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Conceptualizing Business Value of IT in Healthcare to Design Sustainable e-Health Solutions

Research-in-Progress

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Abstract

Today we are witnessing many initiatives to design and implement IT solutions to support superior healthcare delivery. Key stakeholders including policy makers, healthcare practitioners and patients are all agreed that effective, efficient quality healthcare delivery is vital and that IT has a critical role in effecting value driven healthcare delivery. However, to date it would appear that the promised value from IT in healthcare is eluding us. We believe that this is related in part to the fact that we do not have appropriate frameworks and models that capture the business value of IT in healthcare and thus we set out to develop an appropriate framework to address this void. The proffered model is derived from an in depth analysis of multi-spectral literature from various fields including IS, economics computer science and healthcare as the following serves to outline.

Keywords (Required)

Information technology, Information Systems, Healthcare, Business value, Value.

Introduction

Healthcare costs are increasing globally making healthcare industry decision makers try to identify strategies to control these escalating costs and yet not compromise quality (Wickramasinghe and Schaffer 2010; OECD 2013). Investing in Information Systems and Information Technology (IS/IT) has been appealing for healthcare organizations, especially in the developed countries, as a way of improving healthcare quality and controlling costs (Abd Ghani et al. 2010). Influenced by the success of such investments in service industry sectors such as retail, education and logistics and in order to try to maintain a balance between cost and quality, healthcare organizations have turned to invest heavily in IS/IT (Maheu, Whitten and Allen 2001; Leiyu and Douglas 2010). The remarkable international trend to migrate from conventional healthcare to what has become known as 'e-health' has re-enforced the need for further study into the role that IS/IT can play to enhance healthcare quality whilst reducing costs (Eysenbach 2001)

The impact of IS/IT on organizational performance, namely the "business value of IT" is a major focus of research interest (Weill and Broadbent 1998). The current literature has a plethora of studies and research about the business value of IT for different industries, see for example (Silvius 2011; Masli et al. 2011 and Frisk 2007), However, the business value of IT in healthcare is still 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. Given that today many healthcare organizations are now investing more in IS/IT (Conn 2008) in an effort to improve healthcare outcomes (Berner 2008; Kilbridge and Classen 2008)

developing a robust and suitable framework to assess the value of this IT investment clearly becomes a strategic imperative, and vital step toward designing sustainable e-health solutions.

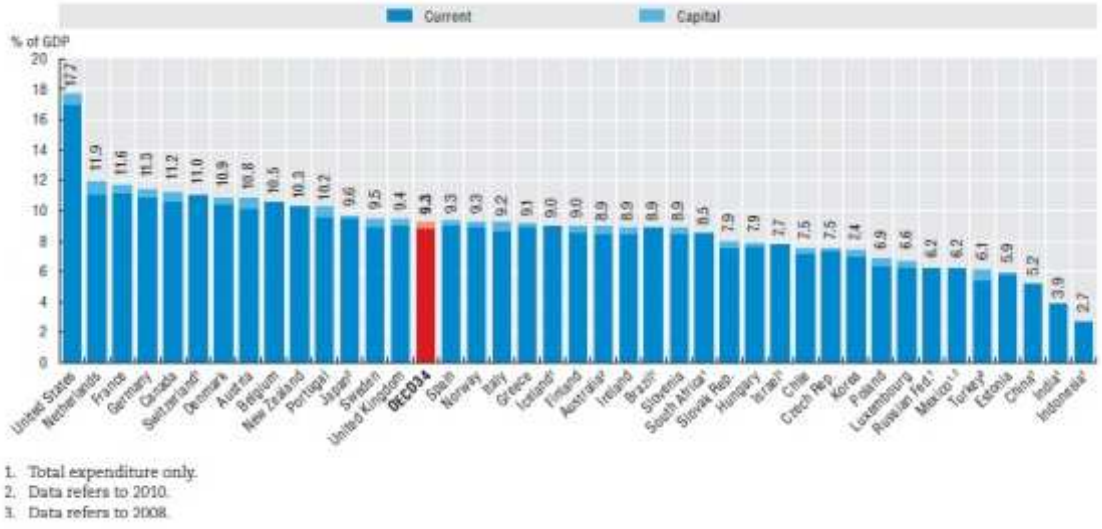
This paper outlines an exploratory research study that aims to address the current void of no clear framework for assessing the business value of IT in healthcare. It does this by proposing a framework for the evaluation of cost versus quality outcomes utilizing different layers within healthcare delivery. This proffered framework is based on two well-known conceptual models that represent IT portfolios and healthcare delivery as will be described in the following sections.

Literature Review

This section includes a summary of the current global healthcare spending trends and a brief contextual analysis of healthcare IT investment outcomes. A summary of the meaning of "business value of IT" is provided along with its applications and prior research. Current healthcare delivery challenges and conditions will be briefly summarized and one of the two conceptual models used in the framework will be explained to highlight its application in this scenario. The other conceptual model (IT portfolio) is then discussed as an introduction to the proposed framework.

Healthcare Spending

Before the economic crisis that began in 2008, healthcare spending in most developed countries had grown much faster than GDP (OECD 2013). For example, the annual growth in health spending in OECD countries in real terms between 2000 and 2009 was 4.1% compared to GDP growth of only 1.5%. Even after 2009, healthcare spending has not declined in a number of large economies. The health spending to GDP ratio in the United States, for example, whose level of health spending is two-and-a-half times the average of all OECD countries, has remained at the same level since 2009, after years of continuous increases. It is not clear yet, however, whether this leveling off reflects cyclical factors and may start to grow again once the economy picks up, or whether it reflects more structural changes such as a slower diffusion of new technologies and pharmaceuticals, and changes in provider payments resulting in greater efficiency (OECD 2013). The higher expenses in the US healthcare, for instance, have not helped the US achieve better outcomes on many important measures, such as the dangerous combination of high costs, irregular quality of care, frequent errors as well as limited access to healthcare (Porter and Teisberg 2006). Figure 1 shows the healthcare spending as a share of GDP across the OECD countries between 2008 and 2010 (OECD 2013).



1. Total expenditure only.
2. Data refers to 2010.
3. Data refers to 2008.

Figure 1: Health expenditure as a share of GDP, 2011 (or nearest year)

Source: OECD Health Statistics 2013, http://dx.doi.org/10.1787/health-data-en; WHO Global Health Expenditure Database.

Information Systems/ Information Technology for Healthcare

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). Based on this, $519 billion was set aside for healthcare IT spending in the 2011 stimulus bill (Das, Yaylacicegi and Menon 2011), 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)

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).

Business Value of IT in 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), who introduced the concept of "IT conversion effectiveness" to explain the reasons of some IT investments failed in improving organizational perforce. 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 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 boost "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 link between implementing specific types of healthcare IT systems, such as electronic medical records (EMRs) using limited sample sizes, with no possibilities to generalize the findings on healthcare industry in total.

For example, hospital capital was classified into three components: IT capital, medical capital, and medical IT capital (Das, Yaylacicegi and Menon 2011). Results obtained with these methodological refinements show that both IT and medical IT capital exhibit a positive influence on output. Similar to prior research that aggregates across various types of capital, this study is subject to problems that occur when the productivity impacts of different IT are averaged (Brynjolfsson 1993). When IT is aggregated over mainframes, personal computers, and networks, the productivity impact of IT may be understated, since mainframes are frequently used past their accounting depreciation life and since the prices of PCs dropped over the period in question (Memon, Lee and Eldenburg 2000).

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 develop sustainable e-health solutions for tomorrow's healthcare 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. The investments include all computers, telecommunication networks, data, software, training, programmers, support personnel, point-of-sale systems, database, and fax machines, whether integrated or standalone (Weill and Broadbent 1998). Managers make decisions about IT investments based of a cluster of factors, including capacities required now and in the future, the role of technology in the industry, the level of investments are viewed, and the role and history of IT in the firm (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). Theses 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 2 depicts these different management objectives and their relationship as they form the IT portfolio and describe them individually, and Table 1 describes the four management objectives. The figure and the table both were adopted from (Weill and Broadbent 1998).

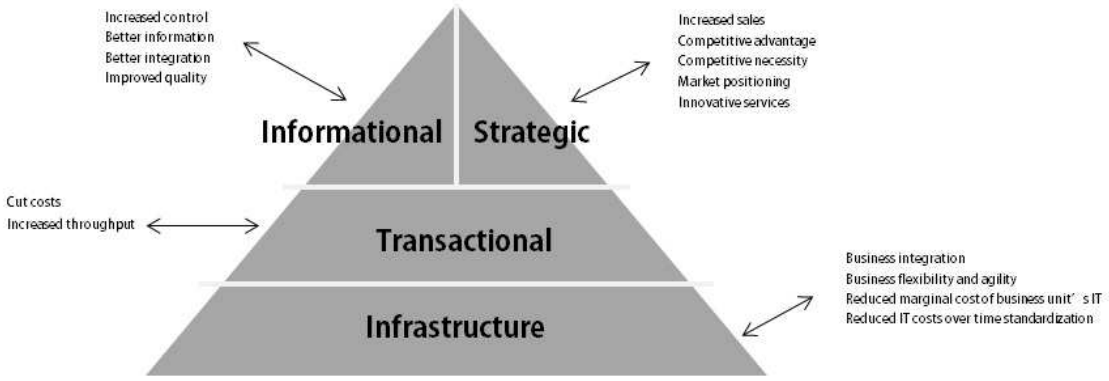


Figure 2: Management Objectives for the IT Portfolio (Weill and Broadbent 1998)

Objectives	Description
Infrastructure	• The foundation of IT capacity which is delivered as reliable services shared throughout the firm and coordinated centrally, usually by the IT group. • Include 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, thus increasing the firm's strategic agility and flexibility.
Transactional	• Process and automate 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. These systems build on and depend on a reliable infrastructure capacity.
Informational	• Provide information for managing and controlling the firm.

	• Systems in this category typically support 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 IT initiatives have usually found a new use of IT 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.

Table 1: The objectives of IT Portfolio

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 (Institute of Medicine 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 (Institute of Medicine, 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, each of which includes many aspects that are relevant to engineering, in terms of implementing ICT and other assets (Institute of Medicine 2001; Reid and Compton 2010).

(Rouse and Cortese 2010) suggest architecture for the healthcare delivery enterprise, shown in Figure 3. 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.

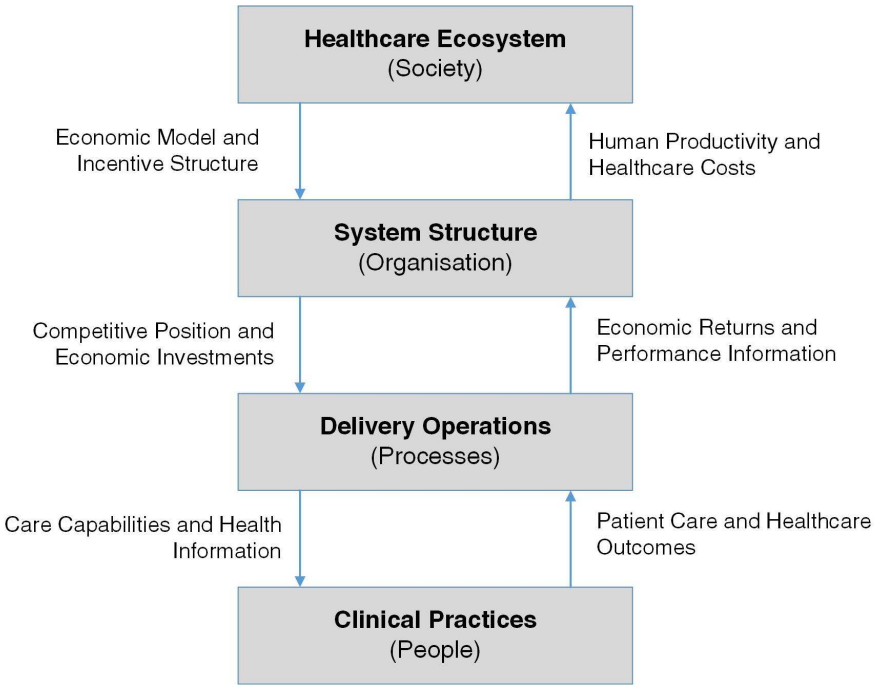


Figure 3: Healthcare Delivery Enterprise (Rouse and Cortese 2010)

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)

Research Design and the Proposed Conceptual Model

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 be based on The Enterprise of Healthcare Delivery Model (See Figure 3), and adapt it to find the business value of IT from a socio-technical perspective in four interrelated levels: (i) Clinical practices (people); (ii) Delivery operations (processes); (iii) System structure (organizations); and (iv) Healthcare ecosystem (society). Figure 4 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, and it is designed to provide a framework to study the business value of the different layers of IT in Weill's well-known model and in the four levels of the model of the enterprise of healthcare delivery. 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, as the following section shows.

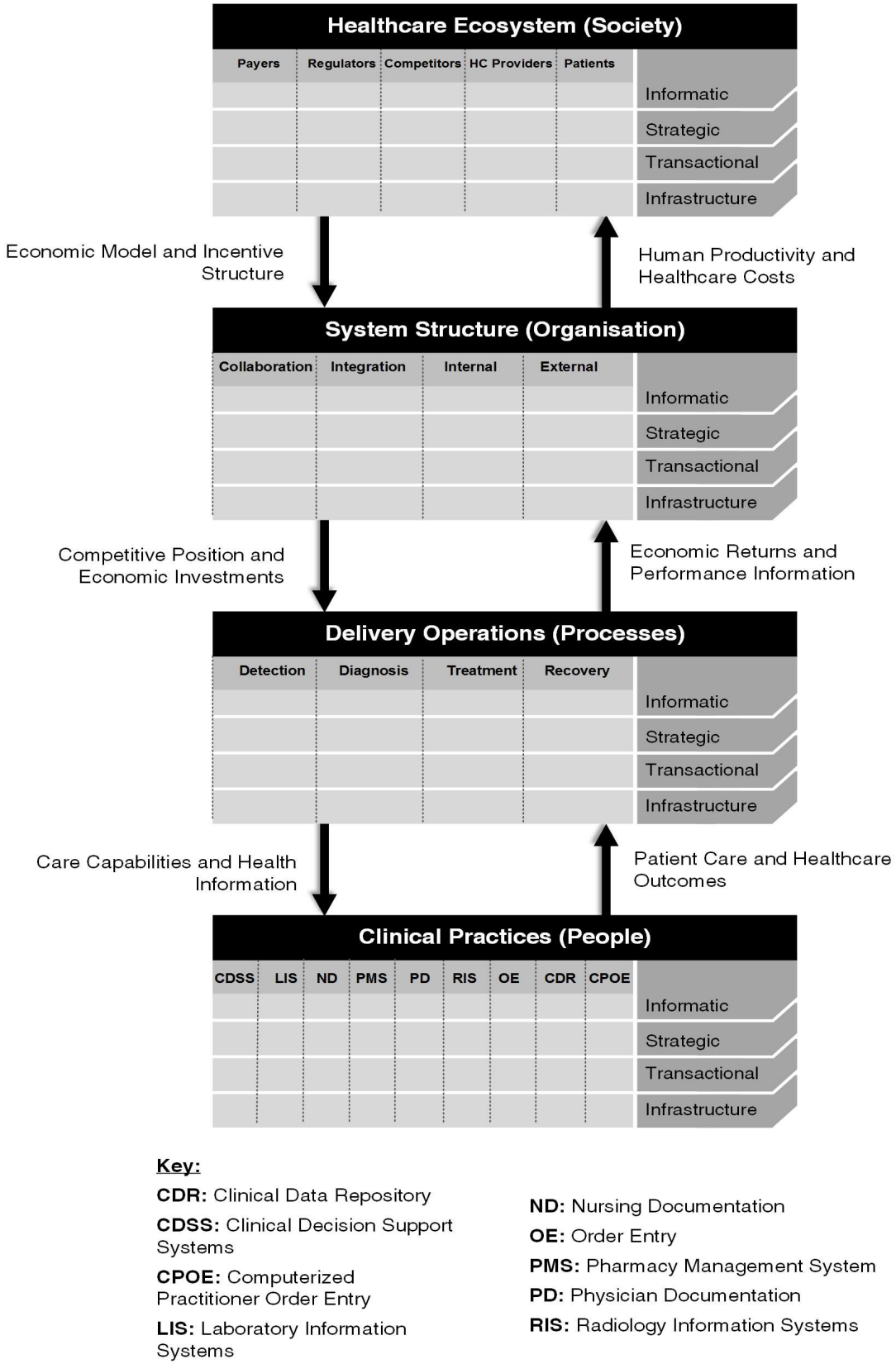


Figure 4: The Proposed Framework and Conceptual Model

Case Vignette

To demonstrate the benefits of the proposed framework we now illustrate its potential with a specific case vignette. We choose the PCEHR (Personally Controlled Electronic Health Record) in Australia as this is a recent, large e-health solution and thus enables all areas of the proposed framework to be examined.

PCEHR – Australia

Australia, like all OECD countries is facing many pressures to delivery cost effective quality healthcare. Recognizing the role for IS/IT in enabling superior healthcare to ensure the Australian Government embarked upon a health care reform initiative which also resulted in the design, development and implementation of a national e-health solution ; the PCEHR(Department of Health and Ageing, Australia 2011a, 2011b, 2012a, 2012b; NEHTA 2013a, 2013b) In particular, the PCEHR was designed to improve the quality of healthcare services and to minimize medical errors resulting from lack of good information collecting and sharing (Lehnbom, McLachlan, and Jo-anne 2012).

A comprehensive examination of the current literature on e-health solutions identified five key considerations that should be taken into account in order to better design and adopt e-health solutions; namely financial, organizational, social, people and technological (Muhammad, Teoh and Wickramasinghe 2012). i.e. a socio-technical perspective is needed to be developed and well-understood to maximize the returns of any e-health sustainable solution. The proposed framework for this study subscribes to this perspective and thus studies the four levels of healthcare delivery: healthcare ecosystem (social, financial), system structure (organizational), delivery processes (technological) and clinical practices (people). Table 2 depicts a mapping between the proposed framework and the PCEHR to illustrate.

Healthcare Delivery Level	**Main components**	**PCEHR Case Study**
Healthcare ecosystem	Payers	Australian Government who invested millions of dollars and keeps investing more for adding new features to the system such as the access to pathology and radiology tests' results. Private healthcare insurance companies as they try to identify their role in the access and use of data in the PCEHR and design their systems accordingly.
	Regulators	Australian Government
	Competitors	On a national level, PCEHR is the only solution of this type for e-health records. Globally more countries are developing (and using) their own e-health records like China (EHR), Germany (e-HC), UK (NpfIT: Ceased in 31st March 2013) (Muhammad, Zwicker and Wickramasinghe 2013). However, global vendors if they want to come into Australia now e.g. Epic need to be aware of the PCEHR and what tailoring may be required in their solutions.

	HC Providers	Australian healthcare sector is 2-teir structure (private and public). Thus, PCEHR aims to get these two main players involved. Further, GPs and specialists will all have access to patient data via this system as will allied healthcare professionals. This requires specific tailoring of the system son the side of all healthcare providers.
	Patients	Although the PCEHR is patient-centric e-health solution; signing up for this system is not mandatory, and does not affect the access to healthcare (Australian Government 2010)Patients do feel that they need assistance in how to navigate the system and use the system effectively (NEHTA 2013a, 2013b, 2013c)
System Structure	Collaboration	PCEHR is designed to sit between an individually controlled health record and a healthcare provider via a shared governance model (Muhammad, Zwicker and Wickramasinghe 2013). Furthermore, the main authority is the person himself/herself, whether or not grant access to healthcare professionals. Thus, collaboration between different players in Australian healthcare is needed, so is integration between PCEHR as a solution and current e-health records available for healthcare providers, both internally and externally.
	Integration	
	Internal	
	External	
Delivery Operations	Detection	It is hoped that using PCEHR will improve healthcare outcomes in Australia by having higher level of collaboration between different stakeholders in Australian healthcare sector, and reduce cost by avoiding unneeded visits to general practitioners (GP), unnecessary hospital admission and further medical operations and procedures in terms of detection, diagnosis, treatment and recovery (Australian Government 2010).
	Diagnosis	
	Treatment	
	Recovery	
Clinical Practices	CDR: Clinical Data Repository CDSS: Clinical Decision Support Systems CPOE: Computerized Practitioner Order Entry LIS: Laboratory Information Systems ND: Nursing Documentation OE: Order Entry PMS: Pharmacy Management System PD: Physician Documentation RIS: Radiology Information Systems	PCEHR is designed to present information captured from different systems to healthcare consumers and their authorized healthcare professionals according to the shared responsibilities and mixed governance model (Leslie 2011). Thus, PCEHR is fed by different clinical information systems like nursing documentation (ND), laboratory information systems (LIB), radiology information systems (RID0; etc. and then grants access to this data together by the consumers the their authorized healthcare professionals.

Table 2: Mapping the Proposed Framework and the PCEHR

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?" is significant in today's healthcare environment, as the literature review has shown, there has been a trend to increase the IT capital investments without detailed justification or knowledge of the increase in quality outcomes within healthcare. Knowledge is also needed on the relationship with other factors in increasing healthcare productivity by reducing cost and improving healthcare outcomes. So it is indeed necessary to measure the business value being facilitated by IT expenditure. 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 illustrate the benefits and use of the framework we provide an analysis of the PCEHR in Australia. This case vignette serves to highlight the breadth and depth of the proffered framework. Although this case vignette is in an Australian context, using the proposed conceptual model to investigate business value of IT in healthcare globally would be possible after noting the differences in healthcare ecosystems (payers, regulators, healthcare providers, etc.) from one country to another.

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.

Examining the potential business value PCEHR would have implications on both theory and practice, as this study aims to investigate whether or not, specific Informational IT solutions facilitate the generation of business value. Hoped results would be beneficial for both decision makers and practitioners to better resources allocations and healthcare outcomes.

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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