

Exploring the Impact of Electronic Health on Total Quality Management in Jordanian Hospitals: The Mediating Role of Knowledge Management Technology

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ABSTRACT

The aim of this study is to measure the impact of electronic-health (e-health) on total quality management (TQM) through knowledge management (KM) technology as a mediating variable at the hospitals of Irbid Governorate in Jordan. Six elements of the e-health variable were considered, including e-health records, e-data transmission, e-medical prescriptions, video consultations, medical image sharing, and continuous medical learning. A questionnaire was designed and distributed to a sample of 600 individuals working at 15 different hospitals that apply an e-health system in the Irbid Governorate in Jordan; 566 questionnaires were deemed valid for statistical analysis. The results of this study show that there is a statistically significant impact of e-health on TQM, at level $P \leq 0.05$, through the mediating role of KM technology at Irbid Governorate hospitals in Jordan. Although the data were collected from hospitals at the Irbid Governorate in Jordan only, it is hoped the results will have some validity for the rest of hospitals in the Jordanian health system. The most significant recommendation of the study with practical implication is to set TQM as an administrative approach at the hospitals of the governorate of Irbid in Jordan, and require the adoption and implementation of an e-health system as a requirement for all Jordanian hospitals to acquire local accreditation certificate with the overall goal of improving the quality of healthcare.

Keywords: E-health, Knowledge management technology, Total quality management

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INTRODUCTION

The accelerating digital revolution of the past several decades has resulted in the emergence of large economic and health entities, with many organizations seeking success and competitive advantage through increasingly relying on many types of information technology (IT) in their new customer centered business models, and pursuing quality as a basic requirement at all levels of the organization. The growing focus on the quality of the healthcare service figures prominently for decision makers and leaders of the health industry, who are tasked with realizing the potential of e-health to transform the industry and the practice of the medical profession through the adoption of virtual and digital technologies in the diagnosis and treatment of diseases and the processing and management of health records and data.

It is well known that the use of traditional paper forms to process large numbers of documents arising in health services, such as patient records, prescriptions, health insurance compensations and complaints make it difficult to publish, organize, and retrieve data.^[1] Therefore, IT professionals are switching to systems for electronic data exchange as technical tools along with advanced e-health devices.^[2] The health sector in Jordan is a most vital sector due to its direct impact on the economy and the welfare of the general populace and adopting technology solutions will minimize the business costs and maintain competitiveness.^[3]

Problem Statement

The rapid technological development that the world has been witnessing, especially in the field of IT, has pushed health-care organizations to modify their business models and incorporate the novel emerging solutions into their health-care services, to move towards the customer, and to adapt their medical practices to better manage the complexities of the health services. Hence, it

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was necessary for healthcare organizations in Jordan to make some radical changes through the design of e-health services in a way that contributes to enhancing the total quality management (TQM).

The focus of this study is on TQM at Irbid Governorate hospitals and the roles that e-health and knowledge management (KM) technology can play in attaining TQM.

The study problem can be summed up as an attempt to answer the following question: What is the impact of e-health (represented by e-health records, e-data transmission, e-medical prescriptions, video consultations, medical image sharing, and continuous medical learning) on TQM through KM technology as a mediating variable?

Research Hypotheses

The main hypothesis of this work is:

There is a statistically significant effect ($P \leq 0.05$) of e-health on TQM through KM technology as a mediating variable in Irbid

Governorate hospitals. The Six sub-hypotheses H1-1 through H1-6, respectively, state that there is a statistically significant effect ($P \leq 0.05$) on TQM through KM technology of e-health records, e-data transmission, video consultations, e-medical prescriptions, medical image sharing, and continuous medical learning.

