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# EXPLORING TRANSITION IN HEALTHCARE INFORMATION SYSTEMS: A PROCESS PERSPECTIVE ON RFID-ENABLED CHANGE

*Research-in-Progress*

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## **Abstract**

*This research-in-progress article reports on an ongoing investigation that explores the transition from RFID-enabled transactional systems to RFID-enabled strategic systems in healthcare settings. By adopting a comparative case study approach and a process oriented perspective, this research explores the underlying causal mechanisms that shape transition processes in this ever important industry. By developing deep insight into the factors that shape transition processes in healthcare, our research aims to generate key findings that are useful for both academic and practitioner audiences. By informing thinking in these areas, we hope to assist healthcare organizations in leveraging the strategic advantages offered by RFID technologies.*

**Keywords:** Healthcare IS, RFID-enabled Capabilities, Strategic IS, IT Enabled Change

## Introduction

The healthcare industry has been slow to adopt innovative information technologies for improving operational performance and enhancing quality of care (Herzlinger, 2006). Yet, absence of such technologies may be nearing an end. For instance, spending on one such technology—RFID tags and systems— is expected to grow considerably (from \$90 million to \$2.1 billion) between 2006 and 2016 (Harrop and Das, 2006). Thus, RFID enabled systems are increasingly being used by hospitals to improve operational efficiencies and improve quality of care (Datamonitor Report, 2008). However, the way in which RFID is used and how it creates value seem to differ dramatically across healthcare settings.

Pilot studies of RFID use in critical care contexts suggest that there may be distinct patterns of use across healthcare settings (Lewis et al., 2009). In one scenario, hospitals implement RFID systems in distinct functional units to automate previously manual processes. In this case, the RFID system remains specific to the functional unit and integration across other applications or functional units appears slow and inhibited. However, in a second scenario, the RFID systems quickly become a baseline application that set forth a chain reaction of change—where previously disparate applications and processes become tightly integrated into a seamless enterprise solution. This transition—from an isolated transaction oriented system to an integrated strategically oriented system—is the object of this investigation.

There has been a clear distinction between transaction and strategic information systems in the IS literature (Burgelman et al., 2008, Chan et al., 1997; Kettinger et al., 1994, Lederer and Sethi, 1996, Segars and Grover, 1998) However, existing research has revealed little about the underlying structures and processes by which a previously transaction oriented system eventually becomes strategic. Most research in this area considers a system to be either transaction or strategically oriented, but neglects the transition process that might change a systems orientation over time. The purpose of this investigation is therefore to explore the underlying causal mechanisms that enable RFID enabled systems to shift orientations in healthcare settings—transitioning from a technology that simply automates previously manual processes to a technology that enables transformational change across the extended healthcare enterprise. For healthcare organizations to fully leverage RFID capabilities, research that informs these transition processes is necessary and crucial.

In particular, we explore these transition processes by focusing initially on RFID enabled inventory management systems that are specific to specialized areas of service delivery in healthcare settings (cardiac catheterization and interventional radiology). As the healthcare delivery unit assimilates the technology into their work practices, the RFID enabled inventory management system may then become integrated with a portfolio of previously disparate applications. By closing the loop on applications such as inventory management, purchasing, and patient billing, operational efficiencies are increased and new sources of value are realized. Moreover, increased product visibility and historical analysis of usage trends related to key products may enable inventory pooling across hospital functions and bulk buying of high asset supplies. The aim of this research is therefore to explore this transition of RFID use across multiple healthcare contexts. In doing so, our study will be guided by the following research question:

*How do RFID-enabled inventory management systems transition from transaction to strategic orientations in healthcare settings?*

While exploring the underlying mechanisms that support and shape the transition, we must also explore the key factors that positively and negatively influence this shift. Therefore, our research will also seek to answer the following question:

*What are the key enablers and inhibitors of the transition that are specific to the healthcare context?*

In the following section, we provide the theoretical background and research framework that guide this study, followed by a discussion of the methodology and the plan for completing the project.

