Internet of Things: Benefits and Risk of Smart Healthcare Application

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Abstract In the Internet of Things (IoT), devices gather and share information directly with each other and the cloud, making it possible to collect, record and analyze new data streams faster and more accurately. That suggests all sorts of interesting possibilities across a range of industries: cars that sense wear and tear and self-schedule maintenance or trains that dynamically calculate and report projected arrival times to waiting passengers. But nowhere does the IoT offer greater promise than in the field of healthcare, where its principles are already being applied to improve access to care, increase the quality of care and most importantly reduce the cost of care. Extensive research has been dedicated to the exploration of various technologies such as information technologies (IT) in complementing and strengthening existing healthcare services. In particular, the Internet of Things (IoT) has been widely applied to interconnect available medical resources and provide reliable, effective and smart healthcare service to the elderly and patients with a chronic illness. The successful implementation of any innovation requires an understanding of its benefits and limitations. This paper contains a narrative review based on benefits and limitations of Smart Healthcare Application. Further, the background the smart healthcare application also been discussed.

Keywords: Smart healthcare, IOT, Healthcare benefits, Smart service

1. INTRODUCTION

The developing rate of the maturing populace has brought about many challenges in healthcare service. For instance, the service of after stroke recovery for the elderly is a developing challenge, which requires a long-term duty of medicinal and HR (Yin, Zeng, Chen, & Fan, 2016).

Recently, the world's attention and interest in alternative medicine and oriental medicine has grown significantly. Specially, the acupuncture treatment as an alternative treatment for sicknesses in the field of oriental medicine has been all the more generally investigated, and is now notable to be successful in treatment and avoidance of certain endless infections (Kim, 2015).

According to Niewolny (2013), IoT offer greater promise than in the field of healthcare, where its principles are already being applied to improve access to care, increase the quality of care and most importantly reduce the cost of care. With the smart perception within an IoT, smart healthcare are capable of improving the performance of public services and medical infrastructure in the ways that real-time data can be collected and analysed promptly, abrupt and emergent events can be acknowledged and responded timely, and resources in the medical centre can be managed and controlled appropriately. Yin et al.(2016) stated that as far as the healthcare services, such as medical rehabilitation, are concerned, an IoT based system makes it possible to provide ‘one stop’ service to the residents conveniently even at remote locations. In contrast to conventional on-site rehabilitation service at local hospitals, all the related resources are shared within communities through smart rehabilitation to provide flexible and convenient treatment to patients. In this way, the utilization of rehabilitation resources can be maximized and it can be anticipated that the IoT based intelligent technology would become an irreplaceable tool in modern healthcare systems.

Besides that, according to Smart Card Alliance Healthcare Council Publication (2007), records, submitting medical claims, making referrals, writing prescriptions, and booking appointments are typically manual processes. The few areas that are automated tend to operate independently of each other. Besides that, Smart Card Alliance Healthcare Council Publication (2007) also stated that, only a minority of physician practices store patient
data electronically. Physicians and other healthcare professionals have a stubborn affinity for using paper-based media to collect and retain patient data. The use of smart healthcare services such as smart cards can reduce healthcare paperwork and protect patient records. The smart card can hold encrypted patient information and use a digital signature or a biometric template to reduce ambiguity about the cardholder’s identity. The use of smart cards can also reduce the incidence of fraud in health benefit claims a significant issue for the Federal government (Smart Card Alliance Healthcare Council Publication, 2007).

Smart healthcare services have dominated the study in recent years. The volume of smart healthcare services research is expanding constantly which smart healthcare influence the most in recent years. We define the research questions to be answered as follows:

1. What are the benefits and risk can be identified in Smart Health Care device?

2. BACKGROUND

IoT related healthcare systems today are based on the essential definition of the IoT as a network of devices that connect directly with each other to capture and share vital data through a secure service layer (SSL) that connects to a central command and control server in the cloud. Let’s begin with a closer look at what that entails and what it suggests for the way people collect record and analyze data not just in healthcare, but in virtually every industry today. Meanwhile in medical technologies, smart systems are critical in driving innovations in the field of medical technology, as they provide the basis for information-based care and cure. The integration of micro sensors and micro-actuators in products will provide the healthcare professional to better treat and take care of patients in the hospital and at home. The seamless linking of microsystems to a telemetric and telediagnostic infrastructure will significantly reduce response time, and simultaneously contribute to containing public healthcare costs (Wals, 2010).

According to Yin et al., (2016) the paradigm of IoT for smart healthcare application consists of three parts: Master, Server and Thing. Master includes the doctors, nurses, and the patients, who have their specific permission to the system by end-user devices (e.g. Smartphone, PC, or tablet). Sever acts as the central part of the entire healthcare system. It is responsible for prescription generation, data base management, data analysis, sub-system construction and knowledge base management. Things refer to all the physical objects (including the patients and human resources) that are connected by WAN, multi-media technology or Short Message Service (SMS). The paradigm of IoT for healthcare has been gradually formed, as shown in Fig.1.

Furthermore, normal devices that cannot be connected to the network but commonly used in current rehabilitation conditions are also included in the smart rehabilitation system and made compatible to the network. The effectiveness of the proposed architecture has been verified by some pioneering exoskeleton applications.

![Figure 1: System architecture of the IoT based rehabilitation](image)

The emergence of the IoT in smart healthcare, in which devices connect directly to data and to each other, is important for two reasons:

1. Advances in sensor and connectivity technology are allowing a device to collect record and analyses data that was not accessible before. In healthcare, this means being able to collect patient data over time that can be used to help enable preventive care, allow prompt diagnosis of acute complications and promote understanding of how a therapy (usually pharmacological) is helping improve a patient’s parameters.

2. The ability of devices to gather data on their own removes the limitations of human-entered data—automatically obtaining the data doctor’s need, at the time and in the way they need it. The automation reduces the risk of error. Fewer errors can mean increased efficiency, lower costs and improvements in quality in just about any industry. But it’s of particular interest/need in healthcare, where human error can literally be the difference between life and death.

IoT in Action in Healthcare

In future, the healthcare systems will not enough facilities to accommodate all patients in hospitals or clinics. There is a directed push towards decreasing the length of stay within hospital and technology has been indicated as a possible influence with regards to assisting this. Smart technology facilities have also the additional implication of assisting patients with emergency assistance, fall prevention/detection, reminder systems, medication administration and assistance for those with hearing, visual or cognitive impairments (Stefan Buttigieg, n.d.).
Therefore, the concept of embedding automation and artificial intelligence into the home environment is introduced. According to Warren (1999), realization of automated, intelligent health care delivery in the home requires smart devices that are aware of their context and are therefore able to assimilate information to support care decisions. Sensors distributed throughout the home will help to provide this context, since each sensor will acquire information regarding a patient’s physiology as well as environmental factors that influence their state of health. Through initiatives targeting home-based networks and distributed computing, communication infrastructures that accommodate these needs may soon be in place. Internet appliances are already taking advantage of some of these capabilities in other settings. In the home of the future, some devices will contribute physiological information about the patient (e.g., heart rate, blood pressure), while other devices in and around the home will contribute information about the patient’s environment (e.g., humidity, temperature, carbon monoxide level). These physiological and environmental data will be collated to assess the patient’s state of health.

In general, the volume of healthcare data is expected to continue growing dramatically in the years ahead. In practice, utilizing the recent advancements on ICT to effectively analyze and utilize such big data can bring about significant benefits for health-care organizations ranging from single-physician offices and multi-provider groups to large hospital networks in several use cases and application scenarios. In particular, healthcare analytics can be leveraged in several applications with the aim of turning large amounts of data into actionable information that can be exploited to identify needs, provide services, predict problems and prevent crises for the population of patients (Sakr & Elgammal, 2016).

3. METHOD

The study methods used in writing this paper is systematic literature review. The protocol for this systematic review is to develop by specifying in advance, the process and methods that will be applied. The objectives of the study are to provide an overview of benefits and risk of smart healthcare application. The study began by searching the extant literature by a specific keywords and search items, in order to obtain as many relevant papers as possible. To ensure the quality of the results, the papers accessed were book chapters in online academic libraries selected journals. Around thirty papers were collected according to the keywords for further research and paper writing. The collected papers are used to identify and develop a paper based on the research questions.

4. RELATED WORKS

In this section, two parts which is the benefits and limitations of smart healthcare application have been discussed. Below is the further explanation accordingly.

4.1 Benefits in Smart Healthcare Applications

Since IoT was first implemented in healthcare field, numerous of profound benefits have been identified which help to sustain healthy life style and upgrade the industry. Nowadays, many IoT-based smart healthcare devices and systems have become commercially available. With the improvements IoT, the healthcare services have been extraordinarily improved (Hassan, Lin, Yue, & Wan, 2015). As stated by Barnes, Isgur, & Tsouderos, (2015), compared to traditional relational database, the present smart health care easier to sidestep the inflexible structure and analyze many diverse forms of data together. There are several benefits can be found by implementing smart healthcare.

As stated by Niewolny (2013), Clinical monitoring is one of the main benefit in smart healthcare. Hospitalized patients whose physiological status needs close attention can be constantly monitored using IoT-driven. This type of solution works sensors to gather inclusive physiological data and uses gateways and the cloud to analyze and store the information and then send the analyzed data wirelessly to healthcare center for further analysis and review. It switches the practice of having a health professional come by at regular intervals to check the patient’s important signs, instead providing a continuous automated flow of information. By using this approach, it concurrently develops the quality of healthcare through continuous attention and lowers the cost of care by excluding the need for a doctor to engage in data collection and analysis.

Besides that, remote monitoring is another benefit in smart healthcare. There are people all over the world whose health may suffer because they don’t have ready access to effective health monitoring. However tiny powerful wireless solutions connected to the IoT is now currently making it possible for monitoring to come to these patients instead of vice-versa. Capture patient health data securely from a many sensors and apply complex algorithms to analyze the data, which later then enable to share it through wireless connectivity with medical professionals who can make appropriate health recommendations can be done by using this remote controlling.

In engineering for the Smart Health future, Harvard sensor network lab have been developed one of the most popular health research projects which is known as Code Blue (Moosavi et al., 2015). Besides that there is there main Smart Healthcare technologies are widely being used in this field. Smart Card, Wireless Body Area Network (WBAN) and Radio Frequency Identification (RFID).

Smart card main benefits in healthcare are to reduce the paperwork and protect patient records. The smart card can hold encrypted patient information and use a digital signature or a biometric template to reduce ambiguity about the cardholder’s identity.
Besides that, by using smart card, the healthcare organization can also reduce the incidence of fraud in health. Many healthcare organization will choose smart card-based solutions because of their ability to support secure data handling and reduce fraud (Card, Healthcare, & Publication, 2007). The smart card also has the eligibility and coverage which can be updated automatically and virtually. This wills directly eliminating the administrative workload by updating employees’ booklets each month. Physicians also can have access to a patient’s entire health summary, the for health record and lab result requests by using the smart card. Furthermore electronic prescriptions can be stored directly on the card, eliminating paper transactions and the potential errors associated with them, as well as the potential for fraudulent prescriptions. The digital storage of information and automation of paper-based processes should result in cost savings and reduce the errors associated with manual data entry and handwritten documents.

Employers, health professionals, and insurance companies can update databases and smart cards automatically and regularly. Members can receive a smart card automatically through the network. During a patient visit, physicians or other providers can immediately view patient eligibility and coverage information and the patient’s primary care physician designation.

RFID is another main device used in the smart healthcare field. For the last few years, many new technologies have been rapid developed in application of RFID (Radio frequency identification) system (J. T. Kim, 2014). The rapid development and changes of information technology give an effect on the healthcare system and life style in the future. As information technologies are developed rapidly in a variety of application. Especially, existing e-healthcare system has been realized in wired communication with specialized area such as database and network protocol in hospital environment. The rapid changes of modern technologies usually provide new requirement, request and give a new chance to generate new market and industry. According to Mitrokotsa, Beye, & Peris-lopex (2009), the rapid developments in technology and semiconductor process made their cost to reduce sharply and new technologies to emerge. As a result of reduced cost of RFID, hardware became cheaper with more storage capacity and enhanced processing power. As stated by R.-H. Kim (2015), application of RFID enabled patient tracking within regional perspective of hospitals is major concerns because of its vulnerabilities and threats and it can be improved patient’s safety and nursing efficiency reduced manual handling error, monitor patient’s medical information, and process efficiency. Therefore, it decrease healthcare expenses but it leads to security problem because of limited resources in smart device. It also improves constraints and medical treatments by joining a living space and a medical treatment together. Wireless Body Area Network (WBAN) is another main entity which is being used in smart healthcare as a vital platform for pervasive computing and communication (Hassan et al., 2015). Nowadays WBAN are being widely used in healthcare organization bodies have become one of the most promising technologies for enabling health monitoring at home. As a subcategory of the general wireless sensor networks (WSNs), WBASNs facilitate the collection of vital signs in people with a health condition, and their subsequent transmissions to on or off-site locations for continuous monitoring (Gonzalez-Valenzuela, Chen, & Leung, 2011). Compared with traditional WLANs, WBANs enable wireless communications in or around a human body by means sophisticated pervasive wireless computing devices and compared to traditional healthcare systems, wearable healthcare systems are very cost effective (Vakil, 2005).

4.2 Limitation in Smart Health Care Devices

Even though there are many uncountable benefits by using Smart Card, Wireless Body Area Network (WBAN) and Radio Frequency Identification (RFID) there are still several limitation and risk by using this device. WBAN usage in the healthcare system has one of the emerging challenges which is caused by the mobility of the sensor nodes and their limited coverage area (J. T. Kim, 2014). Indoor communications are drastically reduced in terms of signal coverage area. To deal with this issue HWSNs should enclose multiple access points and support route variations in order to reach each sensor node. Besides that, WBAN also required a long life node of battery and in several hospital area this type of devices are strictly restricted.

RFID that has been used at hospitals are running by wireless communication systems. However, not many hospitals are aware of the security issues because their working process is mainly focused on emergency than security. Physical Data Modification is one of the main security threats by using RFID in hospital. In RFID systems physical data modification can be achieved either by fault induction or by memory writing (Mitrokotsa et al., 2009). Fault induction involves modifying data when it is being written or processed. Memory writing can be performed by using specialist equipment, such as laser cutting microscopes or small charged needle probes. Besides that, tag cloning is another threat in RFID. Replicating RFID tags has proven to be very easy, since it does not cost a lot of money nor requires a lot of expertise, while all the necessary equipment such as software and blank tags are freely available (Reid, 2016).

The limitation and risk by using smart card-based system is it does not automatically allow user mobility. User mobility is only possible if every machine that the user accesses have a smart card reader attached. According to Markantonakis, Mayes, Sauveron, & Askoxylakis (2008), the machine must support the same standard smart card reader interfaces or use the same proprietary smart card reader. Similarly, to use the same machine sequentially, multiple users must all use the same smart card
technology. Some smart card implementations have slower performance than software based tokens in current Pentium-based PCs, both during initial loading when a user logs on and during message signing and encryption. Because card implementations are relatively new, they are more buggy and rough around the edges than most other software.

5. CONCLUSION

This paper gives an overview and identifies smart healthcare technology as a critical enabling tool to help resolve some of the issues with which the healthcare community is grappling today. Besides that, this paper has discussed all the possible benefits and limitations of Smart Healthcare applications. Smart healthcare can help reduce the inefficiencies prevalent in healthcare, diminish the number and effect of medical errors attributable to a lack of critical medical information, and empower patients to take a more active role in managing and maintaining their medical records. Therefore, deeper analysis of the benefits and limitations, given the complexity of such a system, and the privacy and security concerns it raises, is required. However, a smart healthcare entity carrying critical patient medical must always support patient empowerment. The health organization must able to protect privacy while ensuring information access and security. The endless opportunities that smart technologies provide to the healthcare professionals are worthy of attention and consideration of every healthcare professional. This in turn will encourage an environment where the patient is empowered to take care of his/her own health and will even give the opportunity to the healthcare professional to make his/her work not only more efficient, but effective. In a nutshell, with proper management and research, implementation of such smart technologies together with the backing of cloud computing and healthcare IT professionals could improve healthcare settings in all parts of the world.

6. REFERENCE

Stefan Buttigieg, (n.d.). The Use of Smart Technology in Healthcare Settings. Malta Medical School, University of Malta, Malta.
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