Research Model

On surveying relevant published literature, we adopted the research model shown in Figure 1.^[4-12]

Literature Review

Electronic health

Mitchell^[13] states that he first heard the term e-health in 1999 at the 7th International Telemedicine Conference in London. E-health is the most promising tool for improving TQM, safety, and efficiency of the healthcare delivery system, which is most responsive and patient-centered, by helping clinicians diagnose problems faster.^[14]

Management experts see healthcare in an integrated manner, as a continuum of multiple and disparate processes and thus have a deep understanding of the problems associated with service delivery processes.^[15] Among the dimensions of e-health are:

Electronic health record

E-health record is the backbone of all e-health projects. It ranges from simple storage devices to devices with varying degrees of added functionality, which are active knowledge systems that use individual patient data to generate specific case consultations.^[16]

Electronic medical prescriptions

Here, prescription provision is based on the integration of available information with the e-health record. The prescription is entered by the doctor into the patient's medical file and then transmitted electronically to the pharmacy.^[17] The development of e-prescriptions contributed to the reduction of medical errors compared to the paper-based systems, which were estimated in the millions annually worldwide, and to improving prescribing processes and reducing the duplication of drug dispensing.^[18]

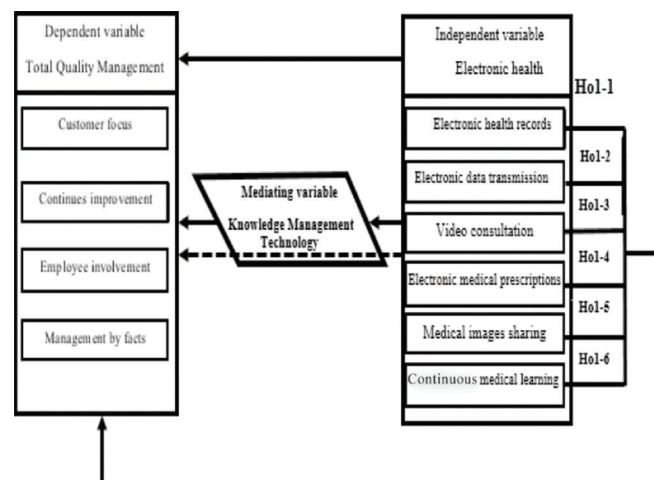


Figure 1: Research model

Medical images sharing

Sharing electronic images (such as radiographs) from one geographic location to another reshapes medical practice by eliminating the need for an image specialist (such as a radiologist) to be at the site. This made it possible to provide standardized services in translating multiple images and to improve the accuracy of diagnostic reports by subspecialists in comparison with general reports.^[19] E-health has contributed to improving the quality of high-resolution digital reports from remote communication with experts in other sites, by providing electronic access for authorized users to images and medical reports to provide consultations.^[20]

Video consultations

Video consultations allow physicians to interact with patients or colleagues and diagnose patients and advise treatment remotely.^[21] Furthermore, given the improvement in economies of scale, telemedicine consultations can now be performed through smartphone.^[22]

Electronic data transmission

Electronic health record systems contain some features that enable interoperability and electronic transfer of data and can support secondary uses such as quality management, result reporting, and public health disease reporting.^[23] This technology has helped in providing more value-added possibilities.^[24]

Continuous medical learning

The emergent powerful information and communication technologies that enable effective communication of large amounts of high-quality information and data have become strategic components in health education and its delivery.^[25] In addition, continuous medical learning, through the process of reviewing the feedback of medical specialists, contributed to the enrichment of the accumulated knowledge, which increased interest in e-health.^[26]

TQM

The philosophy of TQM refers to a set of ideas directed to improving the quality of products or services delivered by an organization, and it is based on the principle that every employee must commit to maintaining high standards of work in every aspect of the organization's operations.^[27]

TQM in the healthcare sector

Healthcare includes services that focus on protecting and improving physical, mental, and social health, in addition to ensuring continuity in fulfilling healthcare responsibilities to enhance the well-being and happiness of the community.^[28] The principles of TQM are interconnected in such a way that the successful application of one enhances the application of the rest.

