

Exploring Barriers To Innovation Diffusion In Health Care Service Organizations: An Issue For Effective Integration Of Service Architecture And Information Technologies

Tugrul U Daim¹, R Tarcan Tarman¹, Nuri Basoglu²

¹ Portland State University, ² Bogazici University

Abstract - *This study explores the diffusion of innovations in health care service organizations. The importance of the diffusion arises from the direct effect of innovations on the quality and efficiency of the sector. For this purpose, the diffusion barriers and mitigation processes are identified through an extensive literature research. Information technology (IT) is used as a case study representing the innovations in health care organizations. A conceptual model is built to lay out the relationships among factors affecting IT diffusion in health care organizations, impacts on the sector and actions that should be taken by the policy makers, managers and end-users for an effective IT integration into health care*

1. Introduction

A recent NSF symposium (www.picmet.org) focused on technology management in the service sector. Critical takeaways from the symposium was that health care service organizations are to benefit from the merger of nano, bio and info technologies. However the current service architecture of these organizations are not structured to diffuse such innovations. So we discuss the barriers against the diffusion of these innovations. We had used a group of experts to confirm our findings and propose a detailed list of propositions to test with additional data collection. Figure 1 is an overly simplified model of current health care service. Figure 2 is what we perceive the service architecture can move into as information technologies diffuse and merge with other emerging technologies. However the path there is a long one and requires us to understand the current barriers in this structure. Over the past 30 years, almost every sector in the world economy has made a transformation in collecting, managing and transmitting information with the results of increased productivity and efficiency. Yet today, health care-one of the most important service industry in the world economy, has lagged most other industrial sectors regarding the technology diffusion. The problems that face the health care service industry today can be pointed out as high expenditures, inconsistent quality and gaps in care and access, which creates a huge

challenge for the policy makers and health care managers. These problems also affect the U.S. economy in a negative way, requiring national attention and a comprehensive technology infrastructure. Technology is an important mean for health service effectiveness. Therefore, the absence of the technology in health care can have a major impact on the quality of the service delivered. Health care services have to make more use of technologies to improve their efficiencies and increase productivity. Studies and research in this area emphasize the importance and the need for widespread adoption of Information Technology solutions to overcome the problems indicated above. However, it is noteworthy to point out the fact that the health care industry has a unique structure and the diffusion of innovations depend on different dynamics. The dynamics are formed from the factors that affect the diffusion process. Therefore, it is important to identify these factors and build a model to have an overview for an effective strategy to implement the IT solutions in health care. This paper identifies the critical components effecting diffusion of information technologies as well as the impacts of the diffusion. Literature review and expert interviews were used to gather the data. Interviews were done with healthcare experts in Portland Metropolitan area.

2. Literature Review

Health care is a complex and a multifaceted environment in which technology and its management has been a critical challenge for health care organizations [1]. Health care technology can be related to the “*devices, drugs, medical and surgical procedures and the knowledge associated with these to prevent, diagnose and treat diseases. It can be also associated with the organizational and supportive systems within which care is provided [2], [3].*”. Management of healthcare technology involves not only the planning and integration of a technology, but the monitoring, surveillance, evaluation, assessment along with the training of the users. Therefore, the management has to deal with a wide scope of sectors and requires the involvement of staff from many disciplines,

including the medical, technical, clinical, financial and administrative staff [3], [4].

Figure 1. Current Service Model in Health Care Organizations – Complaint Push Model

