيانات الديموغرافية المتعلقة بك و من ثم سنكمل إلى الأقسام الأخرى المتعلقة بالتطبيب عن بعد. ليست هناك إجابات صحيحة أو خاطئة. مُرحب بك للتعبير عن خبراتك، معرفتك و أفكارك بما يتعلق بالتطبيب عن بعد.

<u>ملاحظات إضافية</u>:

1. قبل البدء بالجلسة، هل من الممكن تسجيل هذه الجلسة بحتاً لأغراض البحث. الهدف من التسجيل هو الحصول على الكثير من المعلومات عند تحليل النتائج و إصدار تفسيرات موثوقة. لن يتم الكشف عن أي هويات حقيقية أو مشتركتها مع أطراف أخرى.
2. قد تكون هناك مقابلات مستقبلية إذا دعت الحاجة.
3. لطفا، هل من الممكن أن توقع على نموذج الموافقة؟
4. بمجرد توقيعك على النموذج، سنقوم بتشغيل المسجل و بدء الجلسة.

| | | |
|---|---|---|
| المُقابل: شيخة عبدالكريم عبدول<br>Interviewer: | | البحث: التطبيب عن بعد في الممارسة العملية: تحليل إجتماعي-تقني<br>Study: |
| المكان:<br>Place: | وقت المقابلة:<br>Time of Interview: | التاريخ (يوم/شهر/سنة):<br>Date (dd/mm/yyyy): |

| | | |
|---|---|---|
| الجنس:<br>Gender: | العمر:<br>Age: | إسم المُقابل معه:<br>Interviewee: |
| الوظيفة:<br>Job/Position: | | المستوى التعليمي:<br>Education: |

| الرد<br>Feedback | أسئلة المقابلة<br>Interview Questions |
|---|---|
| | |
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| | |

شكراً لمشاركتك. قد يتم التواصل معك مرة أخرى للإستيضاح حسب الحاجة و إذا كان يناسبك.

**Appendix K: Online Questionnaire's Cover Page**

# Telemedicine in the United Arab Emirates (UAE)

(All information will be kept confidential)

This questionnaire is designed by a PhD student at the British University in Dubai (Buid). Data collected from the questionnaire will be used to conduct a thorough research about telemedicine in the UAE.
Telemedicine can be defined as providing healthcare remotely without physical attendance to the healthcare facility; when it is applicable. It could be between different healthcare professionals or a patient and healthcare professionals…etc. The aim of the research is to evaluate the readiness level of implementing telemedicine, demands and acceptance of this technology in the UAE and possible benefits along with challenges from socio-technical aspects.
Participating in this questionnaire is appreciated, which should only take approximately 15 minutes. Your feedback is important to the success of this research.
Participation is completely voluntary and responses will be dealt with confidential and respect. There is no right or wrong answers and no real identifications will be disclosed. The results obtained will be used solely for research purposes.

For enquires and concerns:
Researcher's name: Shaikha Abdool
Address: P.O. Box: 378- Ajman- United Arab Emirates
Contact Number: 00971503071177
E-mail: 2015146060@student.buid.ac.ae

*Required

Telemedicine Demo


By ticking below box, you agree to participate in this questionnaire, otherwise you may close the page and not complete the questionnaire. Participation is completely voluntary. *