Among the most important dimensions of TQM are the following:

Customer focus

Two types of health-care models are adopted in hospitals: The disease care model and the patient care model. In the first, the

physician is the center of the system and he decides the treatment method for his patient based on his clinical experience and the results of medical examinations. In the second, the patient is the focus of the system through his participation in the process of deciding the medical treatment to be provided to him based on his needs and preferences.^[29] Hence, the idea of shifting towards client-led organizations, where the organization focuses on meeting the expectations of its customers.^[30]

Continuous improvement

Achieving high quality as a continuous process is the basis for the birth of the philosophy of total quality, and the concept of quality has become a vital component that includes many organizational activities related to management, evaluation and measurement, accreditation, and certification.^[31] Continuous improvement focuses on deconstructing the organization's system into processes and then deconstructing those processes into inputs. An integrated system is required to enhance communication between the departments of the organization that allows the continuous exchange of information and evaluation of the performance and quality of service.^[32]

Employee involvement

Achieving a high level of employee involvement is a strategic goal of a growing number of service organizations, including health-care organizations. The principle of participation, when properly implemented, is expected to result in greater commitment and satisfaction among employees and a desire to make an additional effort to achieve the goals of the organization.^[33]

Management by facts

The concept of management by facts, or what is called evidence-based management, came about as a result of the development of a new approach in a medical practice known as Evidence-Based Medicine to emphasize the use of the best evidence from well-designed research in decision-making related to the health-care provided.^[34]

KM technology

The idea of KM is based on the idea that the most important resource in any organization is the knowledge possessed by the members of the organization. In evidence-based healthcare, health-care organizations need to support patient health decisions through business intelligence, which is a wide range of technology and decision support tools, some of which target specific audiences of users.^[35]

Previous studies

Askedal^[36] studied the benefits management challenges facing the application of the benefits of e-health technologies in health-care organizations, such as not conforming to the standards of patients included in the telemedicine innovation project, organizational cultures, resilience to change, and technological diversity of systems and the different management approach used among them. Sanyal *et al.*^[37] discuss the urgent need to conduct economic assessments on the use of IT in healthcare and showed that most

of the studies have proven the efficiency and cost-effectiveness, which is considered as a return of e-health interventions.

On the other hand, Halis *et al.*^[38] searched the implementation of TQM on the health services sector at five hospitals in Libya and found that the implementation programs of TQM have serious shortcomings, as 96.23% of the study participants confirmed the absence of specialists in TQM. While the study by Alghamdi *et al.*^[32] shown that the quality of e-health records helps health care providers to offer more efficient care, reduces the time in providing treatment to patients and helps in the documentation. In addition, Mohammadi and Najafi^[39] found a positive impact of customer focus on possessing, sharing, and applying knowledge. While Al-Sohaim *et al.*^[40] investigated whether TQM is a knowledge-enabler tool, and concluded that knowledge and continuous learning are essential components of the TQM infrastructure. Long *et al.*^[41] pointed out the importance of KM practices in the successful implementation of TQM and that knowledge transfer guarantees continuous improvement in TQM. Furthermore, the study of Kraan *et al.*^[42] in the Netherlands investigated the extent of patients' participation in areas related to their safety and indicated that there is a desire for patients to directly access their complete medical records. The study by Tapan *et al.*^[43] identifies the factors related to the opinions of a group of healthcare professionals about TQM in four Turkish cities. The results showed that nearly 70% of the study participants had received training on TQM, while 67.3% approved TQM, and 53.3% of health organizations employees obtained quality certificates.

And the study by Nassar *et al.*^[44] in Prince Hamzah Hospital, showed that learning, growth, order, and quality of information are the basis for linking cause and effect, thus reducing the cost of reaching employees and patients satisfaction.

Budrionis *et al.*^[45] and Furmankiewicz *et al.*^[12] describe the developments of artificial intelligence systems in e-health. The study by Janssen *et al.*^[46] in the Netherlands also discussed the success of entrepreneurship in e-health and concluded that the main driver of innovation was the context in which e-health standards were applied. Lewis *et al.*^[47] conducted a study on^[16] developing countries on how to use information and communication technology in programs that seek to improve health financing for the private sector.