## Theoretical Background

This research adopts a process theory perspective (Van de Ven, 2007) and utilizes Van de Ven and Poole's framework on modes of organizational change (Van de Ven and Poole, 1995) to investigate the transition from transaction to strategic RFID enabled systems in healthcare settings. The modes of organizational change

perspective has been used by many IS researchers that have investigated ERP implementations (Robey et al., 2002) and telemedicine innovation (Cho et al., 2007). Furthermore, process oriented perspectives are becoming increasingly popular in organizational studies (Langley, 1999; Van de Ven, and Poole, 2005)

Van de Ven and Poole (1995) argue that development and change in organizations can be explained using four types of process theories, based on two key dimensions: mode of change and unit of change. They classify the four types as lifecycle, teleology, dialectics, and evolutionary theories. According to Van de Ven and Poole (1995), while lifecycle approach advocates a “unitary sequence of change events, which is cumulative and conjunctive” (p. 515), teleology promotes a “repetitive sequence of events including goal formulation, implementation, evaluation and modification” (p. 516). Dialectical approach identifies the stability and change aspects as explained by the opposing forces in the organization, whereas the evolutionary approach seeks a Darwinian explanation of variation, selection and retention cycles explaining organizational change and development. Depending on the mode and unit of change, one of the four theories would be most appropriate to study the factors causing RFID-enabled organizational change.

Applying Van de Ven and Poole’s (1995) model for understanding the change from RFID-enabled transactional to RFID-enabled strategic information systems is appropriate in the healthcare context, for the following reasons. First, contrary to the popular practice of IT-driven systems implementation, RFID implementation in hospitals is typically user-driven (Caplan et al., 1994). Therefore, studying the underlying organizational change factors becomes essential. Second, in addition to impacting the technological aspects, RFID implementation can also enact process changes in one or many entities (such as groups and departments), across the hospital setting. Hence, the need for applying various process models that deal with one or many “units” of organizational change becomes important. Third, depending on the depth of implementation, the transition can build on prior transitions in the RFID system, build on other systems implementation in the hospital, or undertake an entirely new developmental path. Hence, understanding the transitions enacted by the “modes” of organizational change becomes essential. As our purpose in this article is to identify the various enablers and inhibitors that impact the transition from transactional to strategic systems, the dialectic mode suggested by Van de Ven and Poole (1995) serves as a particularly useful analytical lens to investigate the transition processes in this context.

