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UNDERSTANDING THE ADOPTION AND IMPACT OF INFORMATION TECHNOLOGY ON HEALTHCARE: CASE STUDIES IN ELECTRONIC HEALTH RECORDS AND COMPUTERIZED DIAGNOSIS

Chaza Abdul
Harrisburg University of Science and Technology, United States
cabdul@harrisburgu.edu

Wenli Wang
Robert Morris University, United States
wangw@rmu.edu

Abstract:
Information Technology (IT) in the healthcare industry has improved healthcare efficiency and patient quality of care. This paper identifies two IT theories to explain IT adoption in healthcare: Diffusion of Innovations and Actor-Network theories. The focal technologies in discussion are electronic health records and computerized diagnosis. The research also identifies the impact of IT in healthcare in four dimensions: improved usability, accessibility, operational efficiency and stimulated economic development. It further illustrates the IT adoption and its impact with three case studies.

Keywords — Healthcare Information Technology, Electronic Medical Records, Computerized Diagnosis, Information Technology

1. INTRODUCTION

One of the primary aspects that determine the success of a business lies in the ability to adapt to and incorporate changes in their operations. Certainly, it is impossible to do business the same way it was done in the 19th century or even the 20th century. Consumer needs, institutional operations, industrial changes, market environments and regulations have kept changing, hence demands re-strategizing for business success very few months or years.

Information technology (IT) in general has led to evolutional changes in the business world. Business operations with proper IT implementations can now run more smoothly and efficiently. Zhang et al. (2010) provided examples how businesses implemented software packages to have faster and more cost-effective operations. Businesses are also benefiting from IT-enabled data management and analytics effort through better management via digitalization and forecasting via trends analysis. Technology is used for many reasons, among them, the creation of effectiveness and efficiency in different sectors. In most instances, IT has been described as the solution to efficiency, accuracy, and retention of data.

IT makes it possible for businesses to tailor their operations with the need and preferences of their clients. For instance, IT could increase customer satisfaction through fast delivery of goods and services. In healthcare, for instance, IT has resulted in reforms that have led to improved service delivery in the industry. It is possible for doctors and patients to exchange information without having to meet physically or threatening the security of the information (Yen & Bakken, 2011). As such, IT has significantly reduced the costs of operation and saved the time spent on paper work. Also, IT has increased the security of information as compared to manual storage procedures in which information can easily be accessed. Patients can receive their prescriptions remotely and doctors can check up on them without much overhead.

Importantly, application of IT in healthcare is critical to effective service delivery. In healthcare, technology is considered a solution to issues related to accuracy and cost-effectiveness. Among the most popular technologies in healthcare include the electronic health record and computerized diagnosis.

Electronic health records is a systematic approach through which the patients' information in a health center is computerized. Electronic health records are most used in hospitals. Despite the slow progress in the absorption of IT in healthcare, research demonstrates that the implementation of electronic healthcare is most prevalent. With the inclusion of hospital networks, patients' information is easily accessible from different points. The availability of health information hastes the delivery of services as well as the referrals of patients. Other importance noted in electronic health records includes the sharing of patients' history. The history would be effective in medical reconciliations, recommendations for further testing, change of medication and diagnosis.

Computerized diagnosis is a design through which artificial intelligence is incorporated in healthcare. Through the use of sensors and remote controls and application of artificial intelligence, a health practitioner can assess the health situation of a patient and recommend a course of action.

This paper identifies two theories in IT to explain the adoption of IT in healthcare and the impact. These two theories are diffusion of innovations and actor-network theories. The focal technologies in discussion are electronic health records and computerized diagnosis. The research also identifies the impact of IT in healthcare in four dimensions: usability, accessibility, improved operational efficiency and economic development.

2. IT APPLICAIOTNS IN HEALTHCARE – ELECTRONIC HEALTH RECORDS AND COMPUTERIZED DIAGNOSIS

This paper focuses on two main IT applications in healthcare: electronic health records and computerized diagnosis. Both applications improve services for the patients.

2.1. Electronic Health Records

Over the years, hospitals used manual records and manual identification of patients (Holmes et al., 2009). The process would take time leading unwanted delays before hospital admission. In some cases, patients succumbed as they waited in lengthy queues.

Electronic clinical documentation creates a faster environment through which diagnosis and recommendations for treatment are initiated. For instance, the use of electronic clinical documentation has been considered an effective strategy through which errors in diagnosis and allocation of medication are prevented or reconciled. It is also an effective way of minimizing redundant data in the health system.

The other benefits accruing in the use of electronic clinical data is the ability to track tests. In health services delivery, a series of tests are important as they create a systematic approach through which a patient should be treated. In the same understanding, patients' history is considered a part of the diagnosis. Therefore, electronic health records provide an extensive approach through which the associations between health practitioners and caregiver can access the relevant patient information as a way of improving its relation to patients' needs. The electronic system also contains sections providing for comments from important stakeholders such as caregivers and health practitioners. Other uses include the use of probabilities to estimate lifestyle conditions and illnesses that a patient could be suffering from.

2.2. Computerized Diagnosis

Electronic diagnosis is a remarkable process and innovation that enables health practitioners to assess the patient's health status without having to access those (Blumenthal & Tavenner, 2010). Importantly, the approach is considered important in areas with highly infectious diseases.

Electronic diagnosis could be used to protect health practitioners from contracting illnesses. Enhanced technology in healthcare has demonstrated a positive correlation with public health efficiency. Technology presents accurate data to health experts that help them ascertain the health needs of specific regions (Buntin et al., 2010). The information is also used to create accurate and strategic decisions towards improving the public health of the affected areas.

Computerized diagnosis goes one step further than simply applying electronic means for distant communication. Computerized diagnosis applies advanced algorithms in the process of illness diagnosis. As one of the most improved versions of the use of artificial intelligence in healthcare, computer-aided diagnosis includes the use of sensors as well as the medical interpretation of images. Other elements include the ultrasound and use of sensors to create a digital pathology evaluation. Specifically, the computer sensors are assessed to establish the different forms of correctness in body or physic-correctness.

3. IT THEORIES AND IT IN HEALTHCARE

3.1. Diffusion of innovations theory and IT in Healthcare

The diffusion of innovations theory evaluates the rate at which new ideas are spread. The theory describes the process of the innovation of technology in terms of the actualization stages (Kaminski, 2011). In align with the theory, IT in healthcare can be adopted at five stages namely: the innovation stage, the early adoption stage, the early majority, the late majority, as well as the stage of the laggards. The actualization of all the five stages would demonstrate a full-scale actualization of a specific technology.

The diffusion of innovation theory can be used to explain the relevance and speed of spread of an IT application. Firstly, innovation is considered as an element of IT that improves efficiency in the delivery of services. The roles of the adopters include the creation of usability guides and the actualization of the implementation plan (Lee et al., 2013). In the same way, the specific roles of each of the components is taken as a critical factor in the spread and effectiveness of technology in healthcare. The time taken in a

spread is measured as the unit of the effectiveness of the implementation process as well as the level of need in a health organization. The factors in the innovation diffusion theory explain the spread and effectiveness of IT in healthcare.

Different technology innovations in healthcare have been diffused at different rates. For instance, electronic health records seem to have the highest index of implementation. In this way, the implementation index is depicted by the fact that electronic healthcare records are more cost friendly in implementation (Rameshwara & Raghavendra, 2015). As a result, most health organizations, at least in the developed countries, have actualized the computerization process in electronic health records. In comparison, computerized diagnosis is a complicated process in IT (Lee et al., 2011). It requires extensive information on the use of artificial intelligence in healthcare. The implementation of the computerized diagnosis is, therefore, an expensive adventure making it difficult for most health organizations to implement. It has a lower rate of diffusion than that of the electronic health records.

3.2. Actor-Network theory and IT in Healthcare

However, one attribute is missing from the Diffusion of Innovations theory is the relationship between the implementation of IT and satisfying the needs of the healthcare industry to meet the goals of effective, efficient services, and improving operational outcomes. The Actor-Network theory explains that the existence of different things is founded by a systematic change and shifting of relationships. The connection between the Actor-Network theory and the application of IT in healthcare is focused on the different relationships that technologies pose to the efficiency needs in an organization. In the theory, actors are divided into two; human and the non-human actors. The theory operates under the different mediators and intermediary links. The mediators are crucial elements that relate the active elements in a model. Technology works in a similar symmetrical principle that includes intermediaries and mediators. Technology requires the integration of different stakeholders as the mediators in the actualization of operational efficiency.

The Actor-Network theory resembles the application of technology in healthcare. For instance, technology in healthcare requires the participation of all actors to enhance the rate of effectiveness. The actors act as the network's intermediaries as well as the main forces behind the actualization of the benefit maximization. In electronic health records, the actor-network theory demonstrates that the creation of technologies that merge and store health records would promote the connectivity of the network. In this way, health practitioners can access and use the health information from any point as long as the health facility's network is within coverage (Ratwani et al., 2015). The Actor-Network theory applies through the use of stakeholders as the system's network elements.

Moreover, IT in healthcare operates through the prospect of translations. Through the application of the sociology of translation, on factor in the theory leads to the other. As a result, full implementation of technology in healthcare is considered instrumental only in the instances that the actors demonstrate commitment in the implementation process. At this point, the theory indicates that though there are exclusive benefits in the actualization of technology, the implementation process is considered the most challenging and involving step. The use of quasi-objects creates a social order of rewards. Specifically, the implementation of the electronic health records and the computerized diagnosis result in rewards such as the improvements in agility and cost-effectiveness in healthcare.

4. THE IMPACT OF IT ON HEALTHCARE

IT in healthcare has resulted in significant changes in healthcare systems. It is now possible for patients and doctors to engage from all over the world and patient information is easily stored and retrieved. The following section is an overview of the specific impacts of IT on healthcare, based on the extensive literature studies and knowledge integration.

4.1. Improved Usability

IT in healthcare increases usability. This is attributed to the high-efficiency levels achieved. As compared to the manual systems, health information systems are easy to use, which makes it easy for health providers and patients. There are fewer cases of lost records with IT systems (Karsh et al., 2010). Also, usability is promoted as a service provider do not have to coordinate to provide the same service to the patient as all the services provided and medicines administers are recorded in the system. This reduced chances of repeat tests and services simply because the previous ones are irretrievable. Andel et al. (2012) also note that in the event that patient wants to transfer their services to another health center then they do not have to carry along heaps of manual records since the previous information is already recorded. Bacorro et al. (2018) also added that usability is enhanced in terms of information security. In manual records unlike in hospital information systems, it is difficult to protect patient's information from unauthorized parties. On the contrary, in information systems, information is only accessible to specific parties through the clearance levels.

4.2. Improved Accessibility

Health information systems that are technologically enabled enhance accessibility to the information and the health services in general. According to Gaucher and Greer (2018), IT makes it possible to access information about a patient, the services they need and the services available in a certain hospital. As such, patients do not have to travel through hospitals to look for services. At least the electronic information systems ensure that all this information is available. Gibbons et al. (2016) stipulate that with IT systems in hospitals loss of information can easily be accessed. All good systems have backup systems that restore lost information unlike in manual processes where lost information may never be recovered. To add to these stipulations, (Goldberg et al. 2011) argue that the accessibility of information cuts the expenses incurred when information is lost. Also, online platforms established with the development of IT systems make it possible for clients to reach out to service providers across the globe. Web-based diagnosis also allows patient to access services that are beyond their geographical locations. Finally, Lin et al. (2009) added that such accessibility allows for high quality and follow through.

4.3. Improved operational efficiency

IT improves the overall efficiency in healthcare systems. According to Middleton et al. (2013), IT allows for faster and more accurate prescriptions. With the availability of the E-prescribing systems, the prescription processes are automated, and prescriptions are sent to the pharmacy for the patients to pick them when they get there. Not only does this save time but also it reduces chances for errors. Also, McCullough et al. (2010) added that IT enhances efficiency through instant information sharing. In the event that a doctor adds patient information to the patient's Electronic Health Record system, the information is availed to other service providers who are authorized to access that information. This allows quality services since all the service providers have up-to-date information about the patient.

Additionally, some doctors allow their patients to access their information from the systems, and they do not have to wait for information and feedback from the doctors. Also, this information is stored permanently and can be retrieved at any time. Gyamfi (2016) added that in the face of IT, efficiency is enhanced through reduced paperwork. This way, patients do not have to provide the same information every time they visit a hospital or even spend time looking for lost records. Paperwork is not only disorganized, but it is also a waste of time and resources.

4.4. Stimulated Economic development

Application of IT promotes the economic growth of a country in diverse ways. In the healthcare sector, for instance, IT is responsible for job creation. Indeed, when hospitals incorporate IT in their operation, they require the expertise to run and manage the systems. As a result, a lot of job opportunities are created in the process, and the burden of unemployment reduced significantly. According to Haggstrom et al. (2011), the employment rate is one of the primary elements that measure economic development in any country. Computer programmers, software designers, and web developers are among the top jobs created through the application of IT in organizations. Also, health IT develops the economy in the sense that it is cost and time effective. In the face of IT, a lot of costs are spared as compared to manual processes. Firstly, physicians spend less time on retrieving and taking manual notes and more time is dedicated ion patient care.

Further, productivity in healthcare systems is enhanced by the use of IT. Information exchange between physicians is improved, and more is achieved in less time. In the same way, it becomes easy for healthcare systems to operate for more hours every day since doctors and patients can engage at any time of the day without any physical meetings. On this note, Goldzweig et al. (2009) found that with IT, hospitals are not limited to clients within their geographical locations. Rather, they can reach out to international clients, consequently increasing their revenue and eventually economic development. Also, Jensen et al. (2012) stipulated that IT in the health sector promotes business agility. In the presence of IT, businesses can predict and understand national and international business trends and act accordingly.

5. CASE STUDIES

The qualitative research used in the evaluation of technologies in healthcare involved case studies. Data was collected from reading the case studies and making informed characterization.
Firstly, the Electronic health record system in primary care practice in Cameroon. The case study was chosen as it evaluated the effectiveness of the use of electronic health records in Cameroon's primary health care. In the same understanding, the case study engaged the use of qualitative research though it borrowed slightly from quantitative research methods. In Cameroon, technological processes included; modeling patient-doctor encounter through the coding RFE. The coding is considerably useful in the creation of a central server through which all patients information and treatment history is created. The other justifications of the case study were the fact that it was located and implemented in developing countries. Research and evaluation of the case study demonstrated that automation of health services is slowly and extensively reaching the developing countries. Among the benefits noted in the Cameroonian hospitals was the improved quality of health services delivery.
Secondly, the computerized automatic diagnosis of innocent and pathologic murmurs in pediatrics. The second case study was a pilot evaluation of the implementation of computerized diagnosis as a way of detecting pathologic murmurs in pediatrics. Computerized diagnosis is a remarkable step in the use of IT and artificial intelligence in similar operations. The primary justification behind the selection of this case study was the fact that it explains a pilot case that was used to showcase artificial intelligence in diagnosis. The computerized diagnosis was also a success in the use of technology to study the heart structure and environs as well as the application of computerized algorithms. A combination of the insights obtained from the two case studies acted as the main prospects through which IT has solved health challenges.

5.1. Electronic health record system in primary care practice in Cameroon

The case study was derived from a process of implementation of electronic health records in Cameroonian primary care facility (Kamadjeu et al., 2005). Cameroon was chosen as a demonstration of the extent to which the elements of technology have been achieved in primary care. In this instance, electronic health records are implemented amidst the challenges of sourcing for data. Among the methodologies used in the case study is the electronic provider-patient interactions. The interactions involve a robust approach in sharing of information. The challenges in Cameroon characterize the inaccessibility of data and unreconciled medical plans. In this way, patients suffered wrong diagnosis and wrong prescriptions in different instances. The model demonstrates various advantages accruing from the creation of electronic

health services and data sourcing. Some of the noted advantages included; cost-effectiveness as well as a significant reduction of the burden from infectious diseases.

The most extensive technology used in Cameroon's primary care was the coding practice in the diagnosis process. In this way, patients' codes as identifications demonstrated the other instances that the persons had been treated and any prior recommendations that had been given. The conclusions and findings of the case study included; the implementation of EHR in primary care increased effectiveness in service delivery. The coding process improved agility and the ability of the healthcare institution to retain an extensive and accurate record of patients. The success of the case study is described by a productive relationship between the application of technology and efficiency in healthcare.

5.2. Computerized automatic diagnosis of innocent and pathologic murmurs in pediatrics

The case study is characterized by a demonstration of the use of computer-aided diagnosis in a pediatric case (Lai et al., 2016). Importantly, the case aimed at the evaluation of the applicability of computer diagnosis as a derivation of artificial intelligence in healthcare. In this way, specific value additions to medical practitioners are evaluated. Computer-guided diagnosis is an application of computer algorithms in the creation of accuracy and reliability of in-hospital diagnosis. The case study involved 106 patients in the pediatric ward. The patients created sufficient ground through which computer-aided diagnosis was assessed in terms of improving access to healthcare as well as the enhancement of personalization of patient data. Other equipment such as electronic microscope and acquisition of data from phonocardiograms depicted a high level of effectiveness in the use of technology.

The two case studies are guided by specific equipment in creating an enhanced service delivery system. Importantly, the specifications of the needs of patients through the use of technology has significantly improved primary healthcare and psychiatry. Additionally, the two case studies supported the research hypothesis that technology enhances agility, improves operational efficiency, facilitates access to healthcare and promotes cost-effectiveness. The application of the technology diffusion theory explains the extent to which the effectiveness of service delivery is actualized. The reduction of the cost of operation solves the challenge of the high cost of implementing technology in healthcare. Additionally, the effectiveness of technology is influenced by the extent of skills and expertise of the health services practitioners.

5.3. The use of machine learning to meet oncologists need in the U.S.

Machine learning use in healthcare is growing rapidly in diverse disciplines, especially oncology. Khan et al. (2017), found that machine learning and artificial intelligence (AI) have been adopted in oncology services as a tool for risk modeling (including determining the risk of developing a cancer, treatment complications, and even disease recurrence), improving diagnosis through advanced diagnostic technologies, radiation treatment using machine learning, improving psychosocial oncology, and predicting disease prognosis and response to therapies. By adopting AI and machine learning, oncologists today are more able to leverage their capabilities to improve patient services and apply more advanced method to predict disease for early medical management, and hence improve the outcomes of survival.

Therefore, this case resembles a good justification for the use of the Actor-Network theory which creates a bridge between the use of information technologies and the satisfaction of meeingt the healthcare environment needs. With AI being new in the healthcare arena, it is worth mentioning the need for qualified diagnosticians who understand well the applicability of AI in disease identification using creative methods to employ the IT and systems to improve preventive healthcare and disease control, as well as management.

6. CONCLUSION

The research demonstrates different approaches through which the medical society can cater to the needs of patients. Importantly, the study integrated the use of diffusion of innovation theory and the actor-network

theory to enhance the understanding of the application and usage of the different information technologies in healthcare. This research demonstrates a positive correlation between the use of technology and improvements in healthcare. Specific improvements have been noted in efficiency of operations, improvements in usability, improvement in economics and cost-effectiveness, enhanced agility and accessibility of services. There are different positive impacts of the use of technology in healthcare. The main positive result is the enhancement of technological healthcare is the improvement of patient care. Using theories related to technology enhances the understanding of technology application in industries such as healthcare.

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