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The Technology Factors as Barriers for Sustainable Health Information Systems (HIS) – A Review

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Abstract

Information system is widely adopted in many fields including healthcare. Healthcare organizations now consider increased efficiency, improved patient care, quality of services, and safety. Hence Health Information System (HIS) is basically introduced to transform the traditional way of data collection and organization in hospitals, to a modern way of systematic collection, maintaining and dissemination of data. Its implementation is to support medical practitioners and administrative staff in securing patients' health information in a digital-based record, to efficiently and effectively improve performance in the health system or any of its component parts. However, despite its numerous benefits, some of barriers still hinder its successful implementation and adoption, which needs to be addressed. This study discussed these barriers related to technology using the IS Success Model. This review paper becomes necessary in order to highlight the barriers that led to technical difficulties facing HIS implementation in hospitals, so as to suggest possible solutions that will improve services rendered in health industry based on findings.

Keywords: Technological Factor; Health Information System; Barriers; IS Success Model Benefits; Information Quality, Service Quality, System Quality

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1. Introduction

Today, the use of information systems provides a lot of opportunities through management of information in databases, providing computing and information to support the operations of many business fields, including the health industry. As a result, it is difficult nowadays to imagine a healthcare without an Information System, as health care all over the world is increasingly complexity [1], especially with handling of health information. Health information comprises of any medical or administrative related information that are recorded in any form, which is created or received by a health care provider, health care plan, public health authority etc.; or relates to the physical or mental health or condition of an individual, provision of health care to an individual, or payment for the provision of health care to an individual [2]. Hence, to handle these lots of information, an information system such as Health Information systems (HIS) is required to arrange these data, processes, and people. It is a system that captures, stores, manages or transmits health information of individuals or the activities of organizations that work within the health sector. It is also a mechanized document and information management system in hospitals [3].

2. The importance of health information systems (HIS)

HIS that are successfully developed and implemented can improve health care efficiency and effectiveness. For instance, a common deficiency in healthcare delivery services that happens in every hospital is struggling to reduce patient waiting time to receive treatment. Therefore, HIS is adopted in hospitals to improve the slow and inefficient services especially in retrieving patient's' medical information for internal circulation within the organization [4][5][6]. As a result, patients' wait time especially during registration is reduced with medical professionals as well as administrative workers to attending to patients within a short time. HIS is a system that required users to insert patients' information directly to the system then printout when necessary. This approach reduces medication error as well as incorrect prescription due to medical personnel's bad handwriting [7][8]. HIS plays a vital role in planning, initiating, organizing and controlling the operations of the subsystems of the hospital and thus provides a synergistic organization in the process, and improves patient care by accessing data and making recommendations for care and enables a hospital to move from retrospective to a concurrent review quality and appropriateness of care [9]. Aside from the system improving the quality of care, it also lightens the routine of medical practitioners while enhancing service productivity to provide fast treatment to those in need [10][11]. Adopting HIS makes work routine much easier as papers is replaced by a system. With this, difficulty in retrieving patient information is resolved. Medical personnel can access directly into the system to view patients' medical history then update their information [12][13].

Despite the fact that organizations are always looking for ICT in general or specifically Information System as an enabler for them to improve their services and products [14], studies reported that technological barriers still cause a major roadblock to HIS implementation and adoption. In a study by [15], results revealed that technological barriers cause obstacle in the implementation of a HIS in 16 European countries and 14 US states, which includes; ineffective design, data loss caused by different errors that the system may have and the usefulness of the IT, an issue that has a big impact on their willingness on the adoption of a new HIS. Slow system speed and unexpected system outages are commonly experienced concerns by health care providers attempting to implement these systems [16]. Further, in [17] also reported that technological barriers, such as; inadequate equipment, lack of internet access, are associated with meeting information needs.

