Hospital Information Systems Success: Towards an Evaluation Framework

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A R T I C L E   I N F O

A B S T R A C T

Background: the generic presumption related to the success of hospital information systems (HIS) has been debated by a few medical informatics experts. They have pointed out the extensive failure of HIS. **Objective:** this paper has attempted to develop an improved conceptual base to practically guide the evaluation of the success of hospital information systems. The evaluation of HIS is deemed vital to assure their successful implementation and beneficial effect on the delivery of healthcare; for that reason information systems evaluation theories were reviewed. **Results:** a novel framework has been introduced for the evaluation of hospital information systems. The proposed framework is based on previous IS evaluation models, specifically, the DeLone and McLean IS Success Model and Technology Acceptance Model, integrated with hospital culture dimension. The paper has discussed the proposed methodology based on the evaluation of the success of VistA HIS in Prince Hussein Hospital and Prince Hamza Hospital in the Jordan. **Conclusion:** the proposed framework can be potentially used as a tool to conduct better and comprehensive hospital information systems success evaluation.

INTRODUCTION

During the last decades a remarkable progress has been witnessed in medicine along with informatics (Haux *et al.*, 2002; Haux, 2006; Sultan *et al.*, 2014); mainly because of their impact towards the health care organizations and as well as the potential advancement of hospital information systems (Murphy and Neven, 2014; Sultan *et al.*, 2014). The development of health care has been significantly moulded by the usage of Hospital Information Systems (HIS). The term hospital information systems have been defined as a group of procedures, integrated to facilitate the enhancement of the productivity and usefulness of hospitals, to perform their functions and accomplishing goals. There are different ranges of HIS, from basic systems, including transaction processing systems, to sophisticated systems, like clinical decision support systems. Nevertheless, it is crucial to evaluate these systems to assure their successful implementation and as well as beneficial influence of HIS on delivery of healthcare. Assessment of HIS has been outlined as one of the most significant subjects of researches in Health Informatics (Haux, 2006). Evaluation of HIS has been defined as the process of gauging or discovering the characteristics of a HIS (in planning, development, implementation, or operation), the outcome of which conveys a choice to be made regarding that system in a certain perspective (Ball *et al.*, 2003; Janols *et al.*, 2014; Murphy and Neven, 2014).

As the process of decision making in designing, developing, purchasing or managing HIS needs evaluation, it becomes difficult task to undertake evaluation (Moehr, 2002; Janols *et al.*, 2014). Evaluation provides several benefits. Based on the unstable features of HIS generally, and the purpose of enhancing clinical performance and patient outcomes particularly, evaluation is carried out to recognize the performance of the system (Musen and Bemmel, 1999; Janols *et al.*, 2014). Nevertheless, the hospital culture of a good health service has been recognized as a substantial aspect for successful application of HIS. On the other hand, there is a lack of studies in terms of identifying the association between sub-cultures and the adoption of HIS (Callen *et al.*, 2007a; Andersen, 2008). Basically, assessment of hospital informatics systems has the prospective to enhance the excellence of health care and its expenditures, and to identify the HIS effectiveness (Musen and Bemmel, 1999; Kuhn and Giuse, 2001; Murphy and Neven, 2014; Sultan *et al.*, 2014). However, some researchers and practitioners question the effectiveness of this contribution owing to the well-publicized failure of numerous IS

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initiatives (Storey and Barnett, 2000; Laudon *et al*., 2006). On the other hand demand for useful measures for assessing the overall benefits of IS investments has long been acknowledged (DeLone and McLean, 1992). There is no accepted or more generic framework features the important aspects of effective HIS in a way to assist the success of such information system in health care sector. The solitary option obtainable is, employing the well-known IS success theories and models, by which the success of HIS could be effectively evaluated.

