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Evaluating Business Value of IT in Healthcare in Australia: The Case of an Intelligent Operational Planning Support Tool Solution

Peter Haddad
RMIT University and Epworth Research Institute, Australia, peter.haddad@rmit.edu.au

Mark Gregory
RMIT University, Australia, mark.gregory@rmit.edu.au

Nilmini Wickramasinghe
RMIT University and Epworth Research Institute, Australia, nilmini.wickramasinghe@rmit.edu.au

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Peter Haddad

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peter.haddad@rmit.edu.au

Mark Gregory

RMIT University, Australia

mark.gregory@rmit.edu.au

Nilmini Wickramasinghe

RMIT University and Epworth Research Institute, Australia

nilmini.wickramasinghe@rmit.edu.au

Abstract

The healthcare sector is complex and intricate. It consists of a web of players including clinicians, healthcare organisations, regulators, payers, suppliers, patients and their families to mention the major groups. Taken together they form a complex ecosystem made up of multiple and dynamic sub-ecosystems. With the focus on incorporating technology into this context what we find is one of the most intricate and complex of e-ecosystems that must function effectively and efficiently in order to provide superior care and treat patients. The following tries to ascertain the value associated with the application of technology in healthcare; i.e. the business value of IT in healthcare. This is done by synthesising key literature and then applying it to a specific case of a nursing informatics technology solution. In so doing, a unifying framework is established that enables us to understand key activities that occur throughout this e-ecosystem.

Keywords: Information Technology, Information Systems, Value, Business value, Healthcare, Nursing Documentation, ecosystems

1. Introduction

The unremitting quest to improve healthcare outcomes and reduce escalating costs has encouraged decision- and policy-makers in the healthcare industry to invest more in information systems/information technology (IS/IT) (Berner, 2008; Kilbridge, 2008).

This has been driven to a large extent by success stories for such investments in other sectors of the service industry such as retail, education and logistics. The noteworthy international tendency for healthcare to invest more in IS/IT to both enhance healthcare quality and reduce cost (Eysenbach, 2001) has called for further studies and investigations about the role IS/IT may play to improve healthcare outcomes (Lawler, Hedge and Pavlovic-Veselinovic, 2011). Furthermore, because the Internet has created new opportunities and challenges to the traditional health care IT industry, e-health presents both opportunities and challenges (Wickramasinghe and Schaffer, 2010).

Electronic patient records (EPR) are being introduced and used by more and more healthcare organizations nowadays in different contexts of healthcare delivery (De Veer and Francke, 2010). Moreover, nursing documentation is one of the areas where IS/IT is being used, and the shift from paper-based to electronic-based documentation has raised questions regarding the way nursing documentation should be organized and presented in EPR (Krogh, Nåden and Aasland, 2012).

The impact of IS/IT investments on organizational performance (namely 'Business Value of IT') has been a major point of research since 1992 (Weill, 1992) in different industries (Silvius, 2011; Masli et al., 2011 and Frisk, 2007). Business value of IT in healthcare, however, is still yet to be fully investigated. This is largely due to the fact that healthcare delivery is complex and consists of many systems and subsystems (Lubitz and Patricelli, 2007) or one can think of these as ecosystems which must all be considered if a true sense of value is to be established.

In the light of these circumstances, developing a robust and suitable framework to assess the value of these IT investments clearly becomes a strategic imperative and vital step toward designing sustainable e-health solutions.

This paper outlines an exploratory research study that aims to examine the business value of IS/IT in healthcare, especially it focuses on a new IS/IT system developed in Australia for nursing documentation. To do so, this study proposes a framework for the evaluation of cost versus quality outcomes utilizing different layers within healthcare delivery. This proffered framework is based on two well-known conceptual models (Weill and Broadbent, 1998; Rouse and Cortese, 2010) that represent IT portfolio and healthcare delivery as will be described in the following sections.