3. Health information systems (HIS) in Malaysia

In Malaysia context, The Ministry of Health (MOH) stated that its vision is to lead the nation to work together for better health well-being, services, and infrastructure through technological advances. Hence, [18] confirmed that the government has implemented HIS across the country to maximize the use of technology to improve healthcare delivery. Studies have shown that public hospitals are adopting either one the three types of HIS; Total, Intermediate and Basic. The selection of this system is based on the total number of bed, including the components of Information System installed in the hospital. In THIS environment for instance, users completely use the system all through; they record information related to the patients in their computer [5]. While, in BHIS and IHIS, users will

use mix method of recording patients' information; computer-based along with paper-based [6][19]. According to [5], only 15.2 percent of these public hospitals implemented the systems through THIS, IHIS and BHIS. Meanwhile, [14] recently revealed that few other hospitals adopted different types of HIS applications, such as Patient Management System, Pharmacy Information System (PIS), Radiology Information System (RIS), Picture Archiving and Communication System (PACS) and Clinical Access Information System. However, despite HIS importance [18] study results revealed technological issues experienced by the medical team in adopting HIS in practice, in Malaysia. Their study explained that although generally, physicians believed that using HIS would bring many benefits over a paper-based method to the physician, most especially improved efficiency of the clinical process. But, if HIS is unstable and not user friendly, it will demand increased mental effort to operate and staff will likely feel negatively toward it. In addition, out of the four categories of challenges found from the analysis conducted by [14] at four hospitals in the Northern Region of Malaysia, technology issues were also highlighted. Here, issues like; compatibility, readiness, availability and network stability were pointed out by the respondents during the study data collection.

Therefore, this paper aimed to discuss these barriers related to technology by examining the influence of information system (IS) characteristics namely; system quality, information quality and service quality derived from the DeLeon and McLean in 1992 IS success model on HIS implementation and adoption. [20] for instance takes into consideration various dimensions including technological dimension, where three technological factors; system quality, information quality, and service quality were discussed. Hence, in an attempt to identify technical difficulties hindering hospitals from implementing HIS successfully, this paper adopts this success model.

4. Information systems success model

Amongst the IS models, Delone and McLean is a success model is one of the most widely cited [21][22], attempts to represent the interdependent, process nature of IS success constructs, shown in Fig. 1 below. This model measures the successful adoption of information system based on three criteria, namely; service quality, system quality, and information quality. Information quality is the desirable characteristics of the system outputs, as it relates to relevance, accuracy, conciseness, completeness, understandable, currency, timeliness, and usability. System quality describes the desirable characteristics of an information system, which includes ease of use, system flexibility, system reliability, and ease of learning, as well as system features of intuitiveness, sophistication, flexibility, and response time. Service quality encompasses the quality of the support that system users receive from the IS department and IT support personnel, in terms of responsiveness, accuracy, reliability, technical competence, and empathy of the personnel staff. However, [23] pointed out that an important antecedent factor that could determine IS success is technological factor. Hence, this study aims to investigate the influence of technological factors on IS success of HIS implementation in terms of information quality, system quality and service quality. Data collected from existing studies will be categorized into these groups.
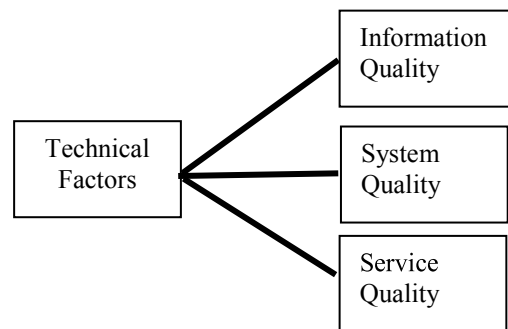

Fig. 1. Categories of technical factors based on McLean and DeLone model (D&M model)