Based on the above discussion, this research has been proposed and will be conducted. Additionally, it is evident that, regardless of the rapid popularity of HIS over health organizations, even now the health IS literature has primarily concentrated on basic theoretical concepts or case studies of Hospital IS projects (Yusof *et al*., 2006). This has motivated us to focus on developing a legitimate measurement model considering the cultural elements to evaluate HIS success and recommend approaches to enhance its application in health care sector, particularly in Hospitals. The study has aimed at developing a multi-dimensional HIS success model depending on the IS success theories: the technology acceptance model (TAM) (Davis *et al*., 1989) and DeLone and McLean information systems success model (DeLone and McLean, 1992; DeLone and McLean, 2003). This study has argued that, employing user satisfaction as alternate indicator for gauging the success of HIS has some conceptual challenges. Likewise, only employing TAM might not be adequate to understand the complete meaning of effectiveness or the success of HIS. Furthermore, this study has presumed that success of HIS is mutually determined by function of system and features of information by means of the hospital culture. This study has suggested that, integration of these powerful theories (the technology acceptance literature and the parallel user satisfaction stream) are not competitive strategies to comprehend the application and importance of information technology (IT), which means that, user satisfaction and TAM signify supporting steps in a causal chain from key features of system design, to beliefs and expectations about consequences, which eventually ascertain the success of HIS.

The Theoretical Foundations Of Hospital Information Systems Success Model:

Our literature review has revealed that, no study has precisely aimed at extensively analysing the success of HIS considering the cultural elements. Attention in HIS success is not new; however, evaluation of the minimal past literature indicates that, it falls into one of two research gaps. The first research gap is related to generalisability; where, some research are extremely precise; concentrating on a individual case study of success, where it is difficult to rightfully generalize the findings (G. Southon *et al*., 1999; van't Riet *et al*., 2001). Whereas, other studies are extremely general, offering general suggestions, which is expected to apply in all conditions (Lorenzi and Riley, 2003; Janols *et al*., 2014). In both cases, the studies have failed to identify the situation-specific elements, which identify success and failure for every single HIS (Collins, 2000). The second research gap is associated with conceptualisation. Few HIS studies offer a helpful practical approach, however, they lack clear theoretical model as a basis (Lorenzi *et al*., 2004; Sultan *et al*., 2014). In contrast, few other studies have provided robust theoretical foundations, but they have offered minimal practical guidance (Bloomfield, 1991; Yusof *et al*., 2008).

Depending on the above research gaps, this study has examined a number of models, verified and proposed in many studies, for evaluating the use and success of IS. In an effort to develop a reliable foundation, this research has proposed a model by integrating three significant IS success models: (a) the technology acceptance model (TAM) (Davis *et al*., 1989); (b) DeLone and McLean information success model (DeLone and McLean, 1992; DeLone and McLean, 2003); and (c) hospital culture (Hignett, 2001; Callen *et al*., 2007b). For acquiring a greater comprehension of the overall HIS phenomena in health care services, the conceptual model has been further reviewed in the following sections (see fig.1)
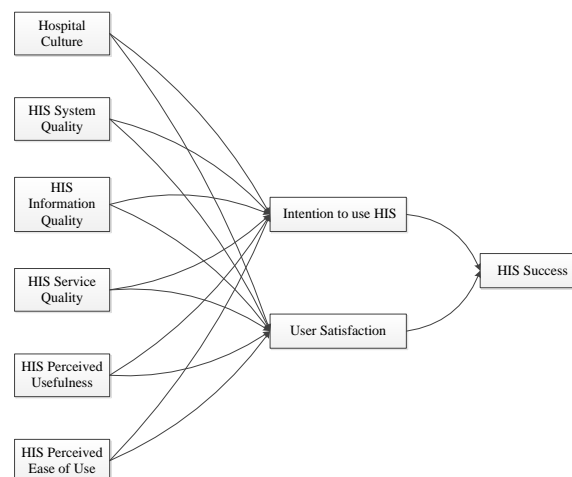
Fig. 1: The Conceptual HIS Success Model.

This study has created the 'HIS Success' as a new factor comprising the use and benefits of the HIS as an ultimate outcome of the system. In the proposed model, the factors consisting of hospital culture, system quality, information quality, service quality, perceived usefulness, and perceived ease of use are considered as potential determinants of health care practitioners' intention to use and user satisfaction. The 'HIS Success' factor has been potentially determined by intention of healthcare practitioners to use and their satisfaction.

