Determinants of Internet of Things Services Utilization in Health Information Exchange

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Abstract: Currently, the exchange of patient information continues to be a challenge. The growing demand for health care makes it necessary to enhance the efficiency of the health care service. The use of Internet of Things services in the healthcare domain can improve the quality of life and help health care professionals in their decision-making. It easily makes data available for health professional's by using IoT. Health records can be exchanged easily through the Internet of Things (IoT) network. The IoT is growing technology to integrate all smart devices, resources and systems to discover drugs, treatments and health records of patients in one network. Despite the advantages of this technology there are a lot of challenges facing the healthcare organizations to utilize it, especially in the context of developing countries such as Iraq. As such the researchers carried out this initial study in the Iraqi healthcare sector to acquire preliminary data. The study conducted in order to investigate current needs and issues faced by the heathcare sector regarding the use of their health systems. In addition the researchers aimed at examining the major factors related to the use of IoT for health information exchange. The qualitative research approach was deemed to be the most suitable in this kind of researches. A semi-structured interview method with 15 open-ended questions was used on a total of 29 IT practitioners and physicians in face-to-face interviews in Iraqi healthcare institutions. It has been found that a number of determinant factors must be taken into consideration, these include the factors related to organization, technology and system that affect individual's perception to utilize IoT.

Key words: Internet of things, health information, exchange, health information system, Iraq, utilization, investigation

INTRODUCTION

The Internet of Things (IoT) is one of the new technologies connecting the world through smart devices or objects for the purpose of seamlessly collecting and sharing any type of information from anywhere, anytime and through anymedia from their environment (Yuehong *et al.*, 2016). The proposed use of IoT technology is to make our lives smart and safer with a unique identifier for each object (Fan *et al.*, 2014). In the healthcare system, IoT provides real-time access to several kinds of health information quickly and efficiently, thus, providing accessibility which is crucial for sharing information among healthcare professionals. The IoT platform allows easy access to and control of the information (Atzori *et al.*, 2010; Zdravkovic *et al.*, 2014a, b).

In recent years, multiple devices have emerged for the purpose of exchanging information by using different technologies (Mitchell *et al.*, 2013). Most of these technologies use the Internet as the bridging network to enable accessibility of the data from any where (Islam *et al.*, 2015). In fact, the availability of health information has become important during the last few years (Kadhum and Hasan, 2017; Zdravkovic *et al.*, 2014a, b; Zhang *et al.*, 2017). Accessibility to data could be immensely beneficial to decision makers, especially when the accessible data is large scale observation data (Kruse *et al.*, 2014). In addition, IoT could aid doctors in the diagnosis of health patient status and facilitate recommended treatment with timely intervention (Li *et al.*, 2015a, b). Moreover, the relationship among healthcare providers in healthcare delivery is necessary to achieve desirable patient outcomes (Richardson *et al.*, 2015; Strauss *et al.*, 2015).

Increase in health care demand for quality services cannot be effectively provided if the healthcare systems are fragmented and there is uneven distribution of healthcare resources (Zhang *et al.*, 2017). HIE is defined as "electronic Health Information Exchange which enables

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doctors, nurses, pharmacists, other health care providers and patients to appropriately access and securely share a patient's vital medical information electronically." It is self-renewed every 2.5 years due to advances in the technology and changes in the environment (Kruse *et al.*, 2014). The report, 'Evolution of State Health Information Exchange' stated that the utilization of HIE has many significant findings in different project designs such as financing, patterns of successes, programmatic sustainability and challenges to identify the trends and best practices (Rosenfeld *et al.*, 2006). Many opportunities are driven by adopting HIE to improve the quality and reduce the cost of health care and to improve the workflow of clinical and administration data within health care system (Dobrzykowski and Tarafdar, 2015; Akhlaq *et al.*, 2017; Zhang *et al.*, 2017). Moreover, information exchange among healthcare systems is among the most complicated issues of electronic Health Information Exchange in health systems and is also, considered as one of the most challenging problems in electronic health records management (Kruse *et al.*, 2014; Richardson *et al.*, 2015; Strauss *et al.*, 2015). If the information is not available for multiple users such as planners, managers, policy makers, individuals, communities and healthcare providers, the information would have little value (Dobrzykowski and Tarafdar, 2015; Richardson *et al.*, 2015). In addition, the health information system is unable to provide an alert for support health patient status and early warning capability (Al-Hilfi *et al.*, 2013; Zhang *et al.*, 2017). Therefore, distribution and communication using smart technology are important attributes for the health information system.