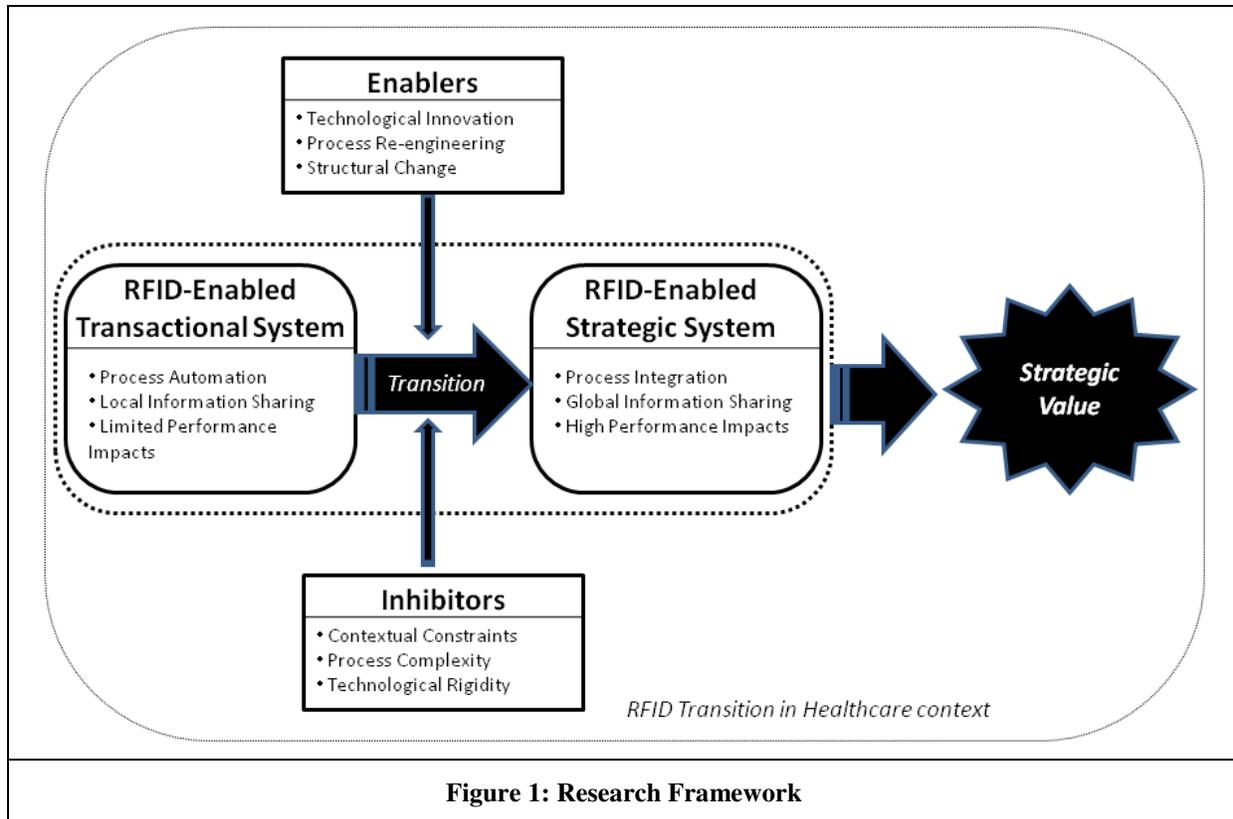
This study seeks to explore how healthcare organizations can leverage RFID technologies to its greatest extent—to support the transition from transaction to strategic orientations. To develop our arguments further, we draw from extant research on healthcare, strategic information systems, and supply chain management literature to build our research framework.

## **Research Framework**

The research framework for our study is provided in figure 1. In this section, we begin with a brief description of the strategic value of IT investments in healthcare context. This is followed by the types of RFID-enabled information systems, and the various factors that enable and inhibit the adoption and transition of the strategic information systems.

### ***Strategic Value of IT Investments***

The strategic value of IT investments in healthcare can be classified as consisting of three dimensions: economic performance, structural performance and clinical performance (Solovy and Chaiken, 2003). Economic performance refers to the return on investment (ROI) from the IT investment (Solovy and Chaiken, 2003). IT investments are shown to contribute positively to the production of services (Menon et al. 2000 ISR) and to financial performance (Menachami et al., 2006) in the healthcare industry. However, several researchers including Bauer (2004) and Vogel (2003) argue that conventional analysis of ROI as increase in revenues has led to a misconception among healthcare practitioners that IT investments in healthcare does not yield positive ROI. They argue instead that in healthcare settings ROI should be computed as reduction in costs and should be based on future cost of health personnel. Structural performance refers to the process improvements in the functioning of various activities from the IT investment (Solovy and Chaiken, 2003). It includes improvements such as workflow efficiencies, streamlining of processes and reduction in processing time, enhanced inventory turns, less inventory shrinkage, increased visibility, and provision of secure information. Clinical performance refers to the process improvements in the various patient-care processes from the IT investment (Solovy and Chaiken, 2003). It includes improvements in processes such as reductions in errors associated with patients, reductions in errors associated with inventory use, and reductions in inventory use due to mistakes, and streamlining of patient ordering processes.