Technology Acceptance Model:

The technology acceptance model (TAM) was developed by Davis *et al.* (1989) to predict and explain information technology acceptance and usage (Davis, 1989; Davis *et al.*, 1989). This model of IS success relies on theory of reasoned action (TRA) which was developed by Fishbein and Ajzen (1975). In order to specify the causal relationships between system design features, Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), Attitude toward using (A), Behavioural Intentions (BI), and actual system use (Davis *et al.*, 1989). PU is defined as "the degree to which person believes that using a particular system would enhance his or her job performance". While, PEOU is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989 p.320). Davis's model shows how the actual system use is determined by BI to use the technology, which is predicted by attitude toward using the system. Whereby, attitude refer to "an individual's positive or negative feelings (evaluative affect) about performing the target behaviour' (Fishbein and Ajzen, 1975 p.216). As well as both PU and PEOU predict attitude toward using the system. Additionally, behavioural intention to use the technology is also affected by PU directly.

TAM has been considered as valid model in predicting the individual's acceptance of information technologies applications (Davis, 1989; Davis *et al.*, 1989; Adams *et al.*, 1992). Most recently TAM has been applied to examine the use of web information systems (Gefen and Straub, 2000; Chen and Tan, 2004). Whereby, central to the success of IS is the fact that the IS has to be installed, utilized, and accepted (Tung and Rieck, 2005).

In health care, TAM has been need in studies concerning factors that affect systems and applications acceptance, such as mobile healthcare systems (Wu *et al.*, 2007), and healthcare informatics (Ward, 2013). In other words, TAM represent complementary steps in a causal chain from key characteristics of health care systems design, to beliefs and expectations about outcomes that ultimately determine usage.

DeLone And McLean Information Systems Success Model:

Since the DeLone and McLean IS success model is published in 1992, nearly 300 articles have used or have referred to the model in refereed journals. The main purpose of the model is to synthesize IS success into more coherent body of knowledge and to provide guidance to future researchers. Thus, to create a comprehensive taxonomy model which consist of six interrelated dimensions for evaluating IS success (DeLone and McLean, 1992; DeLone and McLean, 2003). These interrelated dimensions of IS success and their associations are System Quality and Information Quality which affect Use, and User Satisfaction have an influence on Individual Impact which in turn affects Organizational Impact. Whereby, System Quality defined as a measure of the information system processing itself (DeLone and McLean, 1992). Information Quality defined as "measures of the information system output" (DeLone and McLean, 1992). Use is defined as the utilization of an IT application by individuals, groups or organizations (Kim and Malhotra, 2005). User Satisfaction defined as "the net feeling of pleasure or displeasure that results from aggregating all the benefits that a person hopes to receive from interaction with the information system" (Seddon and Kiew, 1996 p. 95). Individual Impact refers to the effects of the outputs of IS systems on users' behaviour. Organizational Impact refers to the effects of the system's output on the organization.

Ten years later, in the updated version of the model, service quality dimension was added as an antecedent of use and user satisfaction (DeLone and McLean, 2003). The individual impact and organizational impact were reconstructed as net benefits. Similarly, in the proposed Integrated HIS Success Model, service quality is added as an antecedent of use and user satisfaction whereby 'service quality' refers to "the overall support delivered by the service provider" (DeLone and McLean, 2003).

Hospital Culture:

Hospitals are classified by a different combination of professional and non-professional staff, who might only share the organizational aims, such as, improving the patients' health (Acar and Acar, 2014). According to Klein (1982), the aspects that influence the environment of the healthcare sector are: heterogeneity in the range of services offered and the IT employed; occupational challenges and interlinking; lack of evidence in the association in terms of the input of health care and output of improved health; prominence of provider ; and unclear objectives. Therefore, the healthcare industries do not just respond to demands of consumers, rather they also create them through the clinical decisions and recommendations of the professional providers about what consumers ought to have (Hignett, 2001).

The principle of organisational culture mainly incorporate the norms, patterns of action, beliefs, and values, which establish social relationships and are replicated in the organisational processes and structures (Ranade and Varnam, 1998; Mullins, 2007). It is noteworthy that, unlike other industries, the diffusion of information and communication technologies in the health industry has been slow, particularly in hospital information systems (Ash and Bates, 2005). The organisational culture of a health facility has been identified as a significant factor for successful implementation of such information systems (Gosling *et al.*, 2003; Aarts *et al.*, 2004; Callen *et al.*, 2007b). Hospital cultures are sophisticated, where individuals with generally multiple cultural features operate concurrently. Sub-cultures rooted in health care organizations might depend on differences based on work, expertise, gender, race or functions, which might replicate or distinguish from organisational culture and can bring their beliefs and values from external entities, for example, medical sub-specialty professional groups and colleagues (Davies, 2002; Scott *et al.*, 2003; Braithwaite, 2006). Despite the evident increase in the value of HIS, still there is a lack of studies measuring hospital sub-cultures and links this to the mandatory use of a HIS.

Research Methodology:

This study has used a subjectivist case study strategy with qualitative methods as research methodology. A formative assessment will be performed on the adoption of a VistA as a HIS project in a hospitals of the Ministry of Health in the Hashemite Kingdom of Jordan, as a result of its relative significance in the patient care and general health care delivery (VistA, 2014). A subjectivist approach will be used in an effort to extensively understand the healthcare context, encompassing the VistA by means of comprehensive, useful description of the study (Faughnan, 1997). Both, qualitative and quantitative approaches will be applied to fully describe the healthcare settings and their cultural challenges, and to comprehend the failure or success of systems in a specific setting. Furthermore, a comprehensive case study will be carried out to get an extensive view and comprehension of the VistA development process. A variety of data collection techniques will be employed, which includes interviews, observation and survey questionnaire. However, this research approach to VistA evaluation comprises of six phases, which are: identification of problems, development of evaluation model, identification of research technique and methods, evaluation of the system, share of results and improvement of evaluation model (Faughnan, 1997). The first three phases have already been accomplished. Identification of problems have been achieved via a literature review and also observations made during immersion. An immersion was performed to establish the general perspective of the research as well as to determine the link with relevant stakeholders. Preliminary data collection was completed during immersion. An initial evaluation framework was created according to the conclusions of the first phase. This framework will be employed as a guideline for evaluating VistA. The research strategy and methods were selected depending on the research problem.

During the evaluation phase, the proposed evaluation model would be evaluated using the case study of VistA in Jordanian hospitals. However, a pilot study will be performed before to the actual case study, with regards to improve the planning, tracking and assessment process of the research. Observations of respondents with regards to day-to-day clinical functions and meetings would be held at various units and departments. In the course of observations and interviews, patients will be asked about their understanding about the system.

Following the interview, questionnaire would be developed for the several constructs (see fig 1). So as to test the validity of the questionnaire, a pilot study would be conducted with the users of VistA in Jordanian hospitals (Prince Hussein Hospital and Prince Hamza Hospital). The development of final research instruments would be made after the evaluation of the pilot study. The survey would be conducted by the researchers, and the data would be analysed through Statistical Package for Social Science (SPSS) to determine descriptive statistics analysis for expressing the distribution of responses; and factor analysis will be done to examine validity of concepts and variables and to examine reliability of the instrument. Following that, the model would be evaluated by structural equation modelling (SEM) to analyse the strength and direction of the relationship among the variables; path analysis will be carried out to analyse the strength of associations amongst the variables in the study. Outcomes of the survey and interview would be compared with earlier findings, and if essential new factors would be developed depending on the analysis.

VISTA In Jordan:

Similar to most other countries in the world, health system in Jordan has been experiencing substantial demand with regards to enhancing health quality, accessibility and results, while attempting to minimize costs (Murphy and Neven, 2014). Certain priorities in Jordan involve, enhancing patient safety and medication management, along with minimizing waste in areas such as imaging and laboratory tests. The Jordanian government in January 2009 has made a strategic decision to deal with the challenges related to health services quality and cost by making an investment in an efficient and cost-effective e-health system. This initiative happened during a period, when increasing proof from the developed world has been demonstrating that,

traditional e-health approaches were significantly expensive and was unable to offer the full potential benefits of this technology (VistA, 2014).