2. Literature Review

This section mainly aims to give a brief summary of the meaning of "business value of IT" and its applications and prior research. Current healthcare delivery challenges and conditions will be briefly summarized. The two conceptual models used to develop the proposed conceptual model will be given. Then, a few available prior studies to highlight IT-based nursing documentation will be given.

2.1 Business Value of IT in Healthcare:

Investing in IS/IT as a strategy to improve quality of the medical procedures have been appealing (Wickramasinghe and Schaffer, 2010, Gagnona et al., 2003). For example, investing more in health information technology ($10 billion annually for five years) and paying healthcare providers based on quality of care, not quantity of services, were among the few key points of Mr. Obama's healthcare plan declared in his speech delivered in December 11, 2008 (The Hospitalist, 2009). Same trend was taking place in Western Europe, where healthcare IT spending was expected to increase from $9 billion in 2006 to $12 billion in 2011 (IDC Report, 2008). These escalating investments were mainly driven by the success of IS/IT investments, whose impacts were studied in details in different industries than healthcare.

The term business value of IT is commonly used to refer to the organizational performance impacts of IT (Melville et al., 2004). In their review of research on business value of IT (Melville et al., 2004) used different measurements of performance, including cost reduction, profitability improvement, productivity enhancement, competitive advantage and inventory reduction to measure business value of IT. One of the first researchers to study business value of IT was (Weill, 1992) .Since then, studying business value of IT has not stopped (Kohli and Grover, 2008).

Although the business value of IT has long been investigated, the current literature is still to develop better understanding of the relationship between IT investments and firm performance (Masli et al., 2011), especially with the contradicted findings in this area of research, and this could be the reason why researchers believe that a productive approach is to move from the question of whether IT creates value to how, when and why benefits occur or fail to do so (Melville et al., 2004).

The healthcare informatics literature is relatively new (Dalrymple, 2011), and the term business value of IT is still to be studied in this industry, especially that healthcare providers have started to invest heavily in various healthcare IT systems to enhance "quality of patient care," which has therefore been a major criterion for related studies on hospitals (Burke and Menachemi, 2004). To cover this new trend, a number of studies tried to limitedly investigate the impact of implementing specific types of healthcare IT systems, such as electronic patient records (EPRs) using limited sample sizes, with less possibilities to generalize the findings on healthcare industry in total (Das, Yaylacicegi and Menon, 2011).

Investigating business value of IT in healthcare, thus, is a clear void in the current literature, and investigating that would be a key step to help focus IS/IT investments on value generating technologies and systems.

To further clarify the term business value of IT, this paper adopts the IT portfolio conceptualization as described in the next section.

Information Technology Portfolio

The IT portfolio of an organization is its entire investment in IT, including all of the people dedicated to providing IT services, whether centralized, decentralized, distributed, or outsourced (Weill and Broadbent, 1998). Principally, firms invest in IT to achieve four fundamentally different management objectives: transactional, infrastructure, informational, and strategic (Weill and Broadbent, 1998). These management objectives then lead to information, transactional, infrastructure, and strategic systems, which make up the IT investment portfolio, and will be used as a representation of IT whose potential business value will be evaluated in this research. Figure 1 depicts these objectives, and Table 1 describes the four management objectives. The figure and the table both were adopted from (Weill and Broadbent, 1998).
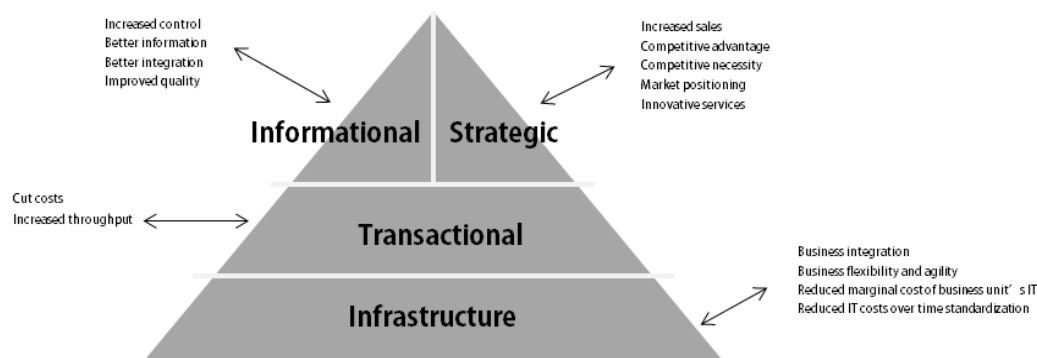