5. Research methodology

This review paper briefly presents the barriers that led to technical difficulties facing HIS implementation in hospitals. To achieve this, searching of articles were narrowed down by using Electronic Journal databases to retrieve published articles and journals based on specific keywords. The authors applied terms such as "Health Information System", "Total Health Information System", "EHR", "EMR", "Information System", "challenges", "technical" and other similar terms to filter resources. To also get a comprehensive bibliography, a systematic search techniques was applied, using keywords, phrases, Boolean connector (AND, OR, NOT, etc.). Moreover, to ensure up to date and relevant information were gather, some inclusive criteria such as year of publication from the year 2010 and above, papers relate to technical factors, articles written by local and international scholars were also applied. Articles that refused to meet criteria such as not contained keyword, articles published before 2010, incomplete manuscripts, articles with incomplete information and articles written in language other than English were excluded from the review. Hence, based on the analysis and evaluations carried out on these articles reviewed, there are technological factors that affects successful implementation of information system in hospital. These factors will be categorized based on three criteria and then discussed in detail in the following section.

6. Health information systems technical challenges

In the past decade, there has been incredible activity and innovation in the development of health information systems, which is spurred in large part by technological developments, including the interest these developments have generated in the health sector. The progress has been made in designing systems that meet the needs of patients and health workers. However, their implementation is frequently affected by various challenges, which often end up with system failures. The paper tried to explain that the success of HIS can be evaluated in terms of information quality, system quality and service quality of the IS success model.

6.1. Technical difficulties on information quality

In context of this study, information quality focus on the information recorded and delivered in HIS. It is an essential aspect to maintain system integrity as it contains confidential information and set as the priority in the HIS implementation. It requires information accuracy, relevance and completeness since it ensures patients' health information is safely recorded and delivered. For instance, information determines the type of treatment to be given to a patient, wrongly provision of information will be harmful to patient. Moreover, data security concern also needs to be put into consideration. Hospitals demand a lot of information, especially on the patients' personal details which requires security consciousness. This personal information, includes; patients' medical history, drug allergy and other important information. As a result, HIS require secure environment since hospital deals with confidential information in order to maintain patients' privacy [24-28]. In addition, most professional jobs are using information system to manage data and information, thus the integrity of information recorded becomes key, especially the quality and the authenticity of the data [29][28][30][31]. Medical information is confidential; therefore, only trusted and authorized personnel are allowed to access and modify such the information.

Furthermore, another aspect to be considered is the end-user input. Medical report is required to be presented during patient-doctor consultation. This report displays different information based on patient's health status. As a result, it is important that the system provides ability to be customizable. This allows users or medical personnel to manually customize the input and output information [32]. To this effect, generation of reports can easily be done when users are able to customize the necessary information required to be displayed in the medical report. Although novice users will benefit from auto-generated report, however intermediate and advanced users will prefer if they can choose which information needs to be displayed. Table 1 below summarizes technical issue related to information quality.

Table 1. List of technical problems related to the quality of information in health information system

Information quality	Author(s)
Content complexity in the design	Karim, N. A.,& Ahmad, M. ,2010
Lack end-user input due (customization)	Cresswell, K. M., & Sheikh, A., 2015
Data security concern	Ahmadi, H.et al.,2015
Data quality and data authenticity	Alsaleh,I.S.,2015 Khalifa, M., & Alswailem, O., 2015

6.2. Technical difficulties on systems quality

System quality is another success factor to be considered. This becomes important as system quality can improve the efficiency of medical professionals in doing work routine. This can be determined by the effective use of the system and satisfaction of users. Thus, system quality for HIS is weighted on the user experience when using the system. The system interface, such as the menu features, colors, font etc. play a major role for a good impression towards the system. In addition, the system interaction with users mainly in work routine can indicate the successful usage in health environment. This means that the system must be free from errors, and must be able to perform any request and function in a short time. Hospitals normally consist of units, departments or management units that ensure the system is able to communicate or exchange information internally within the organization.

The system interface is another crucial aspect to be considered for user acceptance when implementing a system. HIS interface must be user friendly and also easy to read. Poor user interface and less user-friendly has been reported to have led to users' bad perception towards HIS [6][33][34]. Apart from the system interface, the system flow is another vital issue to be considered in order to avoid weirdness. HIS is meant to assist medical personnel, however due to poor system design, the workflow will be unpleasant, it will be additional time consuming for users working on the system [30][32][35][36]. Thus, the system functions need to be based on the work flow or developed according to the medical process. This issue can be resolved by understanding in depth all the process and procedures in the medical world. Different hospital might have different procedure. Thus, system developer is required to work closely with medical team in order to ensure the system is programmed according to their routine.