☐ Yes, I want to participate

NEXT

Page 1 of 7

**Appendix L: Statistical Results**

| Category | Statements/Questions | Min | Max | Mean (n=330) | S.D |
|---|---|---|---|---|---|
| General | There is an evident use of advanced technology in the UAE | 1.00 | 5.00 | 4.04 | 1.08 |
| | Telemedicine is a well-known concept | 1.00 | 5.00 | 2.73 | 1.14 |
| Demand | There is a need for telemedicine in the UAE | 1.00 | 5.00 | 3.71 | 1.02 |
| Perceived Usefulness | Telemedicine would allow accomplishing tasks more quickly | 1.00 | 5.00 | 3.83 | 0.91 |
| | Using telemedicine would improve performance | 1.00 | 5.00 | 3.69 | 0.91 |
| | Telemedicine would be useful | 1.00 | 5.00 | 3.91 | 0.90 |
| Perceived Ease of Use | I would find telemedicine flexible to interact with | 1.00 | 5.00 | 3.52 | 0.92 |
| | It would be easy for me to become skilful at using telemedicine | 1.00 | 5.00 | 3.62 | 0.99 |
| | Telemedicine would be easy to use | 1.00 | 5.00 | 3.55 | 0.92 |
| Attitude | Telemedicine would be better than traditional medical care delivery | 1.00 | 5.00 | 3.05 | 1.15 |
| Behavioural Intention | I will use telemedicine on a regular basis | 1.00 | 5.00 | 3.17 | 0.99 |
| Total | Mean Knowledge score | 1.00 | 5.00 | 3.38 | 0.87 |
| | Mean Usefulness score | 1.00 | 5.00 | 3.81 | 0.82 |
| | Mean Ease of Use score | 1.00 | 5.00 | 3.56 | 0.83 |
| | Mean Attitude score | 1.00 | 5.00 | 3.05 | 1.15 |
| | Mean Behavioural Intention score | 1.00 | 5.00 | 3.17 | 0.99 |
| Usage | Response rate for Actual Usage of telemedicine | N | % | | |

| | | | | | |
|---|---|---|---|---|---|
| | Regularly | 26 | 7.9 | - | - |
| | Often | 88 | 26.7 | - | - |
| | Rarely | 72 | 21.8 | - | - |
| | Not at all | 64 | 19.4 | - | - |
| | Don’t know | 80 | 24.2 | - | - |
| | Total | 330 | 100.0 | | |

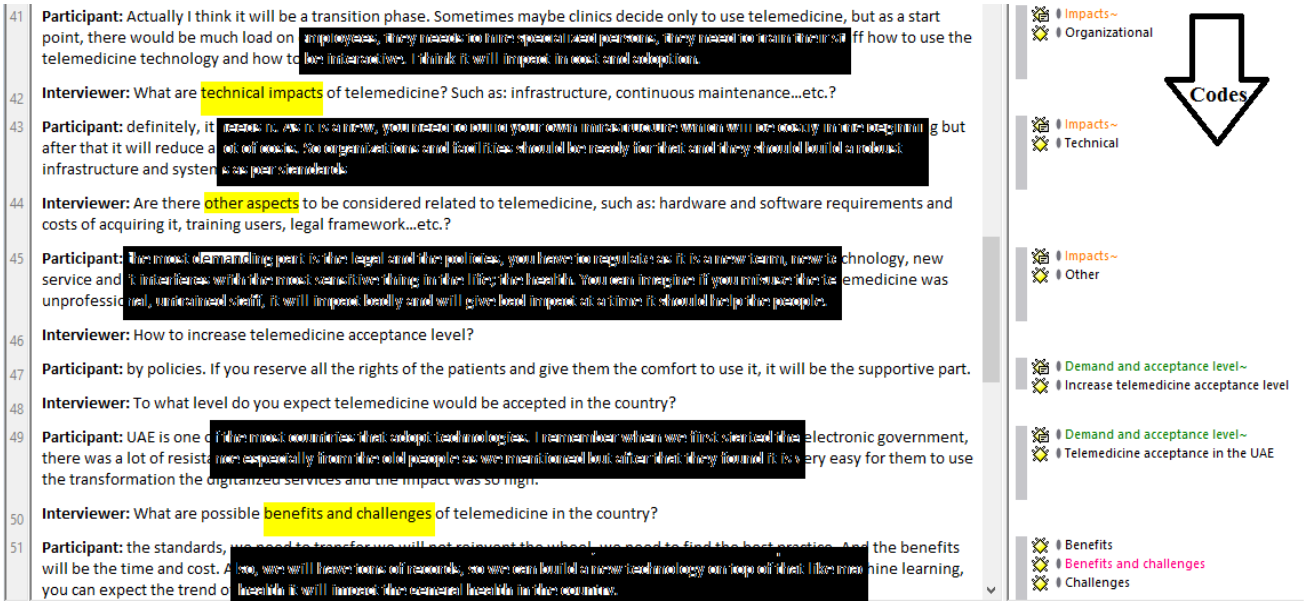
**Appendix M: Qualitative Data Codebook**