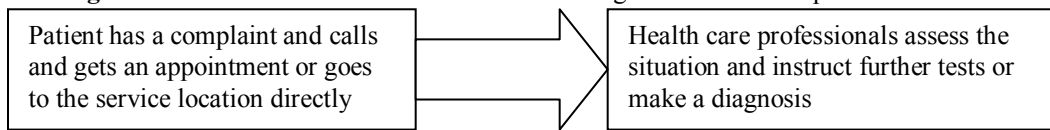
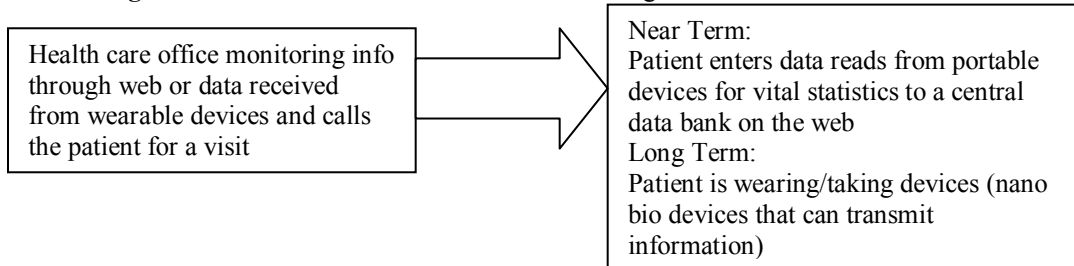


Figure 2. Future Service Model in Health Care Organizations – Data Pull Model



In addition to that, for an effective integration of a technology to the health care services, a collective responsibility including the government, policy makers, planners, managers and staff at all levels from the care facility is required [5]. More and more technology related systems are being integrated into the health care organizations like online consultation systems for remote patient care, image-annotation and reasoning systems to support the assessment procedure of medical screening, medical image database management systems to store medical images, textural metafiles containing descriptions of clinical features and their diagnostic results and etc. [6], [7]. With the introduction of health databases and automated data warehouses, a large amount of routinely extracted data from multiple sources can now be more fully integrated, mined and thereby making available a new type of knowledge, which could be further exploited. Physicians, aided by intelligent clinical decision support systems, can then provide better care for their patients and make their practices more efficient and effective by drawing on timely clinical reminders and alerts based on previously captured expert knowledge of specific diseases. An overview of some health care technologies and their benefits can be seen in the Table 1. Effective management of health care technology contributes to the improved efficiency in the health sector, resulting in improved and increased health outcomes and a more sustainable health service [8]. In addition to that, utilization of technology also improves access, quality and cost-efficiency of public health care services, especially in developing countries [9]. Within this context, information systems,

communications systems, data management systems have been the main interest areas in the health care industry [10]. Policy/planning, standardization, training, operation and maintenance issues have been also widely discussed. Benefits acquired from the technology diffusion can be summarized as below:

- Shorter hospital stays,
- Faster communication of test results,
- Improved management of chronic disease,
- More accurate and complete medical documentation,
- Improved accuracy in capturing charges associated with diagnostic and procedure codes, improved communications among providers that enabled them to respond more quickly to patients' needs.

Even though the importance of managing technology in health care by the application of the concepts, methods, and tools is strongly emphasized in numerous articles, the fields of technology management and health care management have been left mostly apart by the research communities of both areas of academic interests [3]. The U.S. *health care* delivery system is still seen as an information-intensive industry that is complex, inefficient, and highly fragmented [11]. Findings in literature heavily indicate the significant level of resistance to technological systems despite their advantages in the health care service organizations. The large proportion of users demonstrate a consistently low or decreasing level of usage over time [12]. In order to understand the technological dynamics within the health care industry, it is important to look at the diffusion process of innovations and discuss the challenges.

Innovation diffusion in health care services is not always adopted most quickly [13], [14], [15].

Table 1. Discussed technologies in the Health Care Sector

Technology	Benefits	Health Care Sector	Literature
Wireless local area network-based (WLAN) mobile computing system, wearable Monitoring Devices	Increase the quality of patient care, improve a hospital's overall operation, and reduce costs.	Information / Decision Support	[16]
Clinical Reminder Systems	Provide just-in-time reminders to clinicians at the point of care, consistent with the latest evidence-based medicine guidelines	Information / Decision Support	[12]
Clinical Decision Support Systems	Assist with diagnosing a patient's condition, drug dosage, procedures administering reminders to patients	Information / Decision Support	[17], [18]
Computerized patient records and electronic medical record systems	Digitalize patient information for decision support	Information / Decision Support	[8]
Telemedicine	Use IT to deliver health care services from one location to another	Clinical Technology, Information / Decision Support	[19], [18]