Another issue that is worth avoiding is lack of system integration. This result to passing round of patients' information (for medical purposes) from one unit to another, which is a common practice in hospitals. For instance, the traditional way of running activities in the hospital, where patient is required to bring a card for submission at the referral unit where necessary, is unprofessional as patient need to carry the card and manually put it in the box provided at the specific unit. Sometimes things go wrong, because patients misplace this card, which leads to delay in receiving treatment. In some other situation, medical staffs face difficulties receiving patients' information due to lack of information exchange feature and lack of system interoperability [13][32][37][38].

Table 2. List of technical problems related to the quality of system in health information system

System quality	Author(s)
Lack of system integration	Al-Gharbi, K., et al., 2015, Ayatollahi, H. et al., 2013
	Karim, N. A., & Ahmad, M. 2010
Poor interface and less user- friendly	Fadhil, N. F. M., et al., 2012
Time consuming especially for certain processes	Halas, G. et al.,2015
Poor usability, functionality and performance	Cresswell, K. M., & Sheikh, A. ,2015

Therefore, due to this few mentioned situations; HIS is adopted to solve the traditional practice of circulating patients' information and medical result by using system integration. The main benefit of this system integration is to ease information circulation within hospitals as well as waiting time for lab result for example, which can be reduced as the result direct accessibility in the system database using patients' unique identifier. Therefore, technical issues linked to the system quality are listed in Table 2.

6.3. Technical difficulties on service quality

System response time is essential to be discussed under system quality as this matter affects the time taken in serving the patient in a hospital [32][39][40][41]. HIS users are requested to use the system so as to reduce their work routine on manual or paper documentation. Systems with low response time caused longer waiting time for information to be retrieved, which is unacceptable to patients as they need fast treatment service [18]. Usually, most patient are intolerant with late service and freely blame the hospitals (especially hospitals' staff) if they are not being treated on time. Other than improving human factors in hospitals, the usage of Health Information System aimed to improve medical practitioners work routine by increasing availability and responsiveness of computer system. Due to these situations, HIS is required to support medical practice and medical workflow [12][42][43].

Using the system requires medical professionals to update patients' health progress on the spot during consultation hours for outpatients and round hours for inpatients. However, medical professionals and para-professionals feel inconvenient to bring along extra device for documentation purposes [13]. HIS difficulty happens in ward (inpatients) as nurses or doctors need to carry heavy device for updating patients' data especially at inappropriate places. Due to this situation, medical practitioners face difficulties to update patients' information on time. This has made some of them to continue practicing paper-based temporarily pending the time they update patients' information into the computer-based system. However, medical team ought to be provided with hand size mobile gadget to let them able to update patients' information when necessary [44][45]. Technical issues linked to the service quality are listed in Table 3.

Table 3. List of technical problems related to quality services in health information systems

Service quality	Author(s)
Long system response time	Cresswell, K. M., & Sheikh, A, 2015, Khalifa, M., & Alswailem, O., 2015
System orientation and system interaction	Alsaleh, I. S., 2015, Cresswell, K. M., & Sheikh, A., 2015
Inconvenience practice (bulky device)	Karim, N. A., & Ahmad, M., 2010
System does not support medical practices and workflow	Halas, G., et al., 2015, Karim, N. A., & Ahmad, M., 2010

7. Suggestion and recommendation to improve technical difficulty

Improving HIS performance is very crucial so as to ensure successful use of the system by the medical personnel. Some suggestions and recommendation has been introduced to resolve the technical difficulties linked to information quality, system quality and services in order to improve the system and the health sector. This is to encourage effective relationship between the technology and the users. A good system can improve users' computer self-efficacy which allows them to interact effectively with the system. The users will always be ready to use the system as they have total control towards the system [7]. Software and hardware usability can be improved by making the design as intuitive as possible [32]. A well function system also influences user satisfaction toward system adoption [32]. Good system design is the most important to ensure the system is functioning in completing the duties [33]. Successful system should also allow users to share plus exchange information between users in different units and even between different hospitals and countries [46].

