EXPLORING THE IMPACT OF RFID ON ORGANIZATIONAL STRUCTURE CHANGES IN A HEALTHCARE SETTING: AN ADAPTIVE STRUCTURATION THEORY PERSPECTIVE

Completed Research Paper

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Abstract
Changes in organizational structures triggered by information technologies cannot be viewed from a single perspective. There are many factors that influence organizational structure change when advanced technologies are introduced, adopted and implemented. In our research we examine the changes to the organizational structure triggered by RFID adoption in a healthcare setting from the Adaptive Structuration Theory (AST) perspective. Employing the Actor Network Theory (ANT), we described in detail the healthcare organizational structure prior to implementation, during implementation and after the implementation of the RFID technology. We then apply the Adaptive Structuration Theory to explore the role of the RFID technology in the organizational structure change. The contribution of our research is two-fold. First we attempt to clarify the extent to which RFID technology influences the organizational structure change. Second we endeavor to combine ANT with AST to create a roadmap for future research in examining the relationship between IT and organizational changes.

Keywords: Healthcare, RFID, Actor Network Theory, Adaptive Structuration Theory, Case study
Introduction

Since the introduction of computer processing in the last 50 years, researchers have studied if information technology (IT) is the determinant of changes and transformations in organizational structures. Alternatively, there is equal amount of research examining if the organization itself is the determinant of changes and transformations in organizational structures. As IT systems are introduced in organizations, structure changes are inevitably going to occur and the factors that cause the change is of great interest to both researchers and practitioners.

An organizational structure consists of activities such as task allocation, coordination and supervision, which are directed towards the achievement of organizational aims (Pugh 1971). There are three different perspectives for studying organizational structure change and IT: decision-making, institutional, and social technology perspectives. The decision-making perspective focuses on the positivist tradition and assumes decision making is rooted in the organization. The institutional perspective uses technology as an opportunity for change, rather than the cause of change (Barley and Tolbert 1997). The third perspective, known as the social technology perspective, combines both the decision-making and institutional perspectives and combines technology with existing social structure to determine the factors that influence organizational structure changes.

There are many different types of technology that can influence organizational structure change. One type of information technologies that has been in the forefront of the healthcare industry in the past decade is radio frequency identification (RFID). RFID is a technology that has been around for several decades, but only recently has become increasing popular. The healthcare industry has the potential to become one of the fastest growing sectors for RFID applications, driven partly by government influence and mandate (Kontnik 2004). In healthcare, RFID is one of the emