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Exploring Attitudes of Physicians towards the implementation of Mobile Health technology in Saudi Arabia

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ABSTRACT

This study aims to explore Attitudes of Physicians towards the implementation of Mobile Health technology in Saudi Arabia. In order to fulfil such aim, qualitative methodology was adopted and textual data were collected from 12 physicians who work in King Fahad General Hospital Jeddah in Saudi Arabia. The gathered data were analysed through using thematic analysis. Three themes were identified (i.e. Benefits of m-health adoption, Challenges of m-health adoption, and attitudes of medical staff following the application of m-health on their performance). The benefits of m-health include making remote patient monitoring possible and easy, improves provider communication and coordination, and Gives patients faster access to providers and care. The challenges of m-health include issues related to its usability, system integration, data security and privacy, network access, and reliability. The attitudes of medical staff following the application of m-health on their performance are divided into positive and negative attitudes. Positive attitudes that connect between m-health and Increasing performance instead of documentation, and negative attitudes that connect between decreasing performance and m-health due to time consuming and it needs training courses. The findings of this study cannot be generalised to the whole population due to limitations in terms of sample size.

Introduction

Mobile health (m-health) represents a critical advancement in modern healthcare, enabling the delivery of high-quality services through technologies such as smartphones and tablets. Defined as the preservation and secure collection of patient data in monitored networks, m-health is increasingly adopted globally, offering innovative solutions to healthcare challenges. However, the widespread use of m-health technologies faces challenges, particularly concerning data security and the professional capacity of medical staff (Zhao, Ni & Zhou, 2018; Bol, Helberger & Weert, 2018). This study aims to explore physicians' attitudes towards m-health at King Fahad General Hospital in Jeddah, Saudi Arabia.

The research objectives focus on several critical aspects of m-health implementation, such as overcoming staff resistance, addressing training deficiencies, enhancing healthcare quality, ensuring data confidentiality, and reducing physicians' stress while improving efficiency. Scholars have highlighted the potential of the Internet of

Things (IoT) in advancing m-health by enabling interaction among various devices, facilitating real-time data sharing, and enhancing healthcare applications (Abaza & Marschollek, 2017; Santos et al., 2016). M-health technologies are already utilized for monitoring vital signs and managing chronic conditions, demonstrating their potential to transform healthcare delivery.

However, the adoption of m-health technologies requires addressing technical challenges and ensuring the preparedness of healthcare professionals. For instance, difficulties in using m-health applications and the evolving nature of technology necessitate continuous training for practitioners to remain updated (Lu et al., 2018). Systematic reviews reveal diverse perceptions among physicians regarding the benefits and challenges of m-health. While many acknowledge its role in reducing patient demands and improving diagnosis, they also stress the importance of adequate training and knowledge acquisition before implementation (Alghamdi et al., 2018; Symer et al., 2017).

Theoretical frameworks such as the Unified Theory of Acceptance and Use of Technology (UTAUT) and the Technology Acceptance Model (TAM) provide valuable insights into m-health adoption. These models emphasize ease of use, performance gains, and effort expectancy as critical factors influencing technology acceptance (Muralidharan et al., 2017; Aljohani & Chandran, 2019). Research shows that m-health can enhance communication among healthcare professionals, improve decision-making efficiency, and enable practitioners to stay updated with medical innovations. However, the technology's success depends on its accessibility, feasibility, and alignment with user needs (Ganasegeran et al., 2017).

The existing literature also underscores the necessity of risk management in m-health implementation. Overlooking risks associated with data security and operational challenges can negatively impact service delivery (Susanto, 2018). Furthermore, m-health adoption should be issue-driven, ensuring the technology's relevance to specific healthcare challenges. Training healthcare professionals to navigate these technologies effectively is essential for maximizing their potential and mitigating associated risks (Sahin, 2018).

In conclusion, m-health offers significant advantages, including enhanced efficiency, improved patient outcomes, and reduced stress for healthcare providers. However, its implementation requires addressing challenges related to technical proficiency, security, and user acceptance. The integration of m-health technologies within healthcare systems necessitates strategic planning, adequate training, and adherence to robust theoretical models to achieve optimal outcomes (Yang et al., 2018; Thangada et al., 2018). These insights pave the way for future research and practical applications aimed at harnessing m-health’s full potential.