| Theme | Code | Description | Examples of quotes |
|---|---|---|---|
| Familiarity with technologies | Familiarity:<br>a. Well-known concept<br>b. Prior knowledge or experience | To identify how telemedicine is well-known in the UAE and if any prior knowledge or experiences with telemedicine technology exist according to the interviewees. | "Well, the idea is known, among the young population. However, the old population might not grasp the idea yet".<br>"It is a new term, unknown by the public. It is still in premature phase".<br>"No idea'. |
| Demand and acceptance | Demand and acceptance level:<br>a. Factors for demanding telemedicine in the UAE<br>b. Factors for accepting telemedicine in the UAE<br>- Demographic factors impact on telemedicine<br>- Stakeholders and individuals role in acceptance<br>- Telemedicine acceptance in the UAE<br>- Increase telemedicine acceptance level | Factors that impact telemedicine demand and acceptance in the UAE with justifications. Also, identify what sociodemographic characteristics might impact acceptance of telemedicine technology (e.g. age and gender) and other people roles in acceptance of telemedicine, how to increase acceptance level, and whether telemedicine would be accepted in the UAE. | "Our country is not that big; if we are going to use telemedicine between our emirates, it will be more beneficial for the people or the patient who cannot travel between the emirates. It will be demanding for them".<br>"Elderly can use it with the guidance of the young people".<br>"Everyone needs to talk about it, vendors need to advertise it, and patients need to see how it will benefit them and healthcare professionals as well". |
| | Impacts:<br>a. Social | A sociotechnical analysis of telemedicine's impacts | "Save time for patients to travel and for physicians as they might not need to be physically in the |

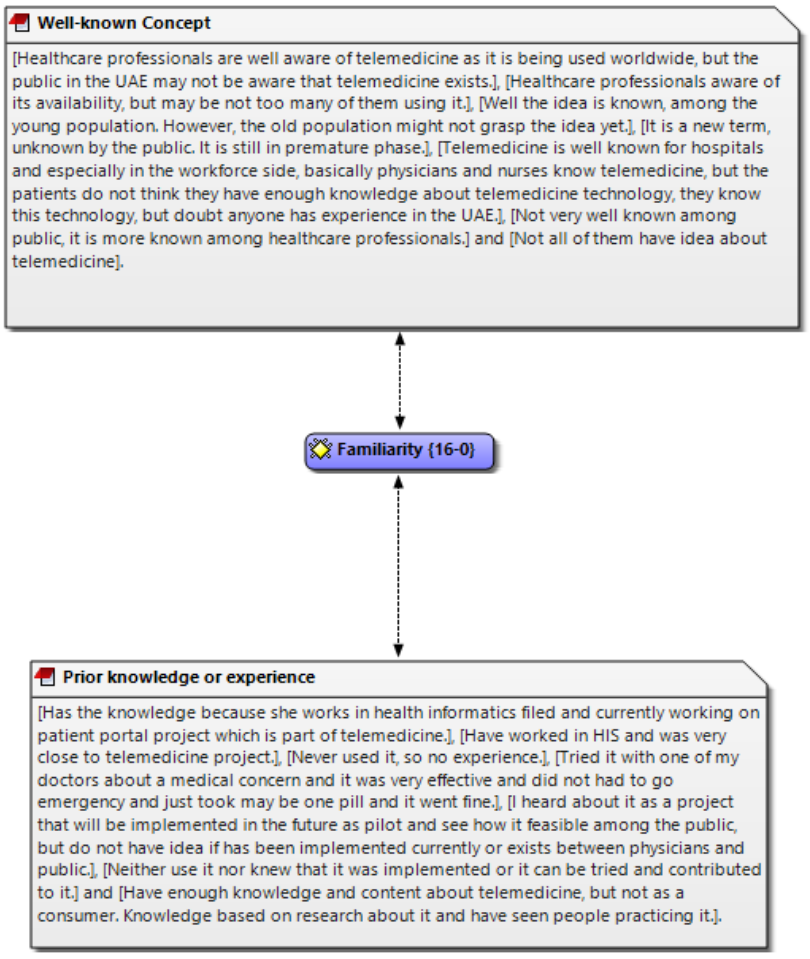
| | | | |
|---|---|---|---|
| Sociotechnical impacts of telemedicine | b. Organizational<br>c. Technical<br>d. Other | from different dimensions: social, organizational, technical and other dimensions (e.g. legal). | hospital as long as they have access to the telemedicine".<br>"Requires more enhancements in the infrastructures and devices (e.g. routers)". |
| Benefits and challenges | Benefits and challenges:<br>a. Benefits<br>b. Challenges<br>c. Telemedicine is better than traditional medicine practice | It describes telemedicine benefits and challenges from participants' point of view and which type of medical practice is better and how awareness of telemedicine's benefits and challenges would be useful. | "Handling emergency cases in the same place and at the same time".<br>"Skills required to use". |
| Personal perceiveness | Personal perceiveness:<br>a. Perceiveness<br>b. Personal use of telemedicine | How participants' perceive telemedicine technology and whether they will use it or not with justifications. | "Of course it is positive innovation, but it has to be properly regulated, that's it. If it is good regulated, then it is a very good innovation, but if it is not, then it can go negatively as well".<br>"Positive innovation".<br>"Do not know". |
| Telemedicine improvements | Improvements:<br>a. Suggested Improvements | Participants' suggestions to improve telemedicine technology in the UAE. | "Simplicity, so people are going to use it especially the doctors as they already fight against using systems in hospitals and they will definitely be against using a complicated program".<br>"Continuous training for end-users". |