The reasons could vary from user resistance such as insufficient computer ability, diminished professional autonomy, lack of awareness of long-term benefits of system use, and lack of desire to change conventional behaviors to organizational barriers [20]. Table 2 summarizes innovations in the health care that have been widely discussed in literature and the barriers that makes their diffusion more difficult to be implemented. For effective innovation diffusion, it is not sufficient to focus on assessments of the system characteristics. It is also important to understand the barriers for the innovations as outlined in the table. Innovations should not create information overload and distract the user from the normal operation. Even if an innovation is rejected at first, it is important to re-engineer it according to the feedback from the user and have it ready for implementation. There is an interest in literature on the innovation diffusion in the health care service organizations. Within this context, Information Technology, an enabler of technology is becoming more prevalent, with healthcare workers and organizations being

exposed to many new technologies [21]. Health care's information dependent characteristic also makes the information technology diffusion a very important field to examine. Therefore, IT diffusion in health care is analyzed more in detail and from different perspectives in this study for to establish a general understanding for the innovation diffusion. The progress in Information Technology in the past few decades has opened the way for enhanced capabilities in several industries. Despite these improvements, health care industry is behind many industries regarding the IT adoption [17], [22]. It is very important to evaluate the IT adoption in health care since health information technology (IT) is identified as a mean to improve the efficiency and quality of medical *care* [11]. In a study by United States Government Accountability Office, it is pointed out that cost reductions in the health care delivery organizations associated with medication errors, communication and documentation of clinical care and test results, staffing and paper storage, and processing of information could be achieved by the effective use of IT [11]. Studies by the Institute of Medicine also emphasized the importance of

widespread adoption of IT solutions to improve patient safety and clinical effectiveness [23].

Table 2. Barriers for innovation diffusion in the Health Care Sector [18], [19]

Technology	Description	Barriers
E-health (Telemedicine, telehealth)	Use of information and communication technologies in support of health-care services, health surveillance, health literature, health education, knowledge and research	Requires an extensive understanding and reworking of the fundamental organizational service processes; interoperability; start-up cost ; Legal issues; Economic interest; Privacy standards; Language barrier
Wearable Monitoring Devices	Display and document physiological information obtained at regular intervals over time from sensors attached to the patient or other input devices	Battery Life Privacy and Security Invisibility and Social Acceptance Usability Language Barriers Fragmented Data Standards
RFID (Radio Frequency Identification)	A technology that uses radio waves to automatically identify people or objects.	Cost Infrastructure Wireless Network Security Global Standards RF Impact
Semantic Web	World Wide Web of connected data, radically different than today's Web of discrete data	Technology Barrier Business Barriers

A recent study found out that medication errors can be easily prevented through computerized systems in hospitals [24]. Moreover, the large annual increases in health expenditures stresses on the importance and urgency of improving health care productivity, utilizing more effective IT systems before the health care system could be a threat for the U.S. economic growth [8]. Health IT will allow comprehensive management of medical information and its secure exchange between health care consumers and providers. Broad use of health IT will:

- Improve health care quality;
- Prevent medical errors;
- Reduce health care costs;
- Increase administrative efficiencies;
- Decrease paperwork; and
- Expand access to affordable care [25].

Interoperable health IT will improve individual patient care, but it will also bring many public health benefits including:

- Early detection of infectious disease outbreaks around the country;

- Improved tracking of chronic disease management; and
- Evaluation of health care based on value enabled by the collection of de-identified price and quality information that can be compared.

Automation and information technology that exists in today's health care industry mostly focus on the administrative and financial side. There is a need to expand it to the clinical side which is often neglected. It is therefore important to analyze the IT infrastructure in the health care services. The infrastructure can support the patient care functions (pharmacy, digital radiology, order entry), safety and quality functions (infection control, data warehousing) and administrative and business functions (admitting, discharge, transfer, scheduling, billing). The challenges in IT implementation and mitigation processes should be understood well due to the profound difference in U.S. health management that could be created by prudent IT investment [22].