### *RFID-Enabled Information Systems in Healthcare*

Increasingly, the healthcare industry provides a unique context for organizational scholars to study the impact of innovative IT investments on overall healthcare performance. For instance, hospitals and other healthcare establishments are expected to increase their investments in advanced technologies—such as RFID—to improve operational efficiencies in areas such as inventory management and to enhance patient care (Datamonitor, 2008). Inventory management and the use of RFID is an often researched topic among operations research scholars (Scott and Westbrook, 1991; Turner, 1993) who focus largely on functional problems (Rai et al., 2006). However, inventory management takes on a new light in hospital settings as it lends itself to two distinct types of uses: RFID-enabled transactional systems and RFID-enabled strategic information systems.

#### **Transactional Systems**

By definition, a transactional system is an IT system which processes transactions involving addition, update and deletion operations (Jesang et al., 2005). Such a system is useful for automating some processes and improves the process efficiencies of that particular functional area. The software system, as a result, is siloed and does not communicate with other IT systems or parts of the organization. It is typically a stand-alone system.

Many hospitals have adopted RFID-enabled systems as transactional systems (Haux et al., 2004). Specialty hospital settings relate to practice areas where high risk procedures are conducted and high value (greater than \$2000) products are likely used. By using RFID in these settings, the collection of information across activities—those that are coordinated within a specialty process (such as a cardiac catheterization or interventional radiology procedure)—is automated. As a result of the limited human intervention necessary for information collection, materials managers can get a near real time digital representation of material flow within practice areas. For instance, typical manual processes, such as counting of inventory, are replaced by automatic processes using RFID technology. Other instances include replacement of legacy systems using bar-code technologies using RFID.

The important aspect to understand is that, in all these situations, the hospitals view the potential of a RFID-enabled system as merely an 'Automation System'. Although the process efficiencies improve (structural performance), other inherent capabilities of an RFID system are left untouched. Therefore, our fundamental premise in this study is that hospitals would realize strategic value from RFID investments, which includes all the three dimensions of performance, when they shift towards utilizing the capabilities of the technology, and adapt them to become an RFID-enabled strategic information system, as discussed below.

### **Strategic Information Systems**

Prior literature has studied the role of strategic information systems and its impacts on the performance of the firm. Many scholars have empirically validated that planning processes for strategic information systems play an important role in predicting the firm-level outcomes (Chan et al., 1997; Kettinger et al., 1994, Lederer and Sethi, 1996, Segars and Grover, 1998). More recently, researchers argue that the higher-order capabilities developed through the strategic information systems impact the sustainable competitive advantage of the focal firm (Burgelman et al., 2008). Recent work in this area continues to call on researchers to investigate the causal pathways linking IT investment and firm performance (Rai et al., 2006; Sambamurthy et al., 2003, Ho et al., 2002). One area of particular interest in IS research today is the role and potential impact of IT in healthcare organizations (Kohli and Grover, 2008).

The healthcare context has interesting challenges for the implementation of strategic information systems. The informational need in hospitals has grown by leaps and bounds (Haux et al., 2004). Right from managing the patient records, to storing test reports, and inventory management, the informational requirements have grown alongside the improvements in healthcare delivery. However, the full realization of the strategic use of such information is still lacking in many healthcare contexts. To generate value from these IT investments, scholars increasingly argue that organizations must leverage the functionalities of these digital resources to create higher order capabilities, such as innovating business processes, shaping new strategy, and extending the enterprise network (Sambamurthy et al., 2003).

An RFID-enabled strategic information system is characterized by increased process integration, extensive information sharing across processes, thereby attaining strategic benefits as a result (Rai et al., 2006). Although inventory information is tracked in multiple systems, such as patient care systems and vendor management systems, due to their siloed nature various higher-order process capabilities, such as reordering points for inventory, patient statistics and reporting, consignment manipulation and tracking, are difficult to accomplish. This becomes the fundamental problem in a transactional system. However, by using the same RFID tag as a common thread among these seemingly distinct activities, an RFID-enabled strategic information system can not only improve one particular functional area, such as inventory management, but also, through interconnections among patient-care systems and vendor management systems, affect the entire value chain. This newfound information visibility can also be combined with and enable new work practices to develop higher order capabilities for reducing par levels through increased product use visibility, improving cost management, enhancing patient safety, and enabling regulatory compliance in hospital settings. This leads us to the fundamental research question of our study – Why wouldn't hospitals shift from using RFID as mere transactional systems? To answer this question, we try to understand the conditions under which hospitals would adapt RFID as strategic information system. In our study, we explore the key factors that potentially enable and inhibit the adoption/transition of the system.

### ***Enablers of IT Related Change in Healthcare***

Several technologies have been used for inventory management in the healthcare industry. For instance, bar code technologies combined with inventory management systems have been used in several cases for handling inventory (HealthCareIT News, 2004). However, implementing an RFID-based system provides unique opportunities for a firm to develop important IT capabilities that were previously unavailable to healthcare organizations (Curtin et al., 2007; Dutta et al., 2007). This study seeks to understand the technological, process, and structural factors that enable healthcare organizations to make the transition to more strategic uses of RFID technology. In doing so, we will seek to study both the technology and the underlying social system in which the technology is embedded. As a result, a variety of factors could serve as enablers of IT related change in healthcare. For instance, top management support, competitive pressure from different hospitals, changes in technological culture in organizations could serve as key enablers of the transition (Soliman and Janz, 2004). Therefore, through our case study, we will explore the social, procedural, and technological factors that enable the transition to more strategic uses of RFID in healthcare settings.

### ***Inhibitors of IT Related Change in Healthcare***

The healthcare context presents unique challenges for realizing the true value of RFID technology. Consequently, a variety of factors can act as inhibitors of IT related change in healthcare. For instance, prior research on the work conditions in hospitals continues to show high levels of stress related to task urgency or the life and death situations workers often find themselves facing (Caplan, 1994; Stordeur et al., 2001). As doctors and nurses face situations that teeter on the edge of life and death, their focus is understandably on patient outcomes rather than process performance outcomes. Thus, assimilating innovative technologies to improve inventory tracking may take a back seat to other potentially more important initiatives. Yet, practitioners should not mistake the importance of quality control in inventory management for improving patient safety and enhancing quality of care (McNutt et al., 1997). Additionally, greater procedural specialization does not necessarily mean that the corresponding IT systems and processes would automatically become tightly integrated (Soliman and Janz, 2004). In fact, such procedural innovations in healthcare might make the conversion from transactional systems to strategic information systems more difficult.

### **Research Method**

This study will adopt a comparative case study design to explore the transition processes that are the cornerstone of our investigation. A case study approach is particularly useful for exploring transition processes because it allows us to dive deeply into the contextual factors that might help to explain how and why such change occurs. According to Yin (1994), this is one of the main reasons researchers should choose a case study strategy, because it allows the phenomenon to be investigated in its real life context. Moreover, in situations where the boundaries between the context and the phenomenon are especially unclear, the case study strategy is particularly useful (Yin, 1994). Our focus on the transition process, whereby an RFID enabled transaction system may become strategic, is clearly one that is best studied in its natural setting. Although the depth afforded by a single case design might be compromised to some degree, a comparative case study strategy enhances our analytical leverage because findings can be compared across cases (Robey et al., 2002).

Principles of theoretical replication will guide our case selection strategy, so we can test our assumptions that predict divergent results but for predictable reasons (Yin, 2003). Directed by this viewpoint, we will conduct a retrospective analysis of eight cases in four separate hospitals. These eight cases represent distinctive implementations of the inventory management system. Meaning, one system is not necessarily used across departments—each department begins by adopting their own system. This approach allows us to ensure differences along important outcome observations as well as contextual characteristics that are assumed to impact the transition processes over time. Accordingly, we have chosen sites that vary; first, in terms of where they reside on the journey to developing a tightly integrated RFID enabled strategic information system (transition stage). Once they transition past the first stage, departments are beginning to integrate with other systems and processes, thereby beginning the shift towards a strategic information system. A vendor of RFID solutions for healthcare organizations provided the access to our initial set of cases, and they helped us choose sites based on their perception of where such organizations fall on the transition spectrum (see table 1). We have also sought hospitals that have both cardiac catheterization and interventional radiology practices, as the contextual differences across these practice areas will be explored to investigate their impact on the transition processes.