The current study is novel in that it collected three important factors together: e-health, TQM, and KMT.

METHODOLOGY

Type of Study

The current study is explanatory in terms of purpose, aiming to uncover a cause-and-effect type of relation. It is also deductive in nature, aiming to test hypotheses derived from a careful survey of the literature and previous studies. It relied on the sampling strategy to collect primary data.

Study Population

The study population consisted of the 17 hospitals in the Irbid governorate, which included governmental hospitals, university hospitals, the royal medical services, and the private hospitals. Hospitals that implement e-health were chosen, and Abu Obeida Hospital and Moath bin Jabal Hospital were excluded because they do not apply any form of e-health.

Unit Analysis and Study Sample

The analysis unit consisted of medical personnel, including doctors, nurses, pharmacists, administrators, and technicians, in the hospitals of Irbid governorate, whose number reached 8788 individuals. Where the employees constitute the first line in the completion of their work depends on the systems provided by e-health, and therefore they are more knowledgeable about its dimensions, which make them the best candidates to answer the paragraphs of the study tool. The required sample size of 370 was determined from the total population, through communication with the higher departments in each hospital, and the permissible margin of error was (5%) according to the table presented by Sekaran and Bougie.^[48] 600 questionnaires were distributed to ensure obtaining the required sample size; 587 were retrieved, 21 questionnaires not valid for analysis were excluded, so the final sample consisted of 566, and the percentage of the valid questionnaires for analysis was 94.3%.

Validity

The questionnaire was reviewed by several arbitrators who expressed their opinions on its paragraphs, and their comments were taken into consideration.

Normality

To verify the regularity of the data, the values of the kurtosis and skewness parameters were examined. Data are considered to have a normal distribution if the values of these two parameters do not exceed the permissible range (+2.2) and (-2.2). The values of the coefficient of kurtosis and skewness of the study variables came within the normal distribution, as shown in Table 1.

Detecting Common Method Bias

Since there are six dimensions in the independent variable, this requires verifying that there is no problem of bias between these dimensions, and for this purpose the Harman single factor test is used as the value of this test should not exceed (50%), meaning that the first factor that is discovered among these factors explain a percentage not exceeding (50%). Thus, the rest of the factors are involved in the interpretation process.^[49] The results of the Harman Single Factor Test showed that the first factor that was discovered explained 43.8%, which is less than (50%), and therefore there are no problems with bias.

Reliability

To verify the stability of the instrument, the values of the reliability parameter Cronbach α were examined. It is recommended that the values of this parameter exceed 0.70 so that the study instrument has high reliability.^[50] Table 2 shows the values of the Cronbach alpha coefficient, which indicate that the study instrument has high reliability.

Hypothesis Testing and Findings

For the purpose of analyzing the nature of the mediation between the study variables, the Macro Process extension of the SPSS package was used. As shown in Table 3, the overall effect that was tested in the main hypothesis of e-health as a whole in TQM

Table 1: The values of the coefficient of kurtosis and skewness of the study variables

Variable	Dimension	The coefficient of kurtosis	The coefficient of skewness
E-health	E-health records	0.906	-1.194
	E-data transmission	0.204	-0.816
	Video consultations	-1.169	-0.009
	E-medical prescriptions	0.087	-0.927
	Medical images sharing	0.687	-0.944
	Continuous medical learning	0.131	-0.593
TQM		0.253	-0.638
KMT		0.114	-0.554

Table 2: The values of the Cronbach alpha coefficient of the study dimensions

Variable	Dimension	Cronbach α
E-Health	E-Health Records	0.926
	E-Data Transmission	0.915
	Video Consultations	0.968
	E-Medical Prescriptions	0.953
	Medical Images Sharing	0.947
	Continuous Medical Learning	0.915
E-Health as a whole		0.963
TQM		0.972
KMT		0.956

indicated that there was a statistically significant effect before the mediating variable is entered into the model, as the value of the R² was 32.60% and the Beta value was 0.5799.