Figure 1: Management Objectives for the Information Technology Portfolio (Weill and Broadbent, 1998)

Table 1: The objectives of IT Portfolio

Objectives	Description
Infrastructure	• The foundation of information technology capacity which is delivered as reliable services shared throughout the firm and coordinated centrally. • Includes both the technical and the managerial expertise required to provide reliable services. • Having the required infrastructure services in place significantly increases the speed with which new applications can be implemented to meet new strategies.
Transactional	• Processes and automates the basic, repetitive transactions of the firm. These include systems that support order processing, inventory control, bank cash withdrawal, statement production, account receivable, accounts payable, and other transactional processing. • Transactional systems aim to cut costs by substituting capital for labor or to handle higher volumes of transactions with greater speed and less unit cost.
Informational	• Provides information for managing and controlling the firm. • Typically supports management control, decision making, communication and accounting. These systems can summarize and report this firm's product and process performance across a wide range of areas. • Two examples of these systems come from Ford Australia (Electronic Corporate Memory), and from the consulting firm Bain & Company which developed Bain Resources Access for Value Addition (BRAVA).
Strategic	• The objective of strategic technology investment is quite different from those of the other parts of the portfolio. • Strategic investments are made to gain competitive advantage or to position the firm in the marketplace, most often by increasing market share or sales. • Firms with successful strategic information technology initiatives have usually found a new use of information technology for an industry at a particular point an time. • Two good examples of theses strategic initiatives are inventing automatic teller machines (ATMs), and designing a system that provides immediate 24-hour, seven-day-a-week loan approvals in car dealerships using expert systems technology. Both of these innovative systems have changed their industries forever.

2.2 Healthcare Delivery: Current Trends and Conditions

(Wolper, 2011) referred to (Reid and Compton, 2010) and used the definition of a system to give a final description for healthcare delivery, as a whole, as a 'fragmented, disorganized, and unaccountably variable. The main reason, we don't hear about a "healthcare delivery system", according to (Wolper, 2011), is that healthcare delivery was never designed as a system and does not operate as one, and according to (Picker Institute, 2000) 75% of patients consider the healthcare system fragmented and fractured, a "nightmare" to navigate, and plagued by duplication of effort, lack of communication, conflicting advice regarding treatment, and tenuous links to the evolving medical evidence base.

The complexity of improving healthcare delivery, on a global perspective can be identified from current statistics. According to (IOM, 2005), for example, more than 98,000 Americans die every year and more than ten times this number injured as a result

of "broken healthcare processes and system failures". These figures are getting worse with time, soaring to 180,000 patients in Medicare alone in a given year (Levinson, 2010) and between 210,000 and 440,000 patients (James, 2013).

The 21st Century healthcare must be: safe, effective, patient-centered, timely, efficient and equitable (IOM, 2001). To meet these six objectives, the committee emphasized the role the engineering community can play to facilitate the complex process of transforming the healthcare delivery systems (IOM, 2001; Reid and Compton, 2010).

