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Internet of Things Adoption for Saudi Healthcare Services

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Abstract

Background: *Recent studies in information systems have predicted that applications of the Internet of Things (IoT) innovations will revolutionise various sectors including healthcare. Besides the issues and opportunities of IoT based innovations, existing studies have shown limitations to advance the adoption of IoT-understanding and relevant interventions to benefit researchers and healthcare practitioners.*

Method: *In this context, a systematic literature review study was conducted to re-position a qualitative, phenomenological investigation that could offer useful insights into the factors affecting IoT-adoption in a developing country's healthcare service. In addition to it, five participants who worked in hospitals and clinics in Jazan, Saudi Arabia, took part in the semi-structured interviews developed based on the diffusion of innovation theory.*

Results: *The study explored the relevant literature and evaluated how the outcome is used to identify the key delivers of IoT in healthcare.*

Conclusions: *According to the findings, the capacity of the Saudi healthcare sector to accept and implement a new IT with IoT technologies is increasing and its integrations remains a debated issue.*

Keywords: IoT Adoption, Healthcare, Diffusion of Innovation Theory, Saudi Arabia, Healthcare innovation.

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Introduction

The previous few decades have witnessed a surge of interest in the Internet of Things (IoT) in developing effectual communication between IoT devices and improving previous innovations. This effectual communication turned to the joint operation of devices, which embodies various instruments within the IoT space (Razzaq et al., 2017). Together with inexpensive sensors that interface with themselves, IoT devices can communicate based on wireless communication systems as well as move important data to an integrated system. In such a system, there is additional administration and delivery of information from IoT devices to the necessary and targeted destinations. As communication mechanisms powered by the internet have developed rapidly, our everyday activities continue to further align with cyberspace or the virtual universe (Kumar & Patel, 2014).

Before IoT emerged, past infrastructure was under development, thereby giving rise to various outstanding innovative services as well as solutions. When it emerged, inventive hardware started coming out, including smart devices, actuators and sensors, as well as profound software products, specifically IoT platforms together with IoT edge or gateway architecture. As these were invented, key wireless IoT connectivity solutions became practical; they offered several creative services via outstanding platforms and suppliers.

The creativity towards the provision of healthcare services based on IoT innovations could be valuable to government agencies and the people if devices like actuators, sensors and RFID are used to process service delivery. It is possible to deliver service in such a way as IoT devices are capable of: interrelating with physical environments parallel with human operators. Another feature of such innovations is their accurate communication with each other, showing unique software mechanisms for services capable of being managed externally via web-like standards. Service delivered based on IoT involves the alteration of prevailing commercial processes by intelligent devices that are directly assimilated, thereby ushering in greatly innovative ones (Meyer et al., 2013).

The current operating digital environment makes integration further remarkable towards providing several government services, including healthcare. When new IT innovations such as big data (McAfee et al., 2012) are sufficiently combined with the IoT (Kopetz, 2011), there is a strong impact. The modern cooperative e-government context involves incorporating information schemes into internal and external operations towards refining service providers' competency and receptivity. Against this backdrop, it is not possible to operate initiated systems and applications as individual bodies; it needs to be ensured that they interrelate with more organizational information systems (Linthicum, 2004). The need to satisfy stakeholders' demand makes it necessary to integrate based on IoT—a critical requirement requiring a comprehensive study on Information Technology design.

This study aims to empirically examine the adoption of IoT integration into the healthcare service delivery in Saudi Arabia. To achieve this aim, the objectives are to investigate the use of IoT integration for healthcare service delivery based on technical and cultural outlooks and to classify the factors affecting the effectual integration of the IoT and healthcare service delivery in the Saudi context.

The paper is organized as follows: the next section presents essential background of the study including key research issues in the target area of our focus. Section 3 includes theoretical frameworks while the section 4 gives insights of the methodological details relevant to the study. Section 5 presents the study outcome and relevant discussions followed by the section 6 for overall conclusion.

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Background of the Research

As mobile technology continues to become more popular, businesses have been geared towards the development of mobile commerce models as well as the modification of the method used by governments for service delivery. Correspondingly, governments worldwide are leveraging the speedy development of wireless technologies, expanding the reach of services using mobile devices (Brous & Janssen, 2015; Faisal & Talib, 2016). Due to the speedy advancement of IT equipment as well as the decrease in its cost, citizens have become more aware of their rights regarding using IT, thereby more encourage to express concerns regarding critical technological challenges such as security and privacy. Consequentially, as people became further aware, this paved the way for new perspectives for governments to achieve improved service quality at a low cost. Due to these changes, so that everyone can communicate freely, there is a need to develop new services.

Mobile devices ensure that interactions are mobilized, thus becoming a critical means through which numerous governments enrich how they engage stakeholders, thereby improving the quality and delivery of services.

According to Chatfield and Reddick (2019), the majority of the impacts of e-government performance stemmed from manipulating and developing IoT-enabled strong capabilities for driving, accelerating and promoting the computer-assisted development of open management and governance. Developing and applying two constituents (IoT security strategy and computer expertise) to balance open policies affect the dynamic capabilities driven by the IoT. Governmental transformation is possible through some contemporary concepts associated with dynamic capabilities, not just through flexible and skillful identification and response to user-requested service requests and technical modifications. Likewise, there was a deliberate formation of forthcoming trends characterized by openly managed facilities towards providing good value. Managing dynamic capabilities is essentially dependent on innovative intent to utilize IoT, IoT rules as well as cybersecurity approaches. Such an objective needs a generally accepted notion to expand an efficient government capable of providing facilities that are well-managed according to the needs of users and capable of establishing intelligent approaches of high value. Dynamic capabilities in government are represented by the efforts of an administration towards predetermining limitations, performing real-time scrutinizes and using devices based on IT to embrace entrepreneurship made for the advancement and organization of pristine facilities. They are established by bearing in mind that clients are the primary stakeholders in the current hyperlinked space, attained by cooperating, managing, developing and grouping of external and internal capabilities.

The design of an easily-understood interface generally done with a variety of computational schemes poses challenges. Nonetheless, medical centers are trying to come up with relevant and user-based interfaces for a variety of health systems to help people leverage and simply utilize innovations like that (Nisha et al., 2016). To ensure that technology is accessible in this regard has to do with allowing access to healthcare applications on cell-phones or laptops towards connecting people with healthcare professionals. The satisfaction of these requirements is followed by recording the facilitation of conditions, trust levels and expectancies as energy consumption, thereby positioning urban medical centers to provide necessary health services. Nevertheless, concerns arise regarding whether mobile healthcare will be accepted in the future and the reason for usage in a country's urban areas. The most critical concern is the possibility of poor insights and undependable healthcare evidence or experience to prevent users from having access to mobile facilities for well-being.

The results of Serra et al. (2015) can alleviate the concerns over this issue; it was asserted that using e-government technologies brings about a variety of opportunities to construct more facilities for citizens. When these innovations are employed, it means more users can enjoy healthcare services and cooperate with governments to build self-reliant access to government or departmental facilities. Hence, highly remarkable requirements must ensure the accessibility of these affordances towards guaranteeing all-inclusive and equal access for the people to benefit from the merits of such technologies. The interfaces required to make this happen (for instance, web and mobile interfaces) are among the most utilized ways of offering services and information. Everyone, as well as people with disabilities, should find it easy to utilize these interfaces and the equipment whenever required.

According to Gao and Lee (2017), open initiatives set up by people and governments (e.g. Miah, 2010; Miah & Gammack, 2008) are majorly influenced by an increase in the usage of web-based applications to reach out to people, disseminate information, elaborate on open service capability, increase exchanges, flexibility and reduce costs (Miah, 2004). This primary engagement with the internet stands for the tendency to interact, which leads to numerous advantages and possible perils. For example, in contrast with traditional e-government services, internet-based applications are offered by those under the direct management of firms or organizations with affiliation with governments. There is a connection between the majority of life ideas based on the Internet and government notions. These outlooks consider the government as the primary user of technology, system manager and content beneficiary. Hence, nascent platforms are presented using a top-down approach influenced by what is needed and technological advances developed by the appropriate authorities.

IoT was introduced by Kevin Ashton eleven years ago via cloud technology towards linking machines, infrastructure and humans. Such a connection applies to day-to-day equipment such as simple machines, home devices and industrial machineries (Breivold & Sandstrom, 2015; Casini, 2014; Li & Li, 2017; Rong et al., 2016; Weber, 2016; Witkowski, 2017).

Meyer et al. (2013) looked into the concept of integrating IoT devices with other business process resources. More recently, the majority of processes of integrating IoT focuses on aspects of genuine technical implementation, with little attention paid to integrating IoT models as well as devices alongside the current software mechanisms. The reason is that business procedures in certain circumstances are still using traditional systems to develop the resources of enterprises. Meyer et al. (2013) identified and incorporated the IoT resources as the earliest involuntary assets into the commercial process that is external to the classical human resource-centric orientation of commercial process models. Due to this, the authors aimed at developing resource planning corresponding to the requirements of future initiative-based domains. Correspondingly, service-oriented architecture is the primary principle of the fundamental system architecture that helps to understand commercial procedures.

The instantaneous enterprise: Haller and Magerkurth (2011) looked into IoT-enabled commercial progression. The IoT suggested potential aspects of refining enterprise applications, specifically regarding the improvement of capability and completely innovative commercial progress and models. There is a need to surmount remarkable barriers to comprehend IoT's potential. Researchers carried out a comprehensive investigation of the factors that restrict the integration of commercial progression through the demonstration of the way IoT services can work. As observed by Haller and Magerkurth (2011), the integration of IoT features into commercial progression frameworks as well as associated tools is a key problem that calls for a solution towards the expansion of the IoT technique.

According to Brous and Janssen (2015), researchers have not adequately looked into IoT as regards to e-government although they recognize the potential. The application of IoT innovations to e-governance poses some anticipated governmental, strategic and functional merits; for instance, further efficient data administration, collaborative efforts between units or agencies or departments, and the kind of relationship between the people in a nation and their government or representatives. The merit of IoT gadgets and connected devices is the generation of adequate reliable information required to produce necessary materials and formulation of excellent decisions when necessary. Likewise, IoT helps to handle and share actual data, ensures that different fields collaborate and separate at every stage of relationships, such as the one between authorities and end-users. Due to these affordances, users' authority is enhanced, thereby making it possible to have administrative transparency, and accessibility as well as inclusivity of administrative facilities. Table 1 below summarizes 19 related studies, including the information regarding past IoT in healthcare research.

Table 1 - Related Studies

Studies	IoT in healthcare solution/purposes	Procedure/Techniques used	Target beneficiaries
(Al-Makhadmeh & Tolba, 2019)	Improving Heart Disease Management	Boltzmann deep belief neural network (HOBDBNN) approach	Patient with heart disease
(Almobaideen et al., 2017)	Solution for tourism healthcare	Using Geographical Routing for Mobile Tourists (GRMT)	Tourists' traveling visit in the city
(Azimi et al., 2019)	Decision making approach	Remote health monitoring	Pregnant women
(Babu et al., 2016)	Using Smart healthcare to prevent infection	Using Radio-frequency identification (RFID)	Clinical staffs
(Din & Paul, 2019)	Designing healthcare monitoring	Hadoop processing based on MapReduce mechanism/ big data analysis	Korea citizen
(Gia et al., 2015)	health monitoring systems/	Wireless Body Area Networks (WBAN)	Experimental/ Case study
(Gkouskos & Burgos, 2017)	Designing healthcare systems	sub-fields of participatory design (PD)	Elderly people over 65+ years
(Hamidi, 2019)	Secure High data smart healthcare capacity	Using Radio-frequency identification (RFID)	End user privacy
(Hou & Yeh, 2015)	New and secured IoT healthcare process	Analysing the existing authentication	IoT healthcare user
(Jimenez & Torres, 2015)	Low cost Health monitoring	Using Radio-frequency identification (RFID)	Healthcare remote monitoring for elderly people
(Kodali et al., 2015)	High coast health monitoring	Analysing existing IoT applications in healthcare	Healthcare systems applications
(Krishnan et al., 2019)	Designing health monitoring	Hyper analytic Wavelet Transform (HWT)/ One Class Support Vector Machine (OCSVM)	Monitoring patient
(Kulkarni & Sathe, 2014)	Previous studies	Cost saving issue/personalized healthcare support	Healthcare monitoring systems
(Manikandan et al., 2020)	Increasing scheduling efficiency and reducing response time	Using the Polynomial Data Collection (PDC) algorithm	Patient with chronic disease
(Moosavi et al., 2015)	New and secured IoT healthcare	Analysing the existing authentication	Remote healthcare user
(Moosavi et al., 2016)	Secure High data smart healthcare capacity	Authentication and authorization	End user privacy

(Kumar et al., 2018)	Severity analyser (Determine disease severity)	Standard UCI Repository dataset and the real health records	Hospitals patients record
(Pal et al., 2019)	Designing healthcare systems	Employing light-weight network authentication protocol	Access control issue by users
(Tuli et al., 2020)	Solution to design framework to analyse big data	Framework called HealthFog	Patient with heart disease

Nevertheless, through the emergence of this new paradigm to offer health services, healthcare distribution has become further reachable, inexpensive and efficient. Despite distribution facilities majorly targeting the general population, approaches have been formulated towards refining acceptance and goals for everyone's access. Global health professionals have shown their zeal towards the potential of mobile services, which basically has to do with transmitting text messages and alerting patients enrolled in a parallel system to take appropriate medications, thus facilitating the care provided by nurses over a network and providing guidance on how to maintain good health to pregnant women. These functionalities intend to push forward health service distribution processes by assisting and training healthcare workers or giving consumers access to healthcare services and, in the process, bringing changes to customary modes of distributing and sharing information (Gagnon et al., 2015). Over the last few years, the number of health-focused mobile applications launched is about 40,000, a reflection of the call towards the improvement of health; the focus has been on wellness, prevention of disease as well as nursing in low-income nations. The motivation behind healthcare providers' embracement of new technology, for instance, is the same as the way computers and IT were embraced in the workplace. Other factors that determine the acceptance of mobile health include interoperability that facilitates connections between systems, issues related to cost, and concerns regarding protection and security. Cost-related issues are considered as critical challenges to the prevalent execution of mobile health technology.

This study's qualitative approach is established in the diffusion of innovation (DOI) concept, which assumes the propagation of new notions (innovations) among those who are within the social system through certain channels as time passes (Rogers, 1995). This study's interview questions were crafted using these factors while the analysis of the interview data was towards ascertaining the most remarkable factor(s) affecting innovation diffusion. The conceptual framework is made up of the beliefs, theories, assumptions as well as anticipations that support and inform this study.

Theoretical Frameworks

According to the postulation of the DOI theory, the diffusion process has to do with the movement of new notions (innovations) via some vehicles among the people in a social system (Rogers, 2003). A critical part of this procedure is innovation, which comes with the execution of new notions characterized by creating organizational value (Yale Information Technology Services, 2018). New notions can exist as services, systems or procedures or even the improvement of the existing ones. The way new notions (innovations) spread (diffusion) is unique. Researchers need to focus on such uniqueness towards the identification of the reasons for the quicker proliferation of innovations relative to others.

Diffusion of Innovation Theory

The DOI theory notes that a method of distributing new ideas (innovations) by some vehicles among people belonging to a social structure requires the movement of new ideas (Rogers, 2003). Innovation, followed by the introduction of innovative concepts that provide the enterprise with value as a characteristic feature, is integral to this phase (Yale Information Technology Services, 2018). Fresh concepts may take the shape of current programmes, structures or processes, or even develop them. How new concepts (innovations) are distributed (diffusion) is special. This particular feature can also be the subject of an empirical study to understand whether certain technologies spread quicker than others.

Studies related to organizational analysis often apply DOI theory to describe the basic patterns in adopting IT innovations (Agag & El-Masry, 2016; Baptista & Oliveira, 2015). Rogers (1995), who introduced the DOI theory, considered innovation adoption as the decision of taking and using new creations. His observation shows that innovation diffusion is strongly dependent on human capital, and that there is almost a normal distribution of the number of people who adopt an invention with time. He identified five classifications of individual innovativeness, including innovators, early adopters, early majority, late majority and laggards (Figure 1).

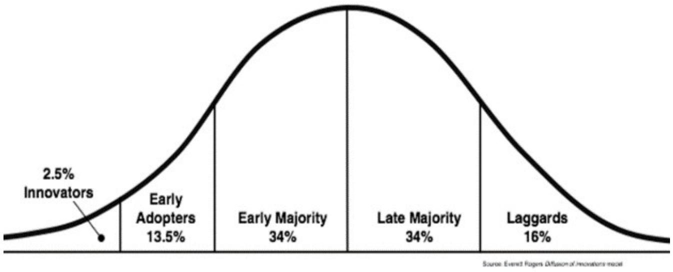

Figure 1 - Five Categories of Individual Innovativeness

Wamba et al. (2013) conducted a review that suggests the DOI theory as a well-known approach in studying IoT adoption. Although it is used extensively in organisational analysis, there have been criticisms regarding this viewpoint due to its individualistic approach in describing organisational behaviours, its inattention to the impacts of environmental factors and its inability to consider aggregate IT implementation (Hameed et al., 2012; Lee & Cheung, 2004). However, some researchers still support this theory. For example, the theory was applied in Wamba and Chatfield (2009) towards investigating the development of value from RFID supply chain projects in logistics and manufacturing domains. Similarly, Quetti et al. (2012) used the theory to examine the RFID adoption procedure in a vertical supply chain, with the silk industry in Italy being the case study. Liu et al. (2015) also used the theory in developing a research model to identify the crucial determining factors in adopting RFID to deliver public services

The IoT can lead to a deep comprehension of any field's intricacies and is among the operational constituents of numerous organizations. Sensors that are associated with IoT innovation help to accumulate huge data useful for practitioners in their efforts of creating a robust as well as a well-functioning society. Businesses and organization's apply the IoT mainly to understand their collected data, but the present practices reflect merging IoT data with third-party and internal data towards ensuring the creation of such comprehension. The installation of uncountable devices and sensors in an IoT setting enables the communication of these technologies with each other over non-standard protocols whose creation is uneasy. The discovery of the recent IFS study is that, in this period characterized by rapid digital transformation, there is a deficiency in assimilation between mobile healthcare service delivery and IoT innovations (Battista, et al., 2015).

Data size and other factors challenge such integration. In general, big data forms a remarkable aspect of the IoT, and the creation of big data systems is through huge amounts of components and equipment, such as sensors, labels as well as IoT solutions. While incorporating IoT data into a mobile system to deliver healthcare service, it involves calculating the volume of data for collection and storage as this removes the chances of overburdening the system. Through an intelligent integration approach, the challenges resulting from the availability of massive records that a system did not deal with in the past are eliminated. Governments, likewise, benefit from integrating IoT and mobile healthcare service systems, especially in operating e-government systems.

Numerous factors may influence the integration of the IoT and mobile healthcare service systems in e-government, as evident in past studies. Nevertheless, an extensive scrutiny of the factors that determine such integration was carried out in a few studies. This inadequacy led to a disparity between the development and integration framework for these innovations, thereby serving as the motivation behind the current study. Regarding this, the research questions that follow were focused on. One, what is the extent of IoT integration into healthcare service delivery in Saudi Arabia? Two, what is the extent to which the adoption of IoT integration can contribute to healthcare service delivery in Saudi Arabia? Three, what are the factors influencing such an integration in Saudi Arabia?

Research Methodology

A research approach talks about the logic of research, the function of an existing body of knowledge as well as the researcher's means of data collection. Likewise, it has to do with the degree of a researcher's clear envisioning of the theory to serve as the basis of the research and the ability to oversee the most appropriate methods for implementation. The second layer in the research onion in Saunders et al. (2016) is made up of the research approach. In literature, the classification of such an approach is into three key domains: deduction, induction and abduction.

When it comes to a deductive approach, it has to do with testing a theory and hypothesis towards establishing a generalization (Hyde, 2000). In general, it is utilized with positivism in experimenting or confirming a hypothesis. Hence, it might be more relevant to use a large sample (Saunders et al., 2009). The inductive approach has to do with collecting data and subsequently formulating a theory based on analytical results (Thomas, 2006). It utilizes theory-building towards the establishment of a generalization regarding the topic being examined (Hyde, 2000). There is a tendency of researchers who use the inductive approach to develop an interest in the contexts where events happen. According to Suddaby (2006), the abduction approach combines deductive and inductive methods. It revolves around examining an astonishing finding instead of basic assumptions (Saunders et al., 2016). Therefore, the abduction approach is relevant if a researcher is examining a phenomenon, identifying themes or modifying or generating an existing theory (Saunders et al., 2016). The current research used an inductive theoretical approach as it was an exploratory study.

Research Design

Research design is the plan that can be referred to in finding a solution to real-world challenges as necessitated by the comprehension of the researchers' and participants' perspectives (Kothari, 2004). No process is ideal in research because the researchers' choice of approaches is dependent on several critical factors (Greener, 2008). All individuals are involved in a research procedure by searching for a solution to a problem. Hence, human day-to-day living and activities involve research.

Initially, the current study involved a qualitative research design, where data was collected and analyzed using qualitative methods to provide definite answers to the research questions. Quantitative research involves hard data or information in the form of figures or numbers (Amaratunga et al., 2002), while the focus of qualitative research is on the 'why and how' of human behaviors as well as observed actualities (Rajasekar et al., 2006). Literature has mentioned several theoretical issues regarding IoT adoption, with researchers highlighting the factors and problems that affect the process of consolidating IoT innovations into healthcare service delivery systems (Kulkarni & Sathe, 2014; Papa et al., 2020; Yang et al., 2019). Nevertheless, there are no proofs and studies that particularly observe the greatest impactful factors for such integration. Correspondingly, the current study used a qualitative research design while collecting data in the first year towards exploring the previously mentioned determinants in Saudi Arabia.

A researcher needs to first consider the most appropriate approach to unravel research challenges (Doyle et al., 2009). Based on history, researchers are forced to select either quantitative or qualitative approaches, but the advent of mixed methods research was the answer (Leech & Onwuegbuzie, 2009), which has to do with using a mix of qualitative and quantitative research notions (Johnson et al., 2007).

Sequential design (mixed methods complex) comes in two major forms; namely sequential exploratory design and sequential explanatory design (Creswell & Plano Clark, 2017; Saunders et al., 2016). The sequential exploratory design has to do with using qualitative data collection and analysis strategies in the first phase of a study and then adopting quantitative approaches in the second phase. The reverse is the case for sequential explanatory design (Creswell & Clark, 2017; Creswell, 2015; Giddings & Grant, 2006). A sequential exploratory mixed or design method (Miah & Ahamed, 2011; Miah & Gammack, 2008; Miah, Kerr, Gammack & Cowan, 2008) is embraced in the current study, involving qualitative data collection and analysis before the use of quantitative approaches in the second phase.

The research onion model has the research strategy in the fourth layer. The identification of particular data collection, as well as analysis methods, is done by researchers with different merits and demerits (Yin, 2014). The selection of the strategy that will work best to achieve the research aim and objectives is a critical task. This is because some strategies are exclusively aligned towards the deductive approach, while others could support the inductive method. When it comes to an entirely qualitative approach, for example, the most appropriate research tactics would be ethnographies, case studies, action research, grounded theory research and phenomenological as well as archival studies (Gray, 2014; Saunders et al., 2009). It is also possible to link other specific tactics with quantitative approaches such as experiments and surveys (Creswell, 2003).

A population is an entire set of units whose observation should be via systematic and scientific methods (Lee, 2003). A researcher chooses a sample from this population, and a sample is made up of a few units or individuals representing the larger population (Kumar, 1996). A sample is, likewise, a population's subgroup, chosen for the generation of forecasts as regards the whole community. Healthcare workers who held managerial positions or higher in the administrative divisions of healthcare workplaces in Saudi Arabia make up the population in the current study.

This study collected data using mixed methods, with implementation via semi-structured interviews and survey data. There was the combination of inquiries and procedures while data were obtained from the participants. The analysis of the results was inductive, moving from particular to general issues, and the interpretation of the collected data. In the first phase, the choice of a qualitative method was made due to the necessity of exploring a particular phenomenon based on the views and experiences of people.

Semi-Structured Interview

The interviews are among the most critical data source and proof to confirm people's perspectives, notions and observations. Many consider interviews as the most remarkable tool to gather deep information about social actors' attitudes, behaviors, observations, knowledge and notions in modern situations (Gray, 2014). There are three categories under an interview:

structured, semi-structured and unstructured designs (Gray, 2014; Saunders et al., 2009). The semi-structured is considered the most useful and effective in collecting qualitative perceptions, examining and understanding human behaviors (Eaterby-Smith et al., 2015; Gray, 2014; Turner III, 2010). The general means of accomplishing this is through open-ended questions, as it permits participants to deeply discuss their experiences and behaviors (Eaterby-Smith et al., 2015; Turner III, 2010). It also offers the chances of understanding a context for exploration and correspondingly connects social situations and social actors' attitudes (Saunders et al., 2009). To carry out interviews, a critical criterion is participants' agreement to reveal appropriate information regarding their experiences (Saunders et al., 2016). It is also possible to explore more themes as well as appropriate information (Tashakkori & Teddlie, 2009). Additionally, this study is a pilot study to gain an initial insight of potential adoption of IoT in Saudi Arabia.

Results and Discussion

The industry has different platforms and applications such as Apple, Android and Windows, which are working as standalone units and providing technical assistance in localised pockets. The integration of IoT will change this situation as all the stand-alone platforms will be linked with this new system. One of the participants (1) (who holds a director position) is quick to confirm that the current technical system supports their basic needs at the moment but IoT will make life easier as processes will be faster and more connected. There is the added advantage that IoT will be more interesting to work with and will be safer than the previous technical setups. This participant (1) also has shown his/her faith that IoT integration will have a major positive impact on the technical aspects of the healthcare industry. Another participant (3) who holds a Physician position (and also works as the administrator) commented that IoT can be used for many needed things such as for monitoring purposes in the healthcare system and that IoT will enable this more easily so that the outcome of the services offered to patients will be more effective and beneficial.

Another participant (4) discussed the current use of smart-phone apps in the healthcare sector and how they have significantly helped the healthcare industry. It would be useful to combine these applications with the use of IoT. For starters, remote health surveillance is available for non-critical patients, which would definitely reduce the burden on hospital services. IoT will ensure greater access to health services for people living in remote areas and track blood glucose levels. The integration of IoT would have a huge effect on telehealth, remote surgery, elder monitoring, commitment to medication and the monitoring of appliances and patient hygiene. Another participant (2) said how the Android device currently assists in the setup of healthcare. The RFID tags are used to constantly track and monitor the health parameters of patients such as the temperature and blood pressure and to identify changes to these parameters and to alert the RHC doctor immediately. Android helps to detect infections early and to detect abnormalities in patients. This participant was sure to rethink systems, re-imagine work, promote operability and transparency, improve live reactivity and advanced collaboration through the introduction of IoT into an established context.

IoT has proved to be advantageous in various fields, including farming, hospitality, advertising, smart buildings, manufacturing and retail stores. IoT is not just the latest buzzword but is also the need of the hour in the healthcare industry. Integrating IoT with the existing technical system will revolutionize the whole Healthcare Industry. However, the overall findings suggested that three vital factors may have impacts on IoT innovation in the healthcare service: costing, security and privacy, which are vital concerns that may lead to any barriers to such innovation.

Given that the Saudi government is keen to provide citizens with optimized healthcare facilities, IoT integration and IoT-based innovation would be key components. For example, the

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integration of IoT in the technical environment will broaden the scope of treatment, link devices, applications and machines with healthcare workers, help improve patient care, make processes more efficient, reduce errors and save a lot of time. To benefit from the benefits of the IoT, individual organization should consider hiring IoT professionals who can study the existing technical environment and help with the integration process. As most of the participants have pointed out, it is not enough for IoT to be implemented but rather for health workers to be trained to be able to move smoothly from the existing system to the new system. Although there is a lot of talk about the benefits of IoT, health workers will be able to see these benefits first-hand once they start using this system. Interviews with the Jazan Healthcare Administrators helped to understand the thinking and thinking of the health care staff. We, therefore, understand that the time is right for IoT integration in the Jazan Healthcare Organizations. The factors related to Rogers' Diffusion of Innovation Theory (Rogers, 1995) have helped to analyze the impact of IoT adoption on the existing technical environment.

This study aimed to learn about the variables that affect the implementation of IoT in healthcare systems in Jazan, Southwest Saudi Arabia. A similar supply chain study was conducted by Robson (2002) to assess the impact of the "Internet of Things" on performance aspects. Our study focuses on the different aspects of managerial requirements, such as the participation of Healthcare Administrators who have a managerial position in their respective healthcare organisations. There were five participants in the study sample. Some of the characteristics of the research participants are that they must be a health care administrator with managerial positions and must be a member of the health care organization of the study site.

The existing technical environment in the healthcare industry has different platforms and applications such as Apple, Android and Windows, which are working as stand-alone units and providing technical assistance in localized pockets. The integration of IoT will change this situation as all the stand-alone applications and platforms will be linked with this new system.

Participant (1) (director) quickly confirmed,
The current technical system is good at the moment but IoT will make life easier as processes will work faster. There is the added advantage that IoT will be more interesting to work with and will be safer than the previous technical setup."

Participant (2) has faith that,
IoT integration will have a major positive impact on the technical aspects of the healthcare industry. Physician Bandar comments that there are many things that need to be monitored closely in the Healthcare system and that IoT will enable this in an easier manner so that the outcome of the services offered to patients will be more effective and beneficial.

Participant (3) expressed his view about
The smartphone applications which are currently being used in the Healthcare Industry and how they have helped the Healthcare industry to a great extent. Integrating these applications with the use of IoT will be advantageous. For example, remote health monitoring for non-critical patients will be possible and this will surely reduce the strain on hospital resources.

IoT will ensure that those living in rural areas will have better access to healthcare and that their blood glucose levels can be monitored. IoT-integration will have a major impact on tele-health, tele-surgery, monitoring of elders, treatment adherence, and equipment monitoring and hospital hygiene.

Participant (3) mentioned how the Android-based system is currently helping in the Healthcare setup.

The RFID tags are being used to continuously monitor and control the patients' health parameters such as temperature, and blood pressure, and helps in detecting changes in these parameters and instantly communicates it to the RHC doctor. Android system helps in the early detection of diseases and in detecting anomalies in patients. The application of big data can be explored in this sector similar to other sector (e.g. in higher education (Miah et al., 2020). Block chain (Prokofieva & Miah, 2020) has also showed data governance options in the IoT based innovations.

Participant (4) was confident that the integration of IoT with the existing environment will reinvent processes, reimagine work, enable operability and openness, develop live responsiveness and advance cooperation.

The findings in the future would be used to improve innovative e-government approaches using IoT-enabled functionalities for empowering citizen's access and remote involvement (Miah, 2010). The entire concept for this would be to enhance the rural population's support services going beyond the healthcare services (Miah, 2008; 2009).

This would be to improve interactions between government officials and citizens (for example using ontology technique for building citizen group-specific service-based systems (Miah et al., 2007; Miah & Ahamed, 2011) in e-governance supporting initiatives taken by the Saudi government.

Conclusion

The research used a qualitative methodology to obtain health care administrators' experience in hospitals and clinics. The data were collected through open-ended semi-structured issues collected during interview sessions. The main research question for this research was: What are the factors that influence the effective integration of IoT innovations and healthcare service delivery in Saudi Arabia?

This investigation, given the new insights it derived regarding the integration of IoT innovations and healthcare service delivery, is expected to be a unique addition to the research community.

The results will be used in the future to develop creative e-government methods using functionalities that have been allowed by IoT to support people's access and remote engagement (Miah, 2010; Waheduzzaman & Miah, 2015). This will be entirely intended to improve rural community social systems that go beyond health services [e.g., Miah, 2008; Miah et al., 2007; Miah et al., 2008)]. It will strengthen the relationship between officials and residents (for example, by using Ontology strategies for building relevant service-based structures and adopting more practical design methodologies (e.g. defined in Fahd et al., 2021; Genemo et al., 2015); research for the civic community in e-government support for Saudi government initiatives).

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