To test the main hypothesis regarding the existence of the mediating effect, the direct and indirect effect, and the mediation nature of e-health as a whole in TQM in the presence of KMT as the mediating variable, beta values were extracted for each of the direct and indirect effects as in Table 3, and they were respectively 0.1569 and 0.4230, and in statistical terms for both, which indicates the existence of a weak direct effect in the presence of the mediating variable in the model, and a stronger (moderate) indirect effect. This indicates the existence of mediation except that it is partial mediation and we accept the alternative hypothesis by partial mediation.

To understand the nature of the mediation and test the sub-hypotheses regarding the existence of the mediating effect, the direct and indirect effects, and the nature of the mediation of the dimensions of e-health in TQM in the presence of KMT, beta values were extracted (before the mediating variable was introduced into the model), as well as the direct and the indirect effects for each dimension [Table 3]. By examining the effect data in the table, it becomes evident that there is a statistically significant effect of the various e-health dimensions in this study before the mediating variable was introduced into the model, as the value of the R² of the continuous medical learning was 41.71%, and for the rest of the dimensions ranged between 14.56% and 19.45%.

When conducting the direct and indirect impact test in the presence of the mediating variable in the model, none of e-health records or e-medical prescriptions showed a direct effect, while there was a weak direct effect for e-data transmission, video consultations and medical images sharing and a moderate direct effect for continuous medical learning. The data indicate an indirect effect in the limits of the low to the medium for e-health records and e-data transmission, and in the limits of the low for video consultations, e-medical prescriptions, medical image sharing, and continuous medical learning.

Table 3: Macro process test results for the impact of e-health on TQM through KMT as a mediating variable

Variable	Total effect		Direct effect	Indirect effect	Mediation nature
	R ² (%)	Beta			
E-health	32.60	0.5799*	0.1569*	0.4230*	Partial
E-health records	16.11	0.3098*	-0.0126	0.3223*	Full
E-data transmission	19.45	0.3518*	0.0512	0.3006*	Full
Video consultations	16.19	0.2641*	0.0651*	0.1990*	Partial
E-medical prescriptions	15.90	0.2877*	0.011	0.2767*	Full
Medical images sharing	14.56	0.3226*	0.0652*	0.2574*	Partial
Continuous medical learning	41.71	0.5721*	0.3067*	0.2654*	Partial

*Statistical significance at the 0.05 level

Consequently, these results can be summarized by saying that both e-health records, e-data transmission, and e-medical prescriptions were able to achieve a direct effect before introducing the mediating variable into the model, but after introducing the mediating variable into the model, it was not able to achieve the effect except through the mediating variable. Thus, there is a full mediation of KMT between these three dimensions of e-health and TQM. Therefore, we accept the first, second, and fourth alternative sub-hypotheses through full mediation.

Then, the study found that video consultations, medical images sharing, and continuous medical learning have been able to achieve a direct effect before and after introducing the mediating variable into the model, and thus there is a partial mediation of KMT between these three dimensions and TQM. We, therefore, accept the third, fifth, and sixth alternative sub-hypotheses with partial mediation.

DISCUSSION

The results showed that KMT plays the role of a partial mediator in the relationship between some dimensions of e-health (video consultations, medical images sharing, and continuous medical learning) and TQM. Whereas, KMT had the role of a full mediator in the relationship of the rest of the e-health dimensions (e-health records, e-data transmission, and e-medical prescriptions) with TQM.

These results are in accord with the study of Askedal,^[36] which showed that there is an urgent need to achieve proactive actions such as technology co-operation in health service delivery systems related to patient data management and exchange across organizations through technological tools. Our results are also consistent with the results of Kraan *et al.*,^[42] who showed that there is a real desire among patients to directly access their medical records through the use of illustrative screens.

The result of transferring data electronically makes sense as a cumulative process over time. Where every authorized person can review the results of medical examinations, note the improvement in the patient's health condition and compare it with similar medical conditions if certain symptoms such as poisoning or infection are suspected.