Literature Review

The chapter delves into the concept of mobile health (mHealth), its definition, applications, relevance, professional roles, factors facilitating its growth, and its specific context in Saudi Arabia. mHealth is a subset of eHealth, utilizing mobile devices like smartphones, tablets, and wearable technology to provide remote healthcare services. The World Health Organization defines mHealth as clinical and public health practices supported by mobile devices, including communication tools such as SMS, MMS, and more advanced functionalities like interactive media and applications. mHealth interventions enhance healthcare delivery by improving reach, communication, and data sharing, while also addressing challenges like chronic disease management (Marcolino et al., 2018; Iribarren et al., 2017).

The relevance of mHealth lies in its ability to overcome geographical and logistical barriers, making healthcare accessible anytime and anywhere. Governments and private healthcare entities globally, including in Saudi Arabia, are recognizing mHealth as a foundation for modern patient care. Applications range from health promotion and chronic disease management to monitoring and diagnostics. Innovations in connectivity, such as 3G, 4G, and Bluetooth, enhance mHealth's versatility, particularly in resource-scarce settings (Hoque & Sorwar, 2017; Miller et al., 2016).

The chapter identifies various mHealth applications, such as clinical decision support systems, chronic disease tracking, and patient communication platforms. These tools facilitate professional workflows, improve patient outcomes, and enable health data collection for analysis. In chronic care, mHealth applications like diabetes and asthma management tools have shown promising results. However, many applications face challenges like limited functionalities and low adoption rates, partly due to insufficient guidance and professional endorsement (Cajita, Gleason & Han, 2016; Istepanian & Woodward, 2016).

The role of healthcare professionals is critical in mHealth’s success. They contribute to patient education, data interpretation, and diagnostic support, ensuring the effective use of these technologies. Applications for provider-to-provider communication, patient monitoring, and system efficiency benefit from their involvement. Moreover, mHealth platforms like OpenMRS and MoTeCH demonstrate how professional collaboration enhances system integration and care quality (Firth et al., 2016; Leichman et al., 2020).

In the Saudi Arabian context, mHealth adoption is growing but remains in its early stages. Studies reveal a limited but increasing awareness and usage of mHealth tools among healthcare professionals. Challenges include technical barriers, lack of interoperability, and concerns about data security. Despite these hurdles, mHealth holds potential for addressing the country's healthcare needs, particularly in underserved areas. Professional attitudes play a crucial role in the adoption and success of mHealth initiatives. Positive perceptions among professionals are associated with increased adoption and efficacy of mHealth technologies (Alsaleh & Alshamari, 2016; Alotaibi, 2015).

Factors facilitating mHealth growth include declining costs of mobile devices, expanding connectivity, and the integration of mobile technologies into broader health initiatives. Projects like the Millennium Villages in Africa highlight the transformative potential of mHealth in addressing resource constraints. In Saudi Arabia, professionals' attitudes towards mHealth influence its implementation and development, underscoring the need for training and advocacy to maximize its benefits (LeFevre et al., 2017; Kim et al., 2015).

The chapter concludes that mHealth offers transformative possibilities in healthcare by improving access, efficiency, and patient outcomes. However, its success depends on professional support, adequate training, and a focus on addressing technical and systemic barriers. In Saudi Arabia, fostering positive attitudes among healthcare professionals will be vital for realizing mHealth's full potential and aligning it with the nation's evolving healthcare landscape (Alanzi, 2018; Agarwal et al., 2015).

Research methodology

This chapter will cove research design, data collection method, data analysing process, quality and trustworthiness, and ethical considerations.

3.1. Research design

Research methodology helps in examining useful methods and techniques that are employed by the researcher for doing specific study properly (Marshall and Rossman, 2009). These research elements are important for obtaining the desired outcomes of the research. For conducting this specific study, the researcher has applied a **qualitative research** technique that helps a lot in studying and effectively and holistically investigating the exact topic and gathers all the relevant information properly (Saunders, Saunders, Lewis & Thornhill, 2011). This chapter describes the research strategy, instruments of data collection, time horizon, and research philosophy.