3. Methodology

We have followed a 4-phase approach to develop a framework for diffusion of information

technologies in the health care service

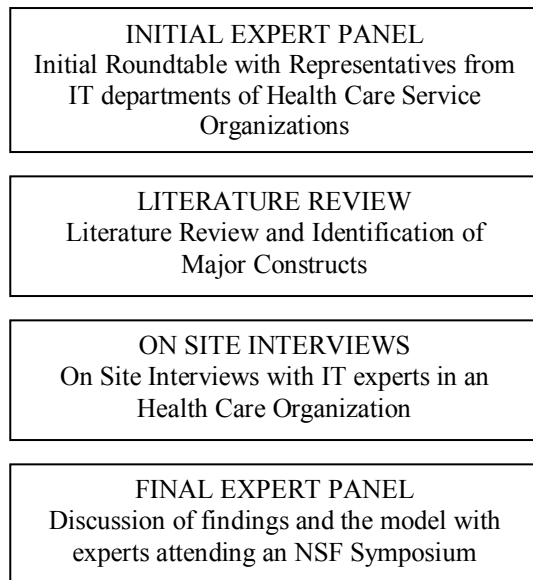


Figure 1 Research Approach

The initial expert panel was a 2 hour meeting with representatives from the following institutes:

1. IT executive from a medical university
2. IT executive from a health care service provider
3. Researcher from a medical university

The major objective of this meeting was to confirm our objective and direction. Our initial motive was to start build a model. The feedback was to start with identifying the barriers. The IT executives were mostly concerned with the cost and time it takes to implement and diffuse new technologies. On the other hand the researcher was more concerned with new systems being forced upon them without adequate support.

After this initial meeting, a comprehensive literature search was conducted. The results are summarized in the literature review section. The findings from the literature then were presented a group of IT staff at a medical university and we had come up with a final model through the on site interviews with these experts

4. Results from the expert Interviews

organizations.

Below is a number of challenges in IT implementation in health care service organizations based on our interviews. These findings were also supported by the literature.

The financial aspect of the IT implementation in health care has been identified as one of the biggest challenges that postpones an effective innovation diffusion [26]. Financial aspect is a general identification of the several financial metrics involved in the diffusion of the innovations. For to have a better understanding on this barrier, these financial metrics have to be analyzed in depth. One of the most important components of the cost for the IT implementation that forms a barrier is the start-up cost, followed by the return on investment. Lack of incentives and investments especially from the government also form a challenge for the health care industry [27]. Also the indirect benefits of the IT systems are not integrated fully in the direct fiscal metrics. A good strategy to overcome the barrier related to the high costs associated with the IT systems is to measure the system's impact on the hospital efficiency and display the cost savings and hospital benefits so that the investors can build the relationship between the investment and the outcome. In addition to that, incentives from the government and the insurance companies could also help the health care providers implement IT systems to their work flow. These incentives can be in forms of grants or loans to decrease the cost or reimbursement to hospitals that have met a certain standard of IT systems usage [28]. **The lack of skills or knowledge to develop, design, manufacture and use health-care specific IT systems** is another major barrier identified in the literature for IT adoption [21]. Clinicians and system users are often neglected in the development and design phase of the systems. Related to this, few people are trained to work at the intersection of biomedicine and IT. System developers usually have less knowledge about the medical needs that will be satisfied by the IT system. There is a growing shortage of qualified health care IT professionals. Alpay [29] also pointed out that the challenge in the implementation of effective IT systems in health care services has been in the area of education and training for the IT systems. The author addressed the biggest gap to be the IT training in the context of a technologically evolving health care sector. Especially for nurses, lack of appropriate skills and unwillingness to enhance their practice and status with the introduction of

IT in the workplace are identified a major challenge by [30] and [31]. Lack of access to the structured knowledge and criteria regarding the system capabilities and implementation processes is also another concern in health care [26], [27]. **The end user resistance** (the users of the IT systems) can also have a great impact on the IT implementation process. In general, cultural resistance to algorithms and IT systems and low computer literacy levels among physicians are identified as one of the most important barriers in the health care [24]. Most physicians associate IT systems as having a negative impact on the workflow and prefer traditional paper-based systems [28]. To overcome this challenge, training the system users is a way; however, it does not offer a complete solution. The time limit of the physicians usually does not allow the hospitals to fully adapt a training program. In addition to that, the motivation of the physicians is usually low in terms of using the designated IT systems [28]. Overcoming the resistance of the end-user of the IT systems, strong leadership is needed in the health care providers. The hospital leaders must believe in the benefits of the IT systems and show full support and commitment to the implementation process [28]. There has to be a clear communication channel between the hospital leaders and the staff in describing the benefits of the implemented IT systems and it contributes to the overall mission and vision of the hospital. Moreover, involvement of the user in the selection and implementation of IT systems is emphasized as a key point for overcoming the resistance. This enables the user to share the concerns with the implementation team and vendors up-front and do the necessary changes accordingly. **The lack of standardization, interoperability and immaturity** of IT-related health care systems and **compliance with national standards** for privacy, security, data storage and exchange, legal issues, threat for data confidentiality are other barriers discussed widely in the literature [26]. Many systems are limited to exchange information only in one location not compatible for information share among institutional boundaries. Not evaluating expectations of the user and absence of feedback could also effect the decision of a physician negatively [32]. Different vendors offer IT solutions to support individual systems such as cardiology care, intensive care or home care increasing the number of different systems used in the organizational flow. The relevant clinical data

from each often does not comply with other systems. A more comprehensive and an integrated platform to manage IT solutions is highly needed in the health care service industry. Many products are also identified not meeting the demands of the hospitals and extensive modifications are needed to fit the workflow of the specific health care facility [28]. At this point, the selection of the vendor, vendor's commitment to the product and the relationship established between the vendor and the hospital are the key elements of overcoming the immaturity. **The lack of published reports** citing the benefits of the IT in health care services and **the support of the academia** are also described as barriers in the literature. **The unique structure of the health care industry** is also among the challenges faced for the IT implementation. Health care is highly information dependent, relying on accurate patient-specific data and expert clinical knowledge. To implement an IT project in the health care, the implementer has to deal with extremely complex requirements, multiple users, different data types and complicated work flows and information needs. **The risks and challenges in IT implementation** is also another barrier for the health care industry. Not many IT projects are completed on time, budget and scope according to a report by Standish Group. Moreover, the leaders of the health care organizations could also be a barrier to effective IT diffusion when they struggle with their organizations' use of and commitment to IT [25]. The traditional mind-set and organizational culture are also seen as major barriers for the IT diffusion in health care services. Health care leaders need to be open to physicians, managers and staff to become aware of their current mind-sets and the inhibitors to adapting to change. Dialogue and involvement of the end-user will increase the effectiveness of the IT system. The leaders of the health care have to include the physicians and the staff in the decision process [33]. Information technology requires skills, knowledge and technology to be useful to the end-user and organization. The relation between the requirements of IT and the capabilities of the user determines the fit of the individual to the technology. This IT-fit will both effect the usefulness and ease of use the user perceives from IT [34], [35]. Perceived usefulness is the relative advantage, subjective norms, compatibility and feedback; whereas, perceived ease of use includes the usability, perceived behavioral control, and support [21]. The

perceptions determine the adoption decision of the IT. We summarize the barriers in Table 3.

We also provided further reference to research that has provided a resolution.

Table 3. Literature related to the barriers for an adoption for IT systems and mitigation approach

Literature	Barriers Identified for an Effective Use of IT in Health Care	Type	Mitigation Approach
[17]	Depersonalization of health care and barriers to the traditional rapport between clinicians and patients.	End-user	Increase the perceived benefit from the system
[24]	Cultural resistance to algorithms and management systems among physicians	End-user	Expanding medical education to include clinically related IT, making the systems user friendly and integrate into the daily work flow, informal communication networks, physicians networks
[26], [27]	Lack of training, lack of access to the structured knowledge and criteria regarding the system capabilities and implementation processes	Organizational and end-user	On-site or off-site training to be provided to the end-user
[19]	Clinicians and system users not involved in the process of design and selection	Organizational and technical	Involvement of the end-user in the design phase of the IT system
[22]	Indirect benefits of IT not integrated in the direct fiscal metrics	Organizational and technical	IT to be integrated in the financial models
[8]	Compliance with national standards for privacy, security, data storage and exchange, legal issues, threat for data confidentiality	Technical and end-user	Certification process for the IT systems, Well-designed systems with suitable attention to authentication and authorization
[36]	Few people trained to work at the intersection of biomedicine and IT	Organizational and end-user	Special trainings for health care systems
[36]	Standards not meeting the demands of HC	Organizational, technical and end-user	Integration of HC into IT development, standardization
[26, 37]	Start-up Cost	Organizational and technical	Not relying on governmental sources only, but try to create alternative resources.
[36]	Lack of published reports citing the benefits of IT in health care services	Organizational and technical	Documentation
[33], [24]	Unique characteristics of health care (content and complexity)	Organizational, technical and end-user	Utilizing the systems for the unique structure of the health care

[36]	Industry's organizational structure-being local and small	Organizational	Involving investors in today's complex healthcare industry
[27]	Lack of incentives and investments	Organizational	Implementing right incentives to use the systems
[26]	The lack of interoperability and standardization among systems	Technical	Working together with the state and federal governments to establish a common framework for the health care organizations
[27]	The lack of clinical leadership	Organizational and end-user	Training the CIOs of the health care organizations to create the effective leadership
[27]	Vendor's inability to satisfactory deliver products and services	Technical	Rating process for vendor's according to their
[27]	Return on investment	Organizational	Direct fiscal measures regarding the IT systems incorporated to the health care organization's financial reports

The health care industry has been evolving from a localized stand point to a more consolidated and commercial point. Therefore, the demand for better information systems, additional coordination and information systems is drastically increasing. Usable, timely and cost-efficient information technology and communication systems contribute to the quality of care by reducing human errors or minimizing the effect of those that still occur [17]. Overall, major cultural change, financial investment, and logistical planning will be required for future implementations of IT. It is vital to integrate the systems into the workflow rather than being a stand-alone capability that requires a break from the process. The technology needs to be placed into the existing system. The competitive nature of the medical marketplace and inhibitors should be also taken into account to maximize the benefit coming from the IT [22].

5. Conclusions

The framework in the study is developed through expert interviews and literature review that is conducted on the innovation diffusion in health care service organizations. Expert interviews were conducted to modify the model. The data was limited and really was used to validate out literature review and model based on that. The model below includes the players in the health

care IT diffusion, the factors affecting the diffusion and the impacts on the health care. The IT diffusion in health care service organizations is visualized with the "Technology Acceptance Model" (TAM) by Fred Davis that examines the mediating role of perceived ease of use and perceived usefulness in their relation between system characteristics (external variables) and the probability of system use (an indicator of system success) [38], [39], [40], [41]. The Technology Acceptance Model (TAM) developed by Davis defines perceived ease of use and perceived usefulness as two determinants of attitude towards behavioral intention and usage In TAM, perceived ease of use is defined as "the degree to which a person believes that using the system will be free of effort", whereas perceived usefulness is defined as "the degree to which a person believes that use of the system will enhance his or her performance". Perceived ease of use - which also determines the perceived difficulty of use - represents the perceived cost of using the system by the individual. Following this a large scale survey will be conducted among the health care service organizations. The objective of the survey will be to test the relationships (from H 1 till H17 in the model provided in the appendix). As a part of this study a set of metrics will be developed to quantify the impacts, TAM elements, diffusion factors.

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