The results also are consistent with the study by Budrionis *et al.*,^[45] which showed that providing video conferencing services in healthcare needs to design remote monitoring systems and implement infrastructure to support general-purpose transmission. In addition, it agrees with the study of Ziuziański *et al.*^[51] that revealed that areas of e-health management need modern artificial intelligence systems, to monitor epidemiological data in societies, which allows quick review of the disease history, accuracy in diagnosis, and choosing appropriate treatment recommendations for the case.

Our result for e-data transmission is in general accord with the study of Badr *et al.*,^[52] which showed that there is agreement among some hospitals that IT enables disease management by providing better data flow, which increases the ability of healthcare employees to make enhanced decisions for treatment and prescribed drugs, and thus the possibility of reducing treatment time and enhancing the results of preventive care.

Our findings support the conclusions of the study by Long *et al.*,^[41] which pointed to the importance of KM practices and the supportive technological foundations that provide opportunities for healthcare employees to easily and transparently disseminate new knowledge for the successful implementation of TQM. We are also in accord with the Alsdan *et al.*,^[53] who showed that the health information system allows for the standardization of the data exchange mechanism through interoperability between different entities and in safe ways, which would assist health policymakers in making evidence-based decisions. Further agreement is found with the study by Lewis *et al.*,^[47] which found that relying on technology-based solutions in low- and middle-income countries has an impact of improving data management, facilitating communication between patients and doctors, extending health care and making it available to people who live in rural and isolated communities.

The results of the video counseling dimension in the study were in agreement with the Glassman *et al.*,^[54] which showed the effect of using video conferencing to provide evidence-based therapies on patients' quality of life after treatment when compared with a procedure provided through traditional face-to-face methods.

The results are consistent with the study by Budrionis *et al.*^[45] that revealed that video conferencing services in healthcare need to be applied in different systems that are used in remote surgical monitoring, and through an updated web browser, in addition to the need for an internet connection as a basic requirement to implement the general purpose infrastructure in video conferencing.

The study confirmed results consistent with the results of Alghamdi *et al.*^[32] study that revealed the impact of implementing e-health records systems and e-health on TQM by providing highly efficient care, which raises the level of organization performance and customer satisfaction and reduces prescription errors. It was also in agreement with Al-Sohaim *et al.*^[40] study that showed that knowledge and continuous learning are essential components of the infrastructure of a TQM.

The result regarding e-data transmission makes sense, since data transmission electronically is viewed as a cumulative process over time; every authorized person can review the results of medical examinations and observe the extent of improvement occurring in the patient healthcare.

The result regarding e-medical prescriptions is attributed to the fact that e-medical prescriptions focus on the customer by preventing misuse or irresponsible use in the dispensing process. The result of connecting e-medical prescriptions to continuous improvement is also attributed to their ability to determine appropriate dosages, allergic effects, and antagonism between prescribed drugs. The result related to the continuous medical learning dimension is that continuous medical learning casts a shadow over the dimensions of TQM, as it is one of the programs to achieve it and a basic requirement for it.

CONCLUSIONS

Based on the discussion of the findings, the following implications can be made:

1. Dealing with TQM as an administrative approach at hospitals in Irbid governorate, and working to enhance the benefits that can be obtained from the application of video consultations, electronic medical prescriptions, and the sharing of medical images through various means of KMT
2. Linking obtaining local accreditation as a tool to improve healthcare quality with the ability to adopt e-health for Jordanian hospitals
3. Supporting higher management in certain areas of e-health such as e-health records, video consultations, e-medical prescriptions, and the sharing of medical images to achieve the desired effect in achieving TQM at hospitals in Irbid governorate
4. Working on taking e-health assessments through its fields as an integrated unit and avoiding dealing with each application separately to achieve a strong positive impact on KMT
5. Conducting more studies on areas of application of e-health, which need to be examined on the efficiency of providing health services at the local level.

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