The **philosophy** that has been adopted by the researcher in this research is **interpretivism** to evaluate the attitudes of Physicians who are working as medical staff asking King Fahad General Hospital in Jeddah towards the adoption of m-health technology. The sole aim of the researcher in employing this philosophy is to collect all the pertinent data from the respondents and analysing the outcomes. The reason behind this is that there are different viewpoints and perceptions of the respondents of the phenomenon of the research and therefore one set of gathered data will be different from others. The diverse point of views of the respondents is useful for helping the researcher in analysing his perspectives and ideas regarding their attitudes towards m-health application within King Fahad General Hospital in Jeddah. From the opinions of the interviewees, the researcher requires to evaluate them in a subjective way of getting the research outcomes (Saunders, Lewis and Thornhill, 2003).

The **inductive research approach** has been chosen over the deductive approach because the inductive approach is useful for garnering more useful and realistic information from the particular event (i.e. physicians from the hospital rather than testing a theory) (Gray, 2009). In other words, the research has not been centered on any specific hypothesis or theory during the time of investigation of the topic.

For identifying the relevance of the topic and getting reliable information, the researcher has employed ***a Case study approach*** which is regarded as 'an empirical inquiry' (Perry, 1998). The case study is useful for achieving three criteria

(1) development of 'how' and 'why' research questions, **(2)** the researcher has no hand or control in manipulating all the behavior events **(3)** the attempt of the researcher in exploring the contemporary research aspects regarding the study (Houghton, Casey, Shaw, Murphy, 2013). This is compatible with this study as the research questions aim to investigate how and why. Furthermore, unlike experiments, the researcher did not have control over the opinions of the participants. Also, the researcher conducted a field study for collecting primary contemporary data rather than exploring and collecting historical secondary data.

All the chosen research participants are from medical staff asking King Fahad General Hospital in Jeddah. Thus, King Fahad General Hospital in Jeddah is regarded as the research case study and all the respondents are considered as the units for analysis (Noor, 2008).

The researcher requires completing the study within a specific period. Therefore, the technique that has been selected by the researcher is ***a cross-sectional time horizon (***Melnikovas, 2018). It is not like the longitudinal time frame of analysis. In this process, the researcher can gather a lot of important data within a specific period. No bias or repetition can be viewed within the cross-sectional time horizon. This indicates the authenticity of the collected data and cannot be manipulated. The reason behind the choice of this specific time horizon is that the researcher does not have adequate time and cost that is useful for accomplishing the study properly.

Moreover, all the data have been gathered from all the interviews of all the respondents by using **semi-structured interviews.** This process is useful for collecting accurate and relevant information and thereby getting the desired result from the study.

3.2. Data collection method

3.2.1. Sampling

Sampling requires determining the factors of population and sample (Smith, 2015). The population of this study consists of physicians at the King Fahad General Hospital in Jeddah, Saudi Arabia. Inclusion criteria include physicians working at King Fahad General Hospital in Jeddah, while exclusion criteria cover physicians who joined hospital after m-health application. Samples include 12 physicians from the sampling frame.

Sampling technique is a procedure that recognizes the most ideal way of removing participants out of the sampling frame (Gill, Stewart, Treasure & Chadwick, 2008). Various elements should be featured while choosing an example. The size of the examination outlines the ability to access and arrive at each unit and having a decisive rundown for the people who qualify, recognizing all aspects in the interview are few of the mentionable examples (Gill et al., 2018).

There are two categories of sampling, i.e. random and non-random sampling, while every sampling includes sampling techniques. In terms of cost, time and logistics, a convenient sample is better for the researcher (Jager, Putnick & Bornstein, 2017). A convenient sampling is also called an accidental sampling (Jager et al., 2017). Since there is no difficulty in reaching the population, there exists no need for snowball sampling. Snowball technique is good for gathering data from top ranking managers in their work premises (Jager et al., 2017). This issue can be neglected since a convenient sample is a better and easier alternative in this study.