Moreover, implementation of HIS requires support and effective strategies from the managerial level [30]. Top management plays a deep role in influencing users in adopting new system. The management are also responsible to provide adequate training to users in order for them to have necessary skills to run the system [47]. They strategies help in developing risk management strategies or predicting or forecasting potential risks, harm and vulnerabilities [30]. This strategy is important as it will help the project team to act and perform their duties efficiently. Therefore, the system must be able to perform task within short period of time compare to the paper-based system [32]. Furthermore, since HIS is implemented to convert medical staffs' job and daily routine to automation, it must be able to perform important medical task [46]. Apart from the system, the hospital infrastructure plays an important role in ensuring that the connection used within the premise is strong and secured so that the confidential information is safe from unauthorized access [48][49]. Information exchange among hospitals and clinics is also

possible in future if each premise having strong technology infrastructure. Table 4 summarizes some of the possible solutions to solve technical issues facing HIS.

Therefore, the explanations provided in this section can be used to improve the system, especially in the area of user interaction, adaptability and flexibility when using the system [32][50]. If improvement is possible, in future, HIS should be able to be expanded or to be upgraded when necessary [32][46]. This will result to new or improve technology, which should integrate relatively easily with existing systems. However, because of the efficient and effective system, the numbers of patients are likely to increase, while the ratio of medical staff per patients becomes low, the system should be able to work efficiently in order to serve people within a short period or time. Situation like this might require system with voice recognition function to be applied so as to improve time length for each treatment and to enhance information quality [31]. Though the idea is good, however the voice recognition must be able to detect information from multiple languages.

Table 4. List of possible solution to solve technical issue in health information system

Possible solution	Dimension improved	Author(s)
Improve computer self-efficacy	Service Quality	Erasmus, L., et al, 2015Radley, David C., et al.,2013
Monitor adverse effects on patient safety	Information Quality	Cresswell, K. M., & Sheikh, A. ,2015
Improve system design to be more user friendly	System Quality	Cresswell, K. M., & Sheikh, A. ,2015
		Khalifa, M., & Alswailem,O. , 2015
Improve system response time	System Quality	Cresswell, K. M., & Sheikh, A. ,2015
System need to be flexible to change and integrate with existing systems	System and Information Quality	Cresswell, K. M., & Sheikh, A. ,2015
		Hassibian, M. R., 2013
Require adequate and effective IT strategies	Service Quality	Alsaleh, I. S., 2015
Look for new methods to improve workload and enhance information quality	Service Quality	Khalifa, M., & Alswailem, O., 2015
System can generate a complete record, report and support related activities	Information Quality	Hassibian, M. R., 2013 Fadhil, N. F. M., et al., 2012
Make a secure intranet for information sharing	System Quality	Hassibian, M. R., 2013, Kushniruk, A., et al., 2010

8. Limitations and future research

This study increases the understanding of Health Information System implementation in the health sector. The paper is based on article findings, where the review provides an organizing model for current paper in order to group and discuss the data collected from existing studies. However, the ways in which Health Information System can be established deserves further investigation. Hence, future research needs more rigorous research into the barriers that led to technical difficulties facing HIS implementation in hospitals, by building on this work through collection real data from hospital workers.

9. Conclusion

In health domain, Health Information System (HIS) is adopted to assist medical personnel in delivering medical treatment to those who require medical attention. Technological issues need to be resolved faster in order to avoid work interruption within the organization. Technical difficulties may lead to major problem to organization if not being identified earlier. Maintenance required high financial support especially when the condition is very critical, however regular service is necessary to reduce the system failure. This paper shows that it is important to identify any technical difficulties as early as possible from the respective users whenever they use the system, where modification or maintenance can only be performed only if the problems are reported.

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