(Rouse and Cortese, 2010) suggest architecture for the healthcare delivery enterprise, shown in Figure 2. The efficiencies that can be achieved at the lowest level (clinical practices) are limited by the nature of the next level (delivery operations). For example, functionally organized practices are much less efficient than delivery organized practices that focus on processes. Similarly, the efficiencies that can be gained in delivery operations are limited by the level above (system structure). Functional operations are driven by organizations structured around specialties, e.g., anesthesiology and radiology. And efficiencies in system structure are limited by the healthcare ecosystem in which organizations operate. Healthcare providers in different countries have different healthcare delivery experiences.
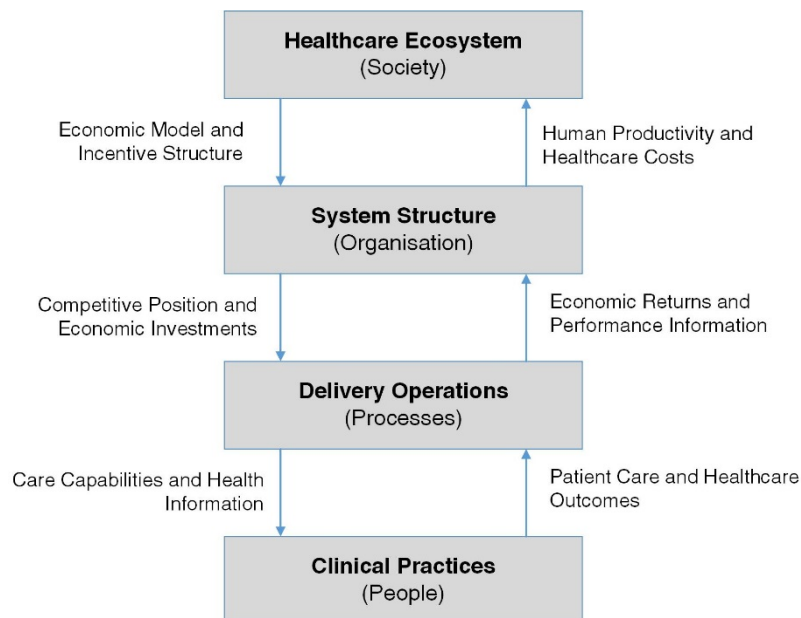

Figure 2: Healthcare Delivery Enterprise (Rouse and Cortese 2010)

Defining Value in Healthcare Delivery

Healthcare commentary often revolves around universal availability and cost control, i.e. access and cost. People are not likely to want the lowest cost; the central issue should really be the creation of a healthcare system that provides the highest value (Rouse and Cortese, 2010).

Value is often defined in terms of the expenditure outcome benefits, divided by the expenditure costs. The healthcare benefits, from a patient's perspective, include the healthcare outcomes quality, the safety of the delivery process, and the services associated with the delivery process, and from society perspective benefits might include the availability of healthy and productive people who contribute to society in many ways. When people are not healthy, their contributions diminish (Porter and Teisberg, 2006).

To examine business value of IT in healthcare, in this research we use a new IS/IT system developed in Australia to facilitate electronic nursing documentation which we give a brief summary of in the next section.

2.3 Electronic Nursing Documentation

Nursing documentation plays a key role in the success of nursing activities, as it supports nursing staff efforts to improve healthcare outcomes by developing customized care plan for patients (Björvell et al., 2003). To further improve nursing documentation, IS/IT has been used to introduce electronic documentation systems, in an attempt to minimize documentation efforts and times and maximise the interaction between caregivers and patients. (U.S. DHHS, 2010).

Nursing Documentation systems are meant to document nursing notes that describe the care or service to that client. Health records may be paper documents or electronic documents, such as electronic medical records, faxes, emails, audio or video tapes and images. Through documentation, nurses communicate their observations, decisions, actions, and outcomes of these actions for clients. Documentation software tracks what occurred and when it occurred (HIMSS, 2009).

This migration from paper-based to electronic-based documentation, which should not be a mere replication of paper forms in an electronic format (Kelley, Brandon and Docherty 2011; Ball, Hannah and Douglas, 2000), have encouraged research in the area of finding the impact of introducing nursing documentation on healthcare outcomes with limited focus on specific parameters, like time consumed for documentation (Munyisia, Yu and Hairly, 2012) and better healthcare outcomes, see for example (Moody et al., 2004; Lee, Yeh and Ho, 2002). A number of studies have focused on time taken for documentation, with contradicted findings and results. For example, time reduction could be monitored and seen after the introduction of different electronic nursing documentation (Bosman et al., 2003; Wong et al., 2003), while this introduction could not make any change in time consumed for nursing documentation (Hakes and Whittington 2008; Menke at al., 2001) and others found that electronic nursing documentation caused documentation time to increase (Saarinen and Aho, 2005).

Another aspect of research on electronic documentation is efficiency. For example (Munyisia, Yu and Hairly, 2012) studied an electronic nursing documentation system in an Australian residential aged care facility and found that introducing this system may not lead to efficiency in documentation, and using both paper and electronic mean for documentation might be a barrier to achieve better efficiency. In general, the impact of the introduction of electronic nursing documentation to improve the patients' outcomes remains unclear, and further socio-technical studies are needed to investigate the daily interaction between nurses and electronic nursing documentation systems (Kelley, Brandon and Docherty, 2011).

3. Research Design and the Proposed Conceptual Model

This research is trying to answer the following key research question:

How can information technology facilitate the generation of business value in healthcare firms?

To operationalize the IT resource, from a technical perspective, we align with (Weill and Broadbent 1998) classification of IT portfolio into infrastructure IT, transactional IT, informational IT, and strategic IT (See Figure 1). From an organizational perspective, this study will depend on The Enterprise of Healthcare Delivery Model (See Figure 2), and adapt it to find the business value of information technology from a socio-technical aspect in four interrelated levels: (i) Clinical practices (people); (ii) Delivery operations

(processes); (iii) System structure (organizations) (iv) Healthcare ecosystem (society). Figure 3 shows the proposed conceptual model for this research with a key that shows the definitions of clinical IT applications.

In this study we will examine the following:

- **Layer 4: Healthcare Ecosystem (Society):**
  - The impact of competition on business value of IT (infrastructure, transactional, strategic and informative)

- **Layer 3: System Structure (Organization):**
  - What is the impact of IT (infrastructure, transactional, strategic and informative) on business value in terms of improving the system structure (internal and external)

- **Layer 2: Delivery Operations (Processes):**
  - What is the impact of infrastructure IT on business value in enhancing recovery processes
  - What is the impact of informational IT on business value in enhancing detection processes
  - What is the impact of transactional IT on business value in enhancing the diagnosis capabilities
  - What is the impact of strategic IT on business value in enhancing the treatment

- **Layer 1: Clinical Practices (People):**
  - What is the impact of transactional IT on business value in enhancing clinical practices, especially CPOE, LIS, OE,
  - What is the impact of informational IT on business value in enhancing clinical practices, especially CDR, CDSS, ND, PD
  - The business value of infrastructure IT in enhancing laboratory and radiology practices (LIS and RIS)

The proposed framework is multi-layered and has been designed to reflect the complexity of the healthcare industry. The research benefits from the existence of the two earlier models, and aims to draw on their strengths to provide a new approach when evaluating how healthcare firms get value from implementing IS/IT in different levels of healthcare delivery like nursing documentation.

Case Vignette: The Case of an Intelligent Operational Planning Support Tool

Case study is a useful method to illustrate critical issues or key points (Yen, 1994). Thus, in this study we use the case of an Intelligent Operational Planning Support Tool (IOPST) to study the business value of this system. IOPST is a new nursing information system being designed and developed in Australia to be used at the point of care in both private and public hospitals. The developers envisage that this IOPST system will replace the paper-based nursing documentation in hospital acute wards.

As Figure 3 shows, nursing documentation (ND) belongs to the first layer of healthcare delivery enterprise (Clinical Practices (People)) and has an interchangeable relationship with the upper level (Delivery Operation (Process)), where care capabilities and health information are being fed between these two layers and patient care and healthcare outcomes are to be determined according to this relationship (Figure 3 and Table 2).
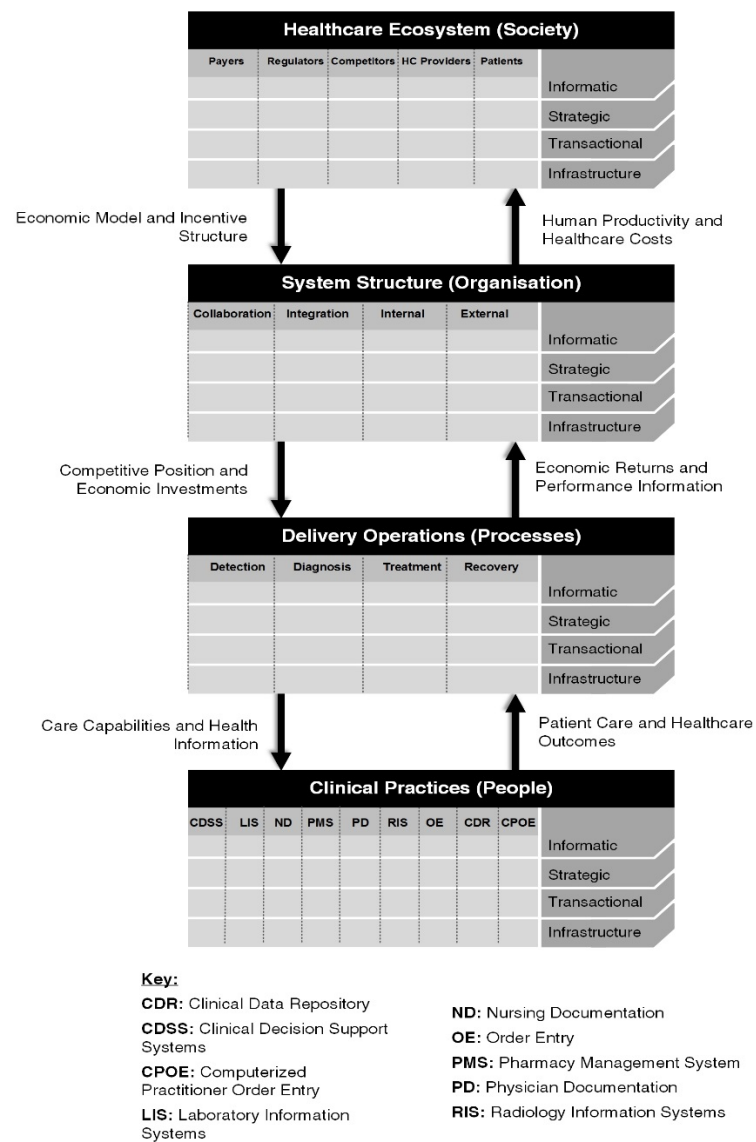
Figure 3: The Proposed Conceptual Model

Table 2: Mapping IOPST to the Proposed Conceptual Model

Healthcare Delivery	Main components	IOPST Case Study
Healthcare ecosystem	Payers	IOPST is expected to be implemented in both public and private healthcare sectors after its validity, usability and other required tests would have been done and research shows that this system would enhance healthcare outcomes.
	Regulators	IOPST needs to meet the regulatory environments of targeted countries. In Australia, for example the regulator is the Australian Government

	Competitors	Commercially, there is a number of nursing documentation systems. The IOPST's designers, however, introduce this system as a new and unique nursing information system (Wickramasinghe et al., 2014)
	HC Providers	Australian healthcare sector is 2-teir structure (private and public). Thus, IOPST aims to get through both sectors.
	Patients	According to its designers, IOPST aims to allocate more time for patients' care by putting IOPST terminals at patients' bedsides, which would create more interaction between nurses and patients (Wickramasinghe et al., 2014).
System Structure	Collaboration	IOPST is meant to allow higher level of collaboration between ward nurses and other healthcare professionals both within a healthcare organisation and between different healthcare organisations enabling nursing staff to document key information, retrieve and share the documented information with other nursing, medical and allied health professionals to provide safe, continuous and high quality care for the patients in the ward. (Wickramasinghe et al., 2014), which would be investigated in this research.
System Structure	Integration	
System Structure	Internal	
System Structure	External	
Delivery Operations	Detection	The system aims to evaluate, filter and process clinical data to ensure the quality of data entry, to support nursing decision making, to provide alerts and prompts to prevent treatment errors such as errors or omissions in medication administration, to 1) improve nursing information access (real time and flexibility); 2) improve quality (accuracy and legibility); 3) reduce time collecting information from multiple sources (Wickramasinghe et al., 2014).
Delivery Operations	Diagnosis	
Delivery Operations	Treatment	
Delivery Operations	Recovery	
Clinical Practices	ND: Nursing Documentation	Nursing documentation systems Nursing Documentation systems are meant to document nursing notes that describe the care or service to that client. Through documentation, nurses communicate their observations, decisions, actions, and outcomes of these actions for clients (HIMSS, 2009). IOPST aims to meet these requirements electronically according to the designers (Wickramasinghe et al., 2014).

According to (Weill and Broadbent, 1998), this solution would fit in Informational IT, as it typically supports management control, decision making, communication and accounting. To operationalize the case vignette, this study benefits from implementing this solution in an Australian private hospital to highlight the role Informational IT plays in generating business value in healthcare delivery, and more specifically Clinical Practices (People) and Delivery Operations (processes) (See Figure 3), by using field observation, surveying nursing staff and making interviews and focus group with different stakeholders at this healthcare provider.

Examining the potential business value out of this IS/IT system has implications on both theory and practice. In particular it becomes possible to make assessments as to whether or not, specific Informational IT solutions facilitate the generation of business value. Such results would be beneficial for both decision makers and practitioners to better allocate resources and thus ensure better healthcare outcomes.

4. Conclusion

This research contributes to the extant body of knowledge in several ways. First of all, current literature lacks rigorous research on the business value of IT in healthcare, so this exploratory study serves as one of the first detailed investigations in this regard. Second, the research question "How can information technology facilitate the generation of business value in healthcare firms?" and more specifically, the business value of informational IT, the case of IOPST to improve clinical practices and delivery operations from a socio-technical perspective is significant in today's healthcare environment Furthermore, this study provides strategies and methods for service providers who are trying to balance costs (the input) and the quality of service (output).

The stated aim of the study; to provide a framework for research into measuring the most value-generating areas in IT investments (Infrastructure, transactional, strategic and informative) for healthcare has been achieved. In addition, from this proffered framework it is possible now to recommend the best practices to minimize the costs (input) and investigate maximizing the output from four interrelated levels: people, processes, organizations and ecosystem. To examine the proposed framework operationally, the case of IOPST would serve as a testing environment to highlight the breadth and depth of the proffered framework.

This exploratory study has developed the first steps for providing significant and last benefits in the determination of business value in healthcare contexts. Future studies will leverage from this work and test various segments of the proffered framework in various healthcare contexts. The future of effective and efficient healthcare provision is linked to IT in one way or another from electronic healthcare devices through the modern e-health delivery models; thus it is likely that the issue of business value of these IT investments will also becoming increasingly more important. In closing, we note as more and more e-health solutions specifically and IS/IT initiatives generally in healthcare appear we must have a systematic framework to aid in the important assessment of the value of these solutions. The proffered framework is both robust and systematic but another advantage is it is as applicable irrespective of the health system and thus enables us to not just assess value of a specific system but also compare and contrast the value of different systems in a systematic fashion.

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