Generalizability to the whole population is the primary limitation as there is sampling bias. Nevertheless, the affirmative outcome of having convenient sampling such as being cost-effective and time-saving derogates the generalizability issue. To decrease the issue of sample bias, the researcher strictly follows rigorous techniques in selecting sample size. The sample size in this study is between 12 (Vasileiou, Barnett, Thorpe & Young, 2018). Sample size of 12 will be sufficient to achieve data saturation.

In regard to the recruitment process, the researcher will update an advertisement that would contain the study's aim, objectives and my details (mobile number, email) within the Hospital premises after receiving permission from the administration. To reduce bias in selecting participants, the first 12 respondents will be considered (Hesse-Biber and Leavy, 2010).

3.2.2. Units of analysis

It is even important for the researcher to select an appropriate and effective unit of analysis so that the entire research study can be carried out fruitfully. The *units of analysis* in this study are physicians working at King Fahad General Hospital in Jeddah (Yin, 2013). Thus, there are 12 units of analysis. However, it must be noted that if the number of interviews increases, then the overall quality of the research study and its accuracy can decline due to difficulties that face the researcher in terms of analysing the textual data in the transcripts. Advertisements will be used to recruit the participants. The advertisements will be put on the notice board of the hospital in the place where physicians can see. The advertisement will request physicians who are interested in the study to contact the researcher on email and/or mobile.

3.2.3. Data collection approach (Interviews)

As a qualitative research technique, interviews can be defined as a technique which involves conducting intensive interviews on individuals, with a small number of respondents, in order to explore their view on a particular idea, program or situation (Glegg, 2019). The components of both structured and unstructured interviews are contained under semi-structured interviews (Glegg, 2019). For semi-structured interviews, a set of the same questions have to be answered by all interviewees as prepared by the interviewer (Glegg, 2019). During interviews additional questions must be asked to clarify certain issues or to ask further questions (Glegg, 2019). One of the advantages of interviews includes possibilities of collecting detailed information about research questions. The researcher has a direct control over the flow of process in this type of primary data collection (Bryman & Bell, 2007). Longer time requirements and difficulties associated with arranging an appropriate time with prospective sample group members to conduct interviews are some of the disadvantages. The timing and interviews should be scheduled properly (Heath et.al., 2018) Interviews should be conducted in a relaxed environment, which is depressurising for interviewees. While conducting an interview, the interviewer should attempt to create a friendly and non-threatening environment. A brief information of the study, the importance of the person's participation and assurance of anonymity or confidentiality must be maintained by the interviewer.

Face-to-face interviews are helpful in making more precise screening, unlike other interviewees or questionnaires. The researcher can easily spot false information during screening questions (Bryman & Bell, 2007). Enabling verbal and non-verbal in the interviews would enrich the collection of data. For the proper completion of the interview, the interviewer has to keep the interviewee focused and on-track, since the interviewer has overall control (Bryman & Bell, 2007). Certain distractions such as texting, reading and answering emails, video streaming, web surfing and social sharing are some of the reasons why surveys are not completed within the time convenient for the respondent. Face-to-face interactive interviews are free from such distractions (Bryman & Bell, 2007).

Even with its advantages face-to-face interviews have disadvantages too. To explain well, cost is a primary and major disadvantage for face-to-face interviews. It requires the researcher to conduct interviews at personnel cost. There falls a negative effect about the trustworthiness of the data collected because it majorly depends on the quality of the data received by the researcher and the ability of the interviewer because of potential biases (Bryman & Bell, 2007; Bryman & Bell, 2007). Data entry can actually lengthen the entire process. Face-to-face interviews enable only a limited sample size which adversely affects the generalization of the data of the whole population. Thus, data collection tool is crucial as it enables the researcher to collect sufficient data on views, knowledge and experience of physicians towards application of m-health in Saudi hospitals. The researcher should have a clear view on m-health amongst physicians. Moreover, the researcher would be able to ask students about their expectations and what they would like to see in the m-health technology. This means that the researcher should not collect data

only on the thought of physicians about the current situation of m-health rather on m-health review.