## Appendix N: Atlas.ti® Screenshots

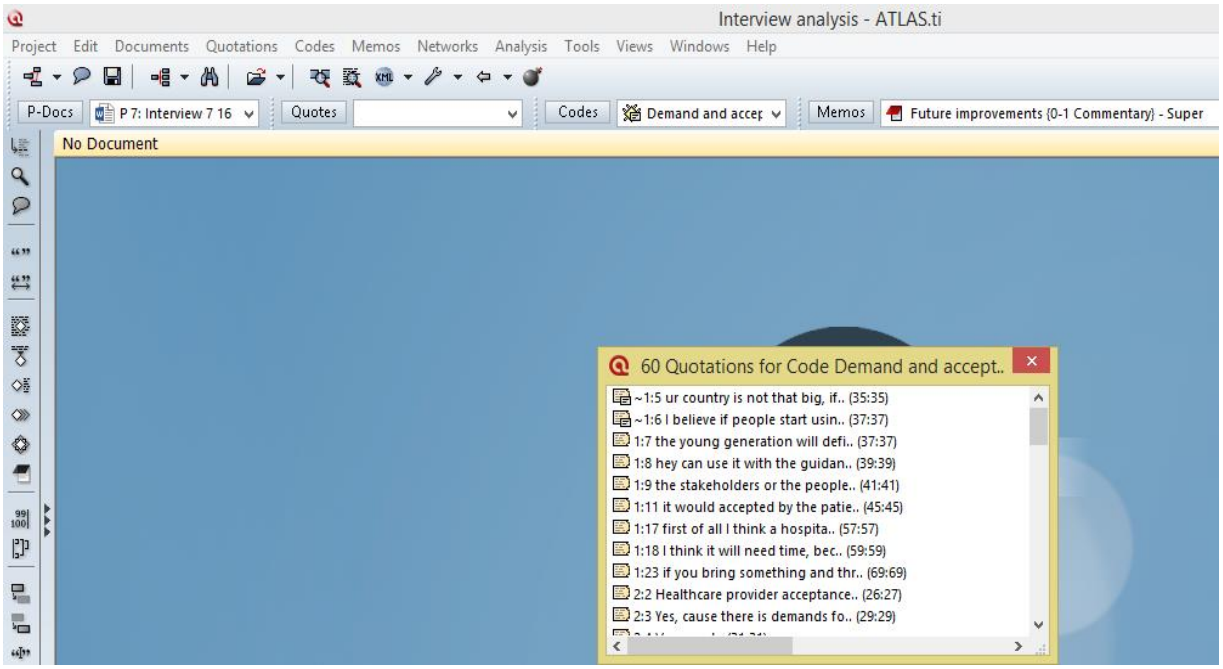
Atlas.ti® coding:




Single code network:



Quotations list:



**Appendix O: Research Ethics Phases**

| Phase | Details |
|---|---|
| Prior conducting the research | - Reducing biases as much as possible by avoiding stating the job title of the researcher and inappropriate questions by piloting the research data collection tools.<br>- Promoting integrity and privacy by defining the protocols of dealing with raw data (Israel & Hay 2006, cited in Creswell 2014), drawing confidentiality statement and preparing required templates (e.g. consent form to participate in the research).<br>- Obtaining the required approvals from BUiD and MOHAP (Approval Reference No. MOHP/REC-3/2018) as shown in Appendices P and Q: BUiD Research Ethics Approval and MOHAP Research Ethics Committee Approval.<br>- After that, Hospital Sector's approval at MOHAP Headquarter that manages MOHAP Hospitals was granted to site visits hospitals that implemented telemedicine technology and collect data, as well as hospitals' management approval was obtained.<br>- Also, the researcher completed and was certified from the National Institutes of Health (NIH) - US the course [Protecting Human Research Participants]: a Good Clinical Practice (GCP) certification, which is used as an international quality standard for conducting research and clinical trials (Certification Number: 2395753).<br>- Developing data collection tools and related documents (e.g. interview protocol template and questions) which were as well available in two languages: Arabic and English.<br>- Defining inclusion criteria for subjects' selection (e.g. competent adults).<br>- Although human subjects were included, the research risk was low, but no clinical trial or medical experiments were conducted. |

Throughout the research

- Defining structured workflow to participate in the research as shown in appendix D: Research Participation Process.
- Several documents were developed by the researcher and used throughout the research, such as:
    a. Invitation letters were sent to the subjects with a clear description of the research's aims and objectives and what will be done and topics covered.
    b. Cover page was available in both languages (Arabic and English). It included various information, such as an introduction about the researcher, the purpose of the research and the researcher's contact details.
    c. An informed consent form was required to be signed by the subjects before completing the data collection instruments that included a description of the research's aims and objectives, confidentiality statement, duration, and how collected data will be handled and dealt with after completing the research. For those who completed the online version, it was mentioned for them on the cover page to tick a box indicating their willingness to participate and a demo video of telemedicine was added for them to better understand the technology under evaluation. Obtaining informed consent from the research's subjects was possible despite that some researchers argued that in some researches, it would be absurd to obtain consent from every individual, such as in observational studies (Punch 1986, cited in Bowling 2009). At the end of the informed consent form, the MOHAP Research Ethics Committee representative's contact details were available for ethical concerns/ complaints related to the research.
- Subjects were informed of the possibility to withdraw from the research at any time without any terms and conditions.
- Data collection locations were as convenient to the subjects as possible in which it did not have vested influences or interests on the research outcomes.
- Transcribed and analyzed data were shared with and reviewed by the research subjects; individually. Each subject was given a copy of his/her interview transcript for further evaluation in terms of anonymousness, consistency,

| | |
|---|---|
| | understandability and matching perceptions shared during the data collection phase. |
| Writing the final report | - Integrity in writing the final report by avoiding reporting only positive findings.<br>- Aliases/pseudonyms were used to maintain privacy.<br>- Although direct quotes and transcribed interview contents were discussed and mentioned in the final report, no real identifications of the research's subjects were disclosed. The same final report would be used for dissemination.<br>- A copy of the final report was provided to academic parties, stakeholders and participants who requested it as well neutral individuals for reviewing purpose and evaluating the report's clarity, anonymousness and appropriateness.<br>- Access to raw data and recorded interview sessions were restricted to the researcher and the academic supervisor; only if needed.<br>- After the research is over, data ownership will be for the researcher and raw data will be kept for some time and then destroyed. For instance, APA recommended 5 years, while Sieber (1998) suggested 5 to 10years, cited in Creswell (2014). |