Most recently, Jordan has made a decision to implement an electronic health record (EHR) system known as VistA, which is an open-source electronic health record system, developed by doctors working for the U.S. Department. The VistA system has been attributed with the exceptional shift of the US Veterans Administration (VA) health care system in the 1990s.

Apart from providing substantial quality and evidence-based healthcare, the national network will allow smooth and extensive care of patients, because the EHR will integrate prevention of disease and training in a patient-centric model of healthcare. The information from the VA indicates that, this will lead to a healthier population and produce significant extended cost savings in health care for the country. VistA comprises fundamental operating system, connected databases, and a number of completely-integrated end-user interfaces, including: (i) patient administration system; (ii) comprehensive health record; (iii) pathology and radiology systems; (iv) electronic prescribing and pharmacy; (v) nursing record; (vi) social care record; and (vii) reporting, dashboards and analysis.

In the course of the first year, a nationwide "gold version" of the VistA was developed, and was examined as a "proof of concept". In 18 months, adequate knowledge transfer and potential building had been accomplished to enable the Jordanian professionals to become 95% self-dependent in assisting their version of VistA (WorldVistA EHR). Two sample sites were then selected, which are a general hospital and a comprehensive community health clinic. These sites effectively gone live at the end of October 2011, and King Abdullah has given the green signal for a launch of the WorldVistA EHR across the whole of the rest of the public health system in Jordan.

The Ministry of Health has planned that, in the near future, the entire of Jordan will share a comprehensive, single, national electronic health care delivery network, to protect the nation's 6 million citizens. This will offer instant and comprehensive accessibility to healthcare information about any patient, who offer authorization to all clinicians at the point of care at all healthcare sites within the country. This scenario demonstrates the immediate requirement for assessing such HIS projects. The studies related to HIS lack knowledge on factors, which impact the success of these initiatives, in present of the sub-cultures of hospitals. Consequently, determining the success factors of HIS may offer a foundation for hospitals, and to induce decision makers in Jordanian healthcare sector, to adopt or change such Health IS projects.

Conclusion:

Even though the evaluation as a topic provides an extraordinary important challenge within the HIS literature in terms of information systems literature, still there is a lack of evaluative case study data, from which, one could recognize the success elements (Yusof *et al*., 2006; Janols *et al*., 2014). The majority of the existing literature pertains only to pilot projects and temporary results, and in several instances the application efficacy was being considered instead of its effectiveness (Anderson, 1997).

This paper has recognized the issues, examined the present approaches and proposed a new model for HIS evaluation. In terms of generating a comprehensive method to evaluate HIS, several validated theories for IS evaluation in Health Informatics and IS literature were analysed. The results of the review have indicated that, it is significant to enhance the existing approaches in HIS evaluation. The advantages and constraints of these models had been reviewed and been employed as a foundation for the new proposed model. Besides the literature review, this model has been developed based on the DeLone and McLean IS success model and technology acceptance model. The proposed HIS success model covers the necessary components of IS, such as human, technical, and organizational culture factors. For the purpose of validating its effectiveness, it is essential to test this model in clinical settings. Results of the tests might be used for further enhancement of this model. In addition, the most significant dimensions and measures might also be emphasized and discussed in detail. This paper is deemed to contribute towards different evaluation studies in both, Health Informatics and IS literature together, for offering a complete picture of research needs of HIS evaluation. The present study had analysed several existing frameworks and models of evaluation in HIS and general IS. The paper had also exhibited the usefulness of IS models in HIS evaluation. Even though it is focused on a particular setting, the evaluation framework of this study will possibly be beneficial for researchers and practitioners to carry out a superior and extensive evaluation on other HIS or IT applications in healthcare settings. Subsequently, suggest ways to improve the usage, operation, and enhance decision-making on investment in WorldVistA and such HIS projects.

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