Interpretivism, inductive study, field study, cross sectional and interviews are the summarized route of this methodology.

3.3. Data analysis processe

The qualitative data was analysed using thematic analysis, as developed by Braun and Clarke (2006). There are six stages that the researcher followed on the information by analyzing and re-analyzing the data while focusing on the basic codes. the researcher created the underlying codes through coding, focusing on the information and examining the information through identifying each of the codes. the researcher grouped the codes into starting topics as social affair information identified with each code. Thereafter, the researcher analysed the subjects that are hidden by checking with codes along with the event. The researcher characterized and named the topics by conducting a continuous study. Lastly, the report concluded with reasonable explanations.

3.4. Quality and Trustworthiness

This study adopted Guba's (1985) criteria for assessing the quality of qualitative research. These criteria are: Credibility, Dependability, Confirmability, and Transferability.

Credibility "refers to the value and believability of the findings" (Houghton, Casey, Shaw, Murphy 2013: p.13). To explain credibility, I adopted an approach of reflexibility throughout the qualitative study. Reflexivity is the process in which I analyzed and examined myself throughout the whole research process in order to reduce any personal bias (Lambert, Jomeen & McSherry, 2010). Reflexivity is required since it explores the researchers' contribution in the process and may influence and inform research (Lambert et al., 2010).

The research would vest his interest into the subject by his prior experiences and the way in which his beliefs and assumptions impacted the research. The entire study revolves from the selection of the topic to the stage of data analysis and conducting the final report to indicate to the reader my potential biases in an obvious way (Myles, 2015).

Dependability "is often compared to the concept of reliability in quantitative research and refers to how stable the data are" (Houghton et al., 2013: p.13). It is assured through creating an audit trail which is meant to sustain obvious accounts of all features of the study and referred to where decisions had to be altered according to circumstances that happen during the study (Vaismoradi, Turunen and Bondas, 2013). Audit trail is an important part of qualitative research since the basis of my study prevails with the help of iterative process (Seale, Gobo, Gubrium & Silverman, 2004).

Confirmability "refers to the neutrality and accuracy of the data" (Houghton et al., 2013). Verifiability is used by me, when discussing the categories and themes in the chapter of result and discussion of my study (Vaismoradi et al., 2013). In detail, the researcher reviewed the findings with researcher's supervisor and the researcher compare researcher's findings with the other research papers (Bazeley, 2013).

Transferability "refers to whether or not particular findings can be transferred to another similar context or situation, while still preserving the meanings and inferences from the completed study" (Houghton et al., 2013). Transferability is the level on which my outcomes can be transferred as the responsibility of the readers. the researcher has given prominent information about the origin of this research without underestimating the role of anonymity. Furthermore, the researcher has provided details about the extent of m-health services in Saudi Arabian hospitals (Vaismoradi et al., 2013).

3.5. Considerations in Ethics

Few mutually agreed ethical standards, such as disclosure, analysis and reporting, voluntary participation, harmlessness, confidentiality and anonymity, should be carefully addressed in conducting scientific studies (Bhattacherjee, 2012).

The respondents in the study were assured that their participation is voluntary when talking in terms of voluntary participation and harmlessness. They were made aware that the interview can be cut short as per their comfort which would not have any negative impact on the interview or them (Bhattacherjee, 2012). The respondents were given assurance that they would not be harmed due to their decision to participate or not participate in this research (Silverman, 2013). The willingness of the participants to interview is detectable from the fact that the participants had read the advertisement that the researcher had put up in the hospital.

Regarding confidentiality, (1) identifiable data were encrypted, (2) explain the issues that have been considered by my assistant and me to protect the confidentiality, and (3) limit the access of computerized identifiable data by providing security code. Personally, the participants were connected with their responses by the researcher.

In matters of anonymity, after collecting the name and signature of the participants on the consent form, no further identifiable information about the participants was collected. To mention, the less identifiable information the researcher collects about the participants, the more the anonymity increases (Noor, 2008).

Data analyzing and discussion

This chapter explores the benefits, challenges, and medical staff attitudes toward m-health (mobile health) adoption, focusing on its implications for healthcare

delivery, patient outcomes, and professional performance.

One of the most significant advantages of m-health is its ability to enable remote patient monitoring, facilitating healthcare access for individuals in areas without physical healthcare facilities. Participants in the study highlighted that m-health allows real-time transmission of patient data to healthcare providers, enhancing the efficiency and accessibility of healthcare services. Chronic patients, such as those with disabilities or long-term illnesses, benefit significantly from remote monitoring, as it reduces hospital visits and enhances quality of life. For instance, remote systems can alert patients to seek emergency assistance during critical health deteriorations, contributing to timely interventions and improved outcomes (Aljaaf et al., 2018; Kalid et al., 2018).

M-health also reduces healthcare costs by decreasing unnecessary hospital visits and enabling clinicians to manage more patients effectively. For example, a program at Oxford University demonstrated a 28% reduction in hospital visits due to m-health integration (Sanabria et al., 2018). However, limitations such as the digital divide and the complexity of smartphone use for older adults present challenges. Despite these hurdles, increasing literacy rates and workforce digitization suggest m-health's widespread adoption is feasible and beneficial in the future (West, 2018).

Another critical benefit of m-health lies in its capacity to improve medication reconciliation accuracy, a significant factor in enhancing patient safety. Medication reminders and real-time updates of patient records via m-health applications reduce the likelihood of prescription errors and improve adherence to medication regimens. Studies have shown that electronic prescription reconciliation can reduce unintended medication discrepancies by 46%, significantly enhancing patient outcomes (Mekonnen et al., 2016). The technology also bridges knowledge gaps for both healthcare professionals and patients, facilitating accurate and efficient medication management (Sarzynski et al., 2017).

M-health improves provider communication and coordination by enhancing real-time interactions between healthcare professionals and patients. Through high-definition devices and applications, medical staff can remotely assess patient conditions, share critical information, and collaborate on treatment plans globally. This connectivity improves care continuity, reduces readmission rates, and ensures better coordination between inpatient and outpatient services (Marcolino et al., 2018). Furthermore, m-health applications like SMS alerts and telehealth consultations have been shown to improve chronic disease management and patient engagement, particularly in low- and middle-income countries (Vijayakumar et al., 2018).

Additionally, m-health provides patients with faster access to healthcare providers. Through encrypted texts, telemedicine consultations, and appointment scheduling, patients can connect with clinicians 24/7, reducing the need for physical visits and enabling continuous care. Mobile devices also improve access to point-of-care resources for healthcare professionals, streamlining clinical decision-making and enhancing work productivity. For instance, electronic health records (EHRs) accessed through smartphones or tablets allow providers to update and review patient information efficiently, supporting better treatment decisions and patient-centered care (Keshta & Odeh, 2020).

Despite its benefits, m-health adoption faces significant challenges. Limited internet access in remote areas and the digital divide among populations, particularly the elderly, hinder widespread implementation. Furthermore, healthcare professionals often express concerns about handling the data generated by m-health applications and its integration into existing workflows (Lowery, 2020). These barriers necessitate improvements in technological infrastructure, training, and user-friendly application designs to ensure m-health's efficacy.

Another concern is the lack of universal accessibility to wearable devices and mobile applications, which restricts m-health's reach. Moreover, while m-health facilitates remote monitoring, its effectiveness relies heavily on robust internet connectivity and data security measures. The absence of comprehensive guidelines and the interoperability of m-health systems further complicate its adoption in healthcare settings.

Attitudes of Medical Staff Toward M-Health

The attitudes of medical staff significantly influence the successful implementation of m-health technologies. Participants in the study noted that m-health applications positively impact their work, enabling better management of patient care, particularly during high-stress situations like pandemics. However, skepticism persists among some healthcare providers, who express concerns about technology altering patient behavior or its potential to overwhelm existing workflows (Lowery, 2020).

Despite these reservations, studies indicate that as healthcare professionals become more familiar with m-health technologies, their attitudes improve. Training and experience help mitigate initial resistance, fostering acceptance and integration into clinical practice. Positive perceptions among healthcare providers are critical to leveraging m-health's potential, as their endorsement directly impacts patient adoption and system-wide efficiency (Mekonnen et al., 2016).

M-health offers transformative opportunities in healthcare, particularly in remote monitoring, medication management, communication, and patient access. It reduces costs, enhances provider efficiency, and improves patient outcomes through innovative applications. However, challenges such as digital accessibility, data integration, and professional resistance must be addressed to realize its full potential. The attitudes of medical staff play a pivotal role in m-health's adoption, underscoring the need for training, advocacy, and system support. With increasing digitization and technological advancements, m-health is poised to revolutionize healthcare delivery, provided these barriers are effectively mitigated.

Theme Two Challenges of M-Health Adoption

The adoption of m-health technologies in healthcare comes with significant challenges, including usability, system integration, data security, privacy, network access, and reliability. These obstacles affect the effectiveness of m-health applications and highlight the need for strategic interventions to improve their design, implementation, and acceptance.

Usability Challenges

Usability remains a major hurdle in m-health adoption. Participants highlighted the lack of awareness and training among healthcare professionals and patients as a barrier to effective usability. Issues such as small smartphone screens, text size, and navigation complexity hinder accessibility, especially for older patients. These challenges align with findings in the literature, which emphasize simplicity and user-centered design as critical for usability (Liew et al., 2017; Gurupur & Wan, 2017). Dawood et al. (2020) and Joshi et al. (2019) identify key usability factors such as ease of learning, efficiency, and user satisfaction. Moreover, trustworthiness, achieved through simplicity and credibility in design, is vital for user confidence in m-health systems (Zahra et al., 2016).

System Integration Challenges

System integration is another significant challenge. Participants noted that interoperability and compatibility with existing healthcare systems are critical issues. Effective m-health applications require seamless data sharing and alignment with current workflows. This is further complicated by the need to integrate diverse health information systems that may not have been designed for diagnostic purposes (Aljohani & Chandran, 2019). Legal frameworks like the Health Insurance Portability and Accountability Act (HIPAA) mandate stringent data protection and system integration standards, making compliance a complex task (Kahler, 2020). Examples from China demonstrate the potential for cultural and technological integration to improve m-health's effectiveness, but these approaches require careful contextualization and user trust (Chib, 2018).

Data Security and Privacy

Data security and privacy are paramount concerns in m-health adoption. Participants expressed apprehensions about unauthorized access, data theft, and the misuse of personal health information. The literature underscores these risks, highlighting the vulnerability of health data transmitted via mobile networks or stored in cloud systems (Janabi et al., 2017; Pawar & Ghumbre, 2016). Secure data storage, user authentication, and encryption are necessary to safeguard sensitive information. However, challenges such as inadequate training for employees and reliance on unsecured networks exacerbate these risks (Bhuyan et al., 2017). Cloud computing, while offering scalability, raises concerns about data localization and backup reliability, further complicating data management (Iwaya et al., 2020).

Network Access

Limited network access in remote areas undermines m-health's potential to serve vulnerable populations. Participants noted that weak or inconsistent network signals make m-health applications unusable in many underserved regions. Reliable and high-speed connectivity is essential for the seamless functioning of m-health devices and applications (Kariuki & Okanda, 2017). Studies emphasize the importance of robust IT infrastructure to support interconnected medical devices and ensure uninterrupted access to health data (Bhattacharya et al., 2018). Without universal network coverage, m-health's reach remains restricted, limiting its utility for marginalized communities.

Reliability Concerns

Reliability is a multifaceted challenge encompassing technical performance, accuracy, and user trust. Participants emphasized the need for m-health applications to deliver consistent and accurate results. However, low-cost applications often lack research-based validation, leading to misinformation and reduced reliability (Aljohani & Chandran, 2019). For example, mobile phone-based diagnostic tools have shown varying levels of effectiveness, raising concerns about their suitability for clinical decision-making (Andrews & Raja, 2019). To ensure reliability, m-health technologies must undergo rigorous evaluation and standardization, particularly when used in high-stakes scenarios such as chronic disease management.

Addressing the Challenges

Addressing these challenges requires a multi-pronged approach. Usability can be improved through user-centered design and simplified interfaces, while system integration demands compatibility frameworks and robust legal compliance. Enhancing data security involves adopting encryption, secure networks, and comprehensive training for users. Expanding network coverage and investing in IT infrastructure are crucial for increasing accessibility in remote areas. Finally, ensuring reliability necessitates evidence-based development, thorough testing, and adherence to regulatory standards.

The challenges of m-health adoption are significant but surmountable with coordinated efforts from developers, policymakers, and healthcare professionals. Usability, system integration, data security, and network access must be prioritized to ensure that m-health technologies fulfill their potential to transform healthcare delivery. As m-health continues to evolve, addressing these challenges will be critical for building trust, enhancing adoption, and achieving positive health outcomes. By overcoming these barriers, m-health can pave the way for more accessible, efficient, and patient-centered healthcare systems worldwide.

Conclusion

M-health has the potential to revolutionize healthcare delivery in Saudi Arabia, providing solutions for challenges such as accessibility, cost, and workflow efficiency. By integrating advanced health technologies, m-health facilitates streamlined medical record-keeping, remote patient monitoring, and reduced hospital visits, all of which contribute to enhanced care delivery. However, the study reveals several constraints, such as restricted access to participants and institutions, limited sample size, and time-bound data collection, which hinder the depth of insights. Close-ended survey questions limit the nuanced understanding of participants' experiences, leaving some aspects underexplored (Rosenthal, 2016).

Despite these challenges, the qualitative data collected underscores the potential of m-health to improve clinical practices by enabling better access to health information and tools. However, researchers must carefully plan studies to address respondent diversity and develop user-centered applications to enhance usability.

Limitations

The study's limitations include a small sample size, restricting the generalizability of findings, and insufficient access to reliable primary data, which undermines the robustness of the analysis (Civelek, 2018; Morgado et al., 2017). Researchers also encountered challenges such as lack of prior studies on m-health in the Saudi context and data collection constraints due to cultural and language barriers (Dragojevic, 2020). Moreover, longitudinal effects and the short time frame for data collection affected the comprehensiveness of the study. Biases related to cultural interpretations and incomplete knowledge of the topic further limited the scope of the findings (Jiménez & Mesoudi, 2019).

Future Recommendations

The study emphasizes the importance of increasing awareness and training among Saudi healthcare professionals to enhance m-health adoption. There is a need for robust training programs to familiarize medical staff with m-health applications, focusing on usability, trust, and security. Strengthening secure data exchange protocols and addressing concerns about privacy and cyber threats are critical to building trust in these technologies (Majumder et al., 2017).

Future research should adopt mixed-method approaches to capture both qualitative and quantitative dimensions, ensuring a comprehensive understanding of m-health's impacts. Expanding sample sizes and addressing cultural sensitivities can improve the relevance and applicability of findings. The development of user-friendly, customized m-health platforms with features like location-based services, interconnectivity, and tailored interfaces can further support its adoption in Saudi Arabia (Butler et al., 2020).

M-health represents a transformative opportunity for Saudi Arabia's healthcare system. By reducing paperwork, enabling remote consultations, and improving workflow efficiency, m-health addresses critical healthcare challenges, especially in remote areas. However, its success depends on addressing barriers like limited awareness, training gaps, and data security concerns. Implementing m-health can alleviate healthcare burdens, reduce patient wait times, and ensure equity in healthcare delivery.

The study highlights the importance of educating healthcare professionals and adapting to technological tools to improve patient-centered care. Reducing workplace stress and improving working conditions through m-health adoption can enhance the overall performance of Saudi medical staff. With strategic planning and stakeholder collaboration, m-health can deliver significant benefits, improving the quality, accessibility, and affordability of healthcare in Saudi Arabia (Albahri et al., 2018; Alaiad et al., 2019).

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