**Appendix P: BUiD Research Ethics Approval**

الجامعة البريطانية في دبي
The British University in Dubai

## Research Research Ethics Form (Low Risk Research)

To be completed by the researcher and submitted to the Dean's nominated faculty representative on the Research Ethics Committee

**i. Applicants/Researcher's information:**

| | |
|---|---|
| Name of Researcher /student | Shaikha Abdulkarim Abdool |
| Contact telephone No. | 0503071177 |
| Email address | 2015146060@student.buid.ac.ae |
| Date | 07th January 2017 |

**ii. Summary of Proposed Research:**

| | |
|---|---|
| BRIEF OUTLINE OF PROJECT (100-250 words; this may be attached separately. You may prefer to use the abstract from the original bid): | The proposed study will cover the following areas:<br>1- What is the readiness level for implementing telemedicine in the UAE Federal Healthcare Organization (UAE FHO)?:<br>a. What is the current status of the UAE health informatics?<br>b. What requirements readiness is needed, such as: technical, financial, business-wise and users?<br>c. What possible delivery Mechanisms between different contacts?<br>d. What possible barriers in implementing telemedicine in the UAE?<br>2- What is the demand and how to measure acceptance level of telemedicine in the UAE?<br>3- What are the possible benefits and drawback of telemedicine? |

| | |
|---|---|
| MAIN ETHICAL CONSIDERATION(S) OF THE PROJECT<br>(e.g. working with vulnerable adults; children with disabilities; photographs of participants; material that could give offence etc…): | As the methodology will be mixed of quantitative and qualitative methods, the study's subjects will be adults (the UAE Federal Healthcare Organization' staff, such as: healthcare professionals, IT professionals and management members. Also, individuals from the public will be involved and patients). However, there is no clinical trials or experiments will be involved as the study is related to addressing and evaluating a technology in healthcare. There will be observation of the technology's usability in a hospital that implemented it. |
| DURATION OF PROPOSED PROJECT (please provide dates as month/year): | Most probably the actual study will start by October 2017. It depends on the University's approval to officially start the study. |
| Date you wish to start Data Collection: | October 2017. |
| Date for issue of consent forms: | It depends on the UAE Federal Healthcare Organization's Research Approval Committee and the British University in Dubai approval. However, the approvals are under process. Before any interviews conducted, a consent form will be signed by the participants (Attached copy of the consent form designed by the researcher). Also, in the questionnaire that will be used, there is a cover page for declaring to participate (Attached copy of the cover page). For the observation, the approval will be obtained from the UAE Federal Healthcare Organization. |

**iii. Declaration by the Researcher:**

I have read the University's policies for Research and the information contained herein, to the best of my knowledge and belief, accurate.

I am satisfied that I have attempted to identify all risks related to the research that may arise in conducting this research and acknowledge my obligations as researcher and the rights of

participants. I am satisfied that members of staff (including myself) working on the project have the appropriate qualifications, experience and facilities to conduct the research set out in the attached document and that I, as researcher take full responsibility for the ethical conduct of the research in accordance with subject-specific and University Research Policy (9.3 Policies and Procedures Manual), as well as any other condition laid down by the BUiD Ethics Committee. I am fully aware of the timelines and content for participant's information and consent.

Print name: _Shaikha Abdulkarim Abdool_

Signature: _____ Date: _07th January 2017_

*If the research is confirmed as not medium or high risk, it is endorsed HERE by the Faculty's Research Ethics Committee member (following discussion and clarification of any issues or concerns)**..... and forwarded to the Research Office to be recorded.*

I confirm that this project fits within the University's Research Policy (9.3 Policies and Procedures Manual) and I approve the proposal on behalf of BUiD's Research Ethics Committee.

Name and signature of nominated Faculty Representative: Professor Ashly H Pinnington

Signature: _____ Date: 23rd January 2017

iv. If the Faculty's Research Ethics Committee member or the Vice Chancellor considers the research of medium or high risk, it is forwarded to the Research Ethics Officer to follow the higher-level procedures.

* ***If the Faculty representative is the DoS, the form needs the approval of the Chair of the Research Ethics Committee.***

الجامعة البريطانية في دبي
The British University in Dubai
www.buid.ac.ae

2 July 2017

Ms Shaikha Abdulkarim Abdool (Student ID 2015146060)
PO Box 00
Dubai, United Arab Emirates

Dear Ms Abdool,

**PhD in Computer Science**

I am writing to inform you that the Research Degree Committee (RDC) met to consider and approve the result of your proposal defence. The RDC has reviewed your modified extended research proposal and has decided that you awarded a "pass" (subject to the Academic Advisor's feedback). The RDC has agreed that you should be allowed to progress to thesis stage. However, the RDC highly encourage you to study the Academic Advisor's report (when received) and report on how you will deal with it.

Yours sincerely

**Professor Abdullah Alshamsi**
**Vice-Chancellor, Chairman of RDC**

Cc Student File
Director of Studies

## Appendix Q: MOHAP Research Ethics Committee Approval

UNITED ARAB EMIRATES
MINISTRY OF HEALTH & PREVENTION

الإمارات العربية المتحدة
وزارة الصحة ووقاية المجتمع

Ministry of Health and Prevention
Research Ethics Committee

Study Title: Telemedicine in practice -A sociotechnical analysis

Subject: Approval Reference No: MOHP/REC- 3/2018

Dear Prof. Sherief AbdAllah,
Ms. Shaikaha Abdool

In regards to the above mentioned Study protocol, this is to confirm that on the meeting dated (20/02/2018), the Ministry of Health and Prevention Research Ethics Committee has reviewed the study protocol as well as all the documents submitted in the submission file from the ethical point of view and has approved the conduct of above mentioned study.

Opinion: Approval

Please find below a list of approved documents:

| Document | Version/date |
|---|---|
| Application Form | Ministry of Health and Prevention Application Form- amended version |
| Protocol | Integrated research proposal _Amended version |
| Information sheet and Informed Consent Form | Participants information sheet and consent form- English and Arabic_ Amended version and invitation letter |
| Data Collection | Data collection questionnaire and interview form |
| Investigators CV | CVs of Principal Investigators |
| GCP Certificate | GCP Certificate of _Principle investigator |

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The MOHAP Research Ethics Committee is organized and operated according to guidelines of the International Conference on Harmonization and constituted according to ICH-GCP requirements.

This Ethical approval applies for the following study sites only:

-MOHAP ,Al Qassimi Hospital ,Kalba Hospital ,Public Areas in UAE

This approval is subject to the following conditions:

1. The MOHAP research ethics committee approval does not imply that the researcher is granted access to data, medical records or biological samples from the MOHAP health care facilities neither the Private MOHAP licenced health care facilities. Researchers must seek permission and follow the policy and procedure from the concerned directories after the approval from the Research Ethics Committee
2. Please note that it is the Principal Investigator's responsibilities, to immediately inform the Committee of any changes in the research protocol and/or the research Methodologies, should the need for those changes arise prior to or during the conduct of this research study
3. The approval is valid for up to 1year from the date of approval. If the study extends beyond this date ,a progress report must be sent to the research ethics committee to renew the approval
4. The research ethics committee must be informed when the research has been completed and a copy of the final research report must be submitted for our records.

Yours sincerely,

Dr. Suad Hannawi

Signature /Stamp

20-02-18

Date