### ***Data Collection***

This multi-case study will use three sources of data to explore the phenomenon and ensure adequate validity of research findings (Yin, 2003; Miles and Huberman 1994). A series of semi-structured interviews will be the principal source of data for this study. Early interviews were conducted from the perspective of a vendor of RFID solutions in the healthcare industry. These interviews included discussions with the Chief Executive Officer, the Vice President of Hospital Services for CCL labs, and the Director of Hospital Services for IR labs. Upon completion of these early exploratory interviews with the vendor, we conducted our initial interviews with members of the first site identified, a CCL lab from a large hospital in the Northeastern part of the United States.

The interview protocol is semi-structured and consists of questions that are both targeted and open-ended. Our intent is to first confirm where a particular organization resides on the transition spectrum. Once we have done so, we ask target questions to explore factors that have enabled and constrained the transition process. Direct observation will be our second source of data, which allows us to act as passive observers within the service areas (Yin 2003). As a

supplement to other sources of data, observational data is particularly useful for means of triangulation (Mason, 2002). Finally, we will leverage a rich set of archival data, which provides yet another means of triangulation. Power point presentations, meeting notes, and white papers generated from both the vendor and hospital perspectives, as well as a rich repository of RFID system data will all be collected, analyzed, and interpreted to generate key insights.

<b>Hospital<sup>1</sup></b>	<b>Size</b>	<b>Service Area</b>	<b>Transition Stage</b>
<b>Southern Hospital</b>	Extra Large	Cardiac Cath.	Stage 3
		Interventional Rad.	Stage 1
<b>Northeastern Hospital</b>	Large	Cardiac Cath.	Stage 2
		Interventional Rad.	Stage 1
<b>Western Hospital</b>	Medium	Cardiac Cath.	Stage 3
		Interventional Rad.	Stage 2
<b>Mid-Western Hospital</b>	Small	Cardiac Cath.	Stage 1
		Interventional Rad.	Stage 2
Stage 1 = no integration, Stage 2 = integration within functional unit, Stage 3 = integration across practice areas, Stage 4 = integration across vendors			

### **Data Analysis**

A combined inductive and deductive coding and thematic development technique will be used during data analysis (Fereday and Cochrane, 2006; Chiasson et al., 2008). In novel settings where extant work is limited, this hybrid approach to data analysis is particularly useful; it allows us to initiate the analytical process by working from the data and lets us move from specific cases to more general conclusions (Schwandt, 2001). By alternating inductive and deductive analysis, we are able to leverage Van de Ven and Pooles (1995) perspective more effectively. Thus, we will first determine which modes of change seem most appropriate for explaining our observed outcomes, and then use the chosen mode to develop deep insight into the processes and structures that shape the transition process.

The majority of the interviews for this study will be conducted by two of the authors, while the third author will act as a sounding board for early findings and observations. Moreover, the third author will critique findings based on reference to prior theory. All interviews will be recorded and transcribed, and an iterative process of listening, reading, coding, and discussing the data will be followed based on Eisenhardt's (1989) recommendations. Computer assisted analysis tools will facilitate the process of coding data into key themes and text segments. Finally, saliency rather than frequency will guide our analysis process for identifying rich insight and for answering our research questions.

### **Project Status**

This research is in progress. In addition to a series of interviews at the vendor firm, we have completed one set of interviews with the Northeastern hospital and are currently conducting the within case analysis of this data set. Upon completion of this first case, we will continue on to the subsequent cases previously identified. Our intention is to have the first round of data collection complete by September 2009 and a first draft of preliminary findings by ICIS in December 2009. We plan to discuss findings from our study during the conference.

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<sup>1</sup> Hospital names have been disguised to protect confidentiality

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