HIE has the potential to involve collaboration and exchanges information among the healthcare providers and stakeholders with patients (Zhang *et al.*, 2017). There is a need to exchange health information by utilizing IoT services to improve the quality and safety of healthcare by appropriately, efficiently and securely access a patient's medical records and remote monitoring data that are available (Atzori *et al.*, 2010; Darshan and Anandakumar, 2015; Gomez *et al.*, 2016; Zdravkoviæ *et al.*, 2014a, b). The ability to exchange information or components among two or more systems is referred to as the interoperability platform (Zdravkovic *et al.*, 2014a, b). Access to the interoperability of healthcare in the public sector is usually related to capability of services to offer a platform for data exchange among different users, procedures, processes and policies (Kadhum and Hasan, 2017).

Within the network of IoT, there is the ability to embed a large number of devices to build access to the large scale of information (Islam *et al.*, 2015). It can
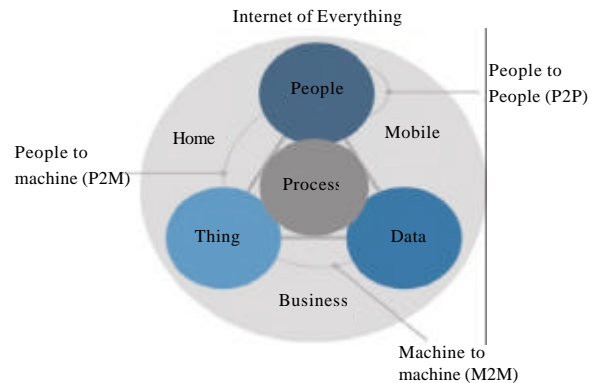

Fig. 1: Internet of things revolution (Mitchell *et al.*, 2013)

be viewed as a grid of computers that can deliver software and data by using the internet (Atzori *et al.*, 2010). The IoT network facilitates the collection of all the information in the same hole by using cloud computing to store the information for easy monitoring of patient health status (Gomez *et al.*, 2016). As illustrated in Fig. 1 the Cisco Revolution defined it as the internet of everything: people, processes, data and things (Mitchell *et al.*, 2013). The IoT-based healthcare system offers multiple advantages as summarized in the following points.

Monitoring: Remote patient monitoring continues in order to help physicians in their diagnoses and treatment of illnesses and diseases by obtaining reliable information with a negligible error rate (Darshan and Anandakumar, 2015; Lim and Thuemmler, 2015).

Sensing: IoT with intelligent medical sensors improves the quality of life significantly and averts the incidence of health problems (Atzori *et al.*, 2010).

Low-cost solutions: Reduce unnecessary visits to the doctor and readmissions for those patients who have chronic diseases and thus reduce testing and treatment costs (Lim and Thuemmler, 2015; Zdravkoviæ *et al.*, 2014a, b).

Ubiquitous access: Flexibility and mobility in accessing data anywhere, anytime and in anymedia (Atzori *et al.*, 2010).

Better quality of healthcare management: Increases the care quality and control by enhancing the management of drugs, reduces the medical error, enhances the patient experience, improves the disease management and improves treatment outcome (Manate *et al.*, 2014; Zdravkovi *et al.*, 2014).

Unified information: Enables automatic data collection from health resources such as monitoring, first aid, tracking, analysis, diagnosis, alarm-triggering, locating and collaboration with medical healthcare on a unified communication platform (Gomez *et al.*, 2016).

Time: Facilitates an interaction among the parts of an enterprise that reduces the time required to adapt itself to the changes demanded by the market evolution (Atzori *et al.*, 2010). However, the IoT-based healthcare system has some disadvantages that make its adoption a concern, shown by the summary below.

Complexity: The IoT network is both diverse and complex. Multiple services are needed to grow device counts; massive increases in internet bandwidth are necessary to drive requirements for lower latency, greater determinism and processing closer to the edge of the network. Thus, any failure or bugs in the software or hardware will result in serious consequences. A single power failure for example, can cause a lot of trouble (Fernandez and Pallis, 2014).

Compatibility: Compatibility problem among the heterogeneous components. When the products of different manufacturers are interconnected, the problem of compatibility arises because there is no common standard agreed to among the different manufacturers. To resolve this incompatibility problem, people will be forced to buy from a single manufacturer rather than from different manufacturers, thus, creating a monopoly for one manufacturer. This stops users from shopping for the best available products from various manufacturers in the market (Li *et al.*, 2015a, b).

Security and privacy: Identifies the locations of persons or objects in real time and collects inappropriate personal data, thus creating more challenges. The issue of protecting identities and privacy would arise and it can also be seen that the massive data from millions of things in a healthcare system could lead to many security challenges (Islam *et al.*, 2015; Yuehong, 2016).

Massive health data: in IoT, devices assemble and communicate data directly together through the internet as well as cloud which manages in order to collect records and analyze data. However, the things or devices that produce huge amounts of data flow on a day-to-day basis and needs to be treated and managed (Islam *et al.*, 2015; Yuehong *et al.*, 2016).

Even with the above drawbacks, the IoT still offers many benefits to the health care system. It provides information in real time of health status of patients and also information to doctors who assist (Darshan and Anandakumar, 2015; Zdravkovic *et al.*, 2014a, b). Additionally, IoT facilitates the use of communication forms which will grow from human-human to human-thing and thing-thing (also, known as Machine-Machine) (Yuehong *et al.*, 2016). That means, IoT always offers new tools which will promote efficiencies to realize the integration of healthcare systems in the context of modern healthcare to ensure appropriate care delivery to patients. This will reduce the healthcare cost and evolve treatment outcomes.

In light of the above, there is a necessity to adopt IoT technology to facilitate the HIE among the hospitals and enhance the healthcare quality by being able to monitor health patient status (Dobrzykowski and Tarafdar, 2015; Richardson *et al.*, 2015; Strauss *et al.*, 2015; Zhang *et al.*, 2017).

When considering this, efforts have been made by the Iraqi Ministry of Health to utilize specific ubiquitous technology models to boost health-related medical practices in various sectors (Al-Hilfi *et al.*, 2013; Kadhum and Hasan, 2017). This involves re-engineering the technique of access to health data which would allow healthcare professionals to monitor and understand patient's conditions (Gomez *et al.*, 2016; Kadhum *et al.*, 2017) efficiently.

Many organizations have failed to utilize new technology such as internet of things (Muhammad Ibrahim, 1998; Al-Jabri, 1998). The lack of understanding of the needs of healthcare organizations to utilize new technology can hamper the utilization of such technology in the healthcare system. Therefore, effective utilization of IoT technology in hospitals would have to address the resources needs so as to create the highest possible value and avoid failure (Lim and Thuemmler, 2015).

Currently the system in most Iraq hospitals is not able to access patient medical records in real-time and physicians have difficulties accessing patient health records from anywhere (Al-Hilfi *et al.*, 2013; Hameed *et al.*, 2015). Moreover, the current circumstances make it difficult to adopt a certain technology such as IoT without any prior examination of its suitability within the usage context. Furthermore, the HIE includes different types of processes based on different types of organizations that continue to increase the access demand for health resources. This has given rise to some major problems for the public health care sectors through 3 points of view; low IT integrity, data exchange process and data complexity.

Consequently it is important to manage and sustain the HIE to healthcare among the organizations. However,

to ensure effective usage of IoT in the healthcare environment, there must be careful focus on a number of factors via., different perspectives that may contain technical and system factors of information technology and attributes of the organization which present the technology as well as the response of individuals in the organization toward the use of technology (Kruse *et al.*, 2014; Li *et al.*, 2015; Akhlaq *et al.*, 2017; Richardson *et al.*, 2015; Strauss *et al.*, 2015).

Therefore, study presents a preliminary study to identify the key factors related to the utilization of IoT services to promote the current system of HIE in Iraq.

Literature review: HIE is certainly one of the core elements of eHealth. It can facilitate a medical group in making better and more appropriate medical decisions by utilizing such technology to transmit in real-time, patient's health care information to any medical group that needs it. Past research has shown how the HIE system can help to raise the quality of medical care, improve patient safety and reduce medical costs (Li *et al.*, 2015; Strauss *et al.*, 2015).

When patients move from one hospital to another, their medical records are kept in several papers and electronically-based systems therefore, there is no lookup directory to locate their medical records. This 'hidden' nature of patient's medical records can lead to additional procedures, duplicated tests and many other issues including adverse drug interaction.

According to Tharmalingam *et al.* (2016) in Canada, only a few studies have indicated and explained the benefits of HIE and this is why many healthcare providers find the system difficult to understand and use. Most healthcare professionals obtain the electronic patient information from outside their practice resources such as drug information systems and labs (Tharmalingam *et al.*, 2016). There are several difficulties facing the use of HIE such as inadequate visibility and knowledge as to where patient's medical records can be found. There is also, a lack of accessibility and data standards which make it difficult to exchange clinical data and complex systems. Also, there are some non-technology barriers such as care burden issues of patient consent, differences of business models, limited understanding, loss of competitive advantage as declared by Downing *et al.* (2016) and Strauss *et al.* (2015).

Now a days, health information systems are being used by most healthcare providers, but there remain some technological and individual challenges among different hospitals. These barriers include resistance to information sharing and failure to understand the new technology. Despite these problems, the review of the literature

regarding the use of health IT and the internet for exchanging health information in both developing and developed countries reveals that the desired rate of distribution and adoption of such systems is far from satisfactory (Al-Aswad *et al.*, 2013).

In the past decade, many countries launched healthcare initiatives aimed at developing a nationwide interoperable Health Information System (HIS) but have encountered many problems such as the lack of information exchange standards no proven sustainable business models and high risks in HIT investments (Zhang *et al.*, 2017). Earlier researches proved that the sharing of patient information among different healthcare providers is a predictably considerable challenge because of employee's resistance to the new technology while the existence of uniform infrastructure for exchanging information is still lacking (Kruse *et al.*, 2014; Strauss *et al.*, 2015; Wang *et al.*, 2015). As such a healthcare information system needs to establish a collaborative platform to share the required efforts in order to increase its acceptance and use between different participants to improve healthcare efficiency and quality.

According to, different studies in several countries, HIS has been reported to be facing many difficulties and challenges (see Table 1). In the US, there are 2 types of HIE: public HIE and private HIE (Wu and Larue, 2015). The value of exchange data does not ensure medical value for exchanged information because it is just a mandatory requirement and most of them do not use auto-query (Downing *et al.*, 2016). Other studies have reported the limited research on current health IT to provide the necessary support of health collaboration. Another study highlighted the problem of inflexible and insufficient data records to meet the requirements for practice, thus, limiting access to health resources and practice (Mishuris *et al.*, 2016; Richardson *et al.*, 2015). In New York, the user needs affirmative consent to patient data access but no such consent is required to make data available on regional HIE. In an emergency, the user can access the patient data without affirmative consent (Campion *et al.*, 2013). Therefore, the implementation of HIE is not enough to overcome these barriers (De Leon *et al.*, 2015).

In China and the Netherlands, 2 studies reported that there is a need for remedial policies to improve the efficiency of actual use and sustainability of the health system (Mastebroek *et al.*, 2016; Zhang *et al.*, 2017). The healthcare authorities in China have planned to complete the construction of health exchange during 2022 but there is still a need to improve the usage efficiency as well as sustainability of completed systems. The lack of shared decision-making and unreliable health information for

Table 1: Summary of the difficulties of HIE in different countries

Case study	Sources	Limitation overview
New York, United State		Several challenges for implementation HIE include: Patient consent Lack in exchange health information between primary and secondary healthcare providers Disrupted workflow and user-unfriendliness Difficulty with finding qualified and trained staff, and some part-time clinicians increase coordination problems Low engage with HIE technologies
Canada		Working with the respective vendor communities need for greater collaboration and integration efforts, reporting technology error and training. Additionally, in German, the perceived communication and information sharing with General Practitioners (GPs) not to work well in the care process.
Australia, UK, German, Finland England		Difficult to obtain or unavailable historical information relevant to patient information including medical histories and testing results with 30% of emergency visitors. Also, different providers have varying information needs, users access HIE systems in different ways between varies organizations
Korea		The HIE its not widespread adopted and limited in accessibility for health patient information. The adoption of an HIE needs to full realization of the new technology benefits
Taiwan		The patient record exchange among hospitals still has technological and individual barriers including resistance to information sharing. The major challenge is employee's resistance and also the capabilities of information storage for doctor consolations Understanding advantage and user intention limited to adoption and many others factors are effects of using of health information exchange
China		Regional HIE in early stage due to the lack of interoperability standards and implementation guidelines. The healthcare authorities working on complete the construction of health exchange during 2022 but still need to improve the efficiency and sustainability of completed systems
Malaysia		In Malaysia there are three kinds' hospitals public, private and university hospitals. The healthcare has a facing lack in the interoperability and the collaboration between types of hospitals. There is no exchange between hospitals. However, only three hospitals have Health Information Exchange (HIE) system for chronic diseases that facing the adult population
Arab Developing Countries		Lack of studies and government roles. Lack of consensus on what EHRs capabilities mean and constitute. The implement and adopt of EHR does not achieve the desired rate of distribution
Iran		Poor hospital management infrastructures and user resistance to using new technology and no recovery planning. Lacks in using HIE and no any significant correlations between the HIS
Case study	Source	Limitation overview
United States, New York	Downing *et al.* (2016), Mishuris *et al.* (2016), Dobrzykowski and Tarafdar (2015), Richardson *et al.*, (2015), Campion *et al.* (2013) and De Leon *et al.* (2015)	Patient consent Lacks in exchange health information between primary and secondary healthcare providers Disrupted workflow and user-unfriendliness Difficulty with finding qualified and trained staff. Some part-time clinicians increase coordination problems Low engage with HIE technologies
Canada	Tharmalingam *et al.* (2016) and McMurray *et al.* (2015)	Vendor communities need for greater collaboration and integration efforts Technology error and training Difficult to understand the user's needs
Australia, UK, Germany, Finland, England	Vest *et al.* (2014), Nissinen and Leino, (2016), McMurray *et al.* (2015), Kushniruk *et al.* (2013), Kamradt *et al.* (2015), Rinner *et al.* (2016) and Melby *et al.* (2015)	Difficult to obtain relevant historical patient information, including medication information, test results, and medical histories Communication and sharing information among General Practitioners (GPs) does not work well
Korea	Park *et al.* (2015) and Lee *et al.* (2014)	The HIE its not widespread adopted limited in accessibility for health patient information The adoption of an HIE needs to full realization of the new technology benefits
Taiwan	Wang *et al.* (2015) and Li *et al.* (2015)	Employee's resistance Low capability of storing doctor consultations
China	Liu *et al.* (2011) and Zhang *et al.* (2017)	Lacks interoperability standards and implementation guidelines
Malaysia	Latif *et al.* (2016)	Lacks interoperability and collaboration between kinds of hospitals.
Developing countries	Al-Aswad *et al.* (2013)	Lacks government roles and understanding Lacks agreement about what EHRs abilities mean and constitute Implementation and adoption of EHR does not achieve the desired rate of distribution
Iran	Hekmat *et al.* (2016) and Ahmadian *et al.* (2015)	Poor hospital management infrastructure Resistance in using IT application lack of planning and data recovery

target patients makes it difficult to understand and communicate between different health information systems which affects diagnosis and treatment plans (Mastebroek *et al.*, 2016; Zhang *et al.*, 2017). The General Practitioners (GPs) reported that the lack of health information led to sometimes unnecessary, burdensome tests and treatments. On the other hand, GPs look needs a longer time to identify medical problems (Mastebroek *et al.*, 2016). Furthermore, healthcare provider's system is fragmented and the uneven distribution of healthcare resources can be considered as the main barriers (Zhang *et al.*, 2017). Otherwise, absence of careers during the consultation and presence of part-time temporary care staff or inadequate recording and sharing between colleagues can all lead to insufficient information that could be retrieved for purposes of diagnosis and the formulation of management plans. Due to conflicting interests among multiple stakeholders it is difficult to be reconciled and there is therefore, limited interoperability due to inconsistent standards, lack of financial incentives and an increase in healthcare demand for quality services, all of which pose a serious risk to under-diagnosis and under-treatment (Liu *et al.*, 2011; Mastebroek *et al.*, 2016; Zhang *et al.*, 2017).

In Korea, the HIE is not widely adopted in most health care organizations. In addition, users face multiple difficultie's such as limited accessibility to health patient records and the need recognize and fully embrace the new technology such as IoT and cloud computing benefits (Park *et al.*, 2015; Lee *et al.*, 2014). Another study in Finland with 37 occupational personnel in the health sector revealed that there was wide use of electronic health records but there was little interest in using HIE as there were some concerns that workflow will increase when using the new technology (Nissinen and Leino, 2016).

In interviews with 41 nurses in a Norwegian hospital, it was found that there was a need for extensive communication and information exchange among health care workers across organizations to facilitate smooth transitions and healthcare information technologies are introduced to facilitate these processes (Melby *et al.*, 2015).

In Ontario, Canada and in Germany, the communication and information sharing with GPs is not working properly. This is due to the restrictions on effective coordination of care and this led to inappropriate healthcare and pose a risk to the best possible care (Kamradt *et al.*, 2015; McMurray *et al.*, 2015). Therefore, there is a need for logical and systematic interoperability between clinical information systems to achieve integration through seamless data exchange.

In Taiwan, 2 studies (Li *et al.*, 2015; Wang *et al.*, 2015) reported that building an electronic health exchange system for medical records was a good idea to provide better continuous medical care and greater security to the health care system as well as the capability to control a number of laboratory tests and the number of doctor consultations.

The increase in medical costs poses a big challenges to the long-term operation and viability of CTHE National Health Insurance system.

Comprehensive information for a patient record is required for information sharing and applying the health information exchange system is an inter-organizational process that demands the significant incorporation of the personal, organizational, ethical endeavours and legal implications (Li *et al.*, 2015; Wang *et al.*, 2015). Therefore, using such technology as IoT can facilitate the exchange of health information and make it available for any medical team that requires it. In addition, multiple issues need to be addressed before adopting the HIE system such as organizational and technological aspects which are crucial the human aspect like user acceptance.

In Malaysia, there are three kinds of hospitals; public, private and university teaching hospitals. The healthcare system in Malaysia is facing a lack of interoperability and collaboration between the different kinds of hospital. There is no exchange between most of these hospitals. There are only three large hospitals with the Health Information Exchange (HIE) system for chronic diseases that mainly affect the adult population; General Hospital, Subang Jaya Medical Centre and Penang Adventist Hospital (Latif *et al.*, 2016).

In Iran, there is poor infrastructure for the scale of hospital management and resistance to using the application of new technology as well as a lack of planning for data recovery. Because of that there is little use of HIS and no significant correlation between the HISs that exist. Researchers have suggested solving this problem by integrating the requirements and using the new technology to collect information and improve human resource management as well as access to services (Ahmadian *et al.*, 2015; Hekmat *et al.*, 2016).

Finally, after reviewing several studies conducted in different countries and examining the challenges they face it can be seen that there is a need to utilize new trend technologies such as IoT in the healthcare sector and specifically in the HIE system to adequately address the current issues. Table 1 illustrates the limitations and issues in different developed and developing countries.

MATERIALS AND METHODS

This study was conducted in Iraq in order to obtain the data on utilization of IoT services to foster the health information system. The preliminary study was done between 25 September 2016 and 1 December 2016. This

study aimed to determine the key factors related to the use of IoT services for health information exchange. The researcher used the interview method with a semi-structured approach to achieve in-depth understanding of the subject in question.

Population and sampling: The population of this study is the public healthcare sector in Baghdad, the capital city of Iraq. The selection of this population was based on the need for functionality and reliability of technology adoption in comparison with other statutes done in Baghdad. There are 29 hospitals in Baghdad but only 3 hospitals were selected for the purpose of this study.

The 3 selected hospitals are all located in Baghdad. They were selected for their capacity and also for their potential capability in healthcare support and level of technological facilities. These hospitals were considered the main hospitals in the adoption of IT infrastructure. The sample hospitals were also selected based on the advice and assistance of the Ministry of Health in Baghdad and taking into account their number of patients, beds, physicians and technicians.

The selected hospitals fitted the focus of the research, particularly with regard to the number of physicians and IT practitioners who are the most frequent users of technology. The other hospitals were excluded because they did not meet the criteria with respect to resources and time. The physicians and IT practitioners of the selected hospitals had knowledge of IoT services.

Of the 29 interviewees, 14 were IT practitioners and 15 of them Physicians. The data collection method used was face-to-face interview and the researcher used the semi-structured form.

The demographic profiles of the interviewees were as follows; were aged ranged between 26 and 49 years; seven were female and 22 were male years of experience ranged from 1.5-18 years in using current technology in health information systems.

Interview: The interview is a common and popular instrument used for data collection in qualitative research. The qualitative method was used to focus in-depth on the individual's experience and perspective. In order to have a guide for the interviews, the researchers constructed 15 open-ended questions to allow the interviewees to provide deep information for the study (Mathews *et al.*, 2002).

The interview questions were constructed guided by the concerns of the Iraqi Ministry of Health about the use of IoT services for HIE among hospitals. The interview questions constructed also took into consideration

various aspects highlighted by the hospital's health managers who assisted the researchers with relevant input regarding their respective organizational systems, technological, aspects and various individual dimensions. The questions were then validated by 3 experts from the selected hospitals. This was done to ensure the reliability of the questions in order to meet the study goals.

Details of the questions are available:

- What is the current system used in the health sector to keep past patient treatment history?
- What are the main challenges facing the utilization of the health information system?
- Do you have a patient-central for Iraqi hospitals?
- What is the current technology used in Health Information Exchange between organizations?
- Does the existing Health Information Exchange management system work as well as you expected?
- What are the main challenges facing staff involved in the information exchange?
- What do you think should be developed to support the Health Information Exchange system?
- Do you have access to online technical support and is you do is it available to you in a timely manner?
- Did you think IoT services can improve the Health Information Exchange system?
- What is the main challenge you face in using IoT services in your hospital?
- Do you think using the IoT will make the staff more productive in performing their work?
- Personally, what do you think are the antecedents that could impact the use of IoT services?
- Did you think that it will be easy for health organizations to apply the Health Information Exchange system?
- Did you think the current technology can support IoT services for Health Information Exchange?
- Do you see the exchange of health information through the current system as easy and possible?

RESULTS AND DISCUSSION

Decades ago, the Iraqi health status had suffered from progressive neglect and low budgetary allocations because of war and sanctions (Al-Hilfi *et al.*, 2013). The Iraqi Ministry of Health is now struggling to restore lost momentum and develop the healthcare systems. The researcher conducted interviews to highlight the current needs in Iraqi hospitals and to investigate the primary antecedents that face the utilization of IoT in these hospitalse. The interview questions were constructed based on the issues raised by the Iraqi health information

system's decision makers to utilize HIE within hospitals. The interviews were conducted in the Iraqi Ministry of Health and in three selected hospitals located in Baghdad: the Shahid Ghazi Al-Hariri Hospital, Sheikh Zayed Hospital and Al-Chuader Hospital. During the interviews, the interviewees provided in-depth answers regarding the use of Health Information System and the status of data exchange between different healthcare providers.

The answers revealed by the 29 Iraqi interviewees painted a negative picture of the utilization of current technologies in the Health Information Systems. Some of the Iraqi hospitals were still using the paper-based system despite having electronic health systems; this was due to the user's skepticism regarding the current technologies used and the security of data. Furthermore, the interviewees reported some problems in using the Iraqi health information systems such as the lack of health patient information sharing, difficulty in obtaining earlier treatment records for patients and the low ratio of number of physicians to patients admissions and the patient's understanding.

The physicians reported some difficulties in their decision-making because of poor patient's health information and some difficulties in getting treatment when the patients visited different physicians. The physicians expressed some concerns about the reliability of information records and the presence of medical errors. Some cases needed to be monitored for a long time and previous records had to be checked-if they were available. Most of the physicians admitted using social media to share the information about some cases among multi-specialist doctors but that required more time to describe and to upload the results. These physicians suggested using the HIE to help them in sharing the Patient ID with each other in order to be able to monitor the patient's health status in real-time and anywhere. The Interviewees from the Ministry of Health reported; "if we can enable the electronic HIE system to be used among hospitals it will help the physicians and decision makers to provide better healthcare and assist the Ministry of Health with weekly reports and notify them of any disease outbreak". The Iraqi Ministry of Health needs to establish a new healthcare system utilizing new technology among different healthcare providers.

In the Emergency Department, the interviewees reported problems in accessing the health status of the patient on admission and they had to conduct new tests and make new diagnoses. Also, the increased number of received patients in the emergency department has inevitably increased the time taken for admission which has annoyed patients and led to public dissatisfaction with the service at the Emergency Department. The interviews with 2 heads of Emergency Departments from different hospitals revealed that the absence of an HIE system was a challenge in terms of controlling and monitoring the health workers.

The interviewees, also, complained about the difficulty of accessing data. However, they admitted it would be much easier to work with the HIE system. Most of the respondents agreed that the existing system did not work as planned. Therefore, the respondents indicated that they like to see the system being upgraded to fit their workflow. A different system is used to process the clinical information which makes it difficult to process or update data. The respondents mentioned that there were no flowcharts available to keep track of data. Therefore, the understanding of the user's workflow (Yusof, 2015) is based on process needs and as such it is necessary to implement a system that accommodates these needs.

The physicians and IT staff reported that training is an important factor to encourage frequent use of the system not only during the first stages of the system set up and implementation but also, during training. Proper training can lead to better deployment of the system use. Cooperation among the healthcare staffs by filling up the information and details of patient status would provide a clear patient information record and make it easily understandable for other users.

With a view to utilizing a new system, the interviewees expressed concern about the cost-effectiveness because of the absence of a business plan (Kruse *et al.*, 2014). These concerns were due to the limited budget of the organization to meet all the system requirements and also based on fears about the increase in the cost of maintenance of hardware and software availability. Other researchers have indicated that cost saving is a benefit of using the IoT-based healthcare system (Yuehong *et al*, 2016).

The reason for the absence of an electronic health record exchange system among hospitals could be the desire of individual hospitals to keep the information to themselves. Also, they highlighted, some other issues such as network capacity in their respective organizations as well as concerns about security and privacy for their patients and poor connectivity that made it difficult to access the patient's information.

Most of the HISs in the Iraqi health sector do not use cloud computing, RFID and IoT. Also, unfortunately, the health information is stored locally and not connected with any other patient systems. The interviewees in the IT department indicated that they would like to adopt new technology with most of the health devices having the ability to be connectd through the internet. It was also, reported that most of the medical staff had poor computer knowledge and therefore, their record-keeping was mainly paper-based. It was also common practice to use CDs, USB memory sticks and email for data exchange among hospitals. As such sharing of patient information with

other hospitals was neither convenient nor feasible. The researchers, also, reported poor internet connetivity in Iraq compared to many other countries. The Iraqi participants attributed the poor intrnet condition to the cost factor. On the whole it was generally agreed that IoT technology would significantly improve the current healthcare information exchange systems efficiency if all these related issues could be addressed.

As a result were found during the survey of the interview. Controlling the process in using IoT technology in health sectors were found to be due to some reasons related to several factors. The participants complained from increasing the workflow when using both electronic and paper-based data entry. In addition, they also highlighted other concerns related to the data security and privacy when utilizing IoT technology. Therefore, the workflow, cost-effectiveness, training and cooperation play as key factors to influence the organizational domain to use IoT technology in health information exchange system.

In addition, other factors related to the technological domain in terms of network capability, security and privacy, compatibility and ubiquitous connectivity. Observed other system factors in terms of accessibility, usefulness factors that have a significant effect on individuals of utilizing IoT services in health information exchange. Finally, there are multiple factors that found have effect on individual's. The actual usage behaviour and trust play as key factors for a medical team to utilizing IoT services in healthcare sectors.

After a number of factors deduce, the researcher administered the agreement form to the interviewees to asking them about their agreements upon for the extracted factors that they mostly agreed upon. The responses were combined in Table 2. From the result it might be concluded which majority of the respondents agreed on these factors and that they preserve a remarkable impact on current utilization of IoT services for health information exchange.

Table 2: Agreements on the extracted factors

Factors	Agreements
Organizational domain	
Workflow	26
Cost-effectiveness	29
Cooperation	26
Training	29
Technological domain	
Security and privacy	28
Ubiquitous connectivity	27
Compatibility	28
Network capacity	29
System domain	
Accessibility	29
Usefulness	26
Individual domain	
Actual usage behaviour	25
Trust	25

CONCLUSION

The main objective of this study was to determine the key factors related to the utilization of IoT services in order to improve the current health information systems in Iraq which are unsatisfactory in many ways. The study discussed the current situation in Iraq and the various issues facing the introduction and utilization of IoT services. The relevant factors are many and encompass: workflow, cost-effectiveness, cooperation and training as well as ubiquitous connectivity, system compatibility, network capacity, security and privacy of patient information. Additionally there are also, factors such as accessibility and usefulness that need to be considered as they would affect personal factors associated with the actual usage behaviour and trust in the system. From the results it can be concluded that the majority of the interviewees agreed these identified factors greatly impacted the current utilization of IoT services in the Iraqi health information systems.

LIMITATIONS

One of the limitations of this study is the response rates of only 29 selected individuals from the three hospitals and the Iraqi Ministry of Health who were interviewed. Each interview was conducted to elicit the individual's vires and knowledge of HIS and the benefits of IoT services. Each interview lasted from 30 min to an hour with field times taking over a month. However, there is also a need to extend the interviews to other relevant personnel in other hospitals and also review the concerns of other researchers in relation to the concerns determined in this research.

RECOMMENDATIONS

However, the results identified and presented in this study are only the preliminary information for a larger study which will be the next stage toward addressing the existing issues of using IoT services. The health information exchange might have a significant effect on improving care quality and potentially enhance patient's engagement in managing their chronic conditions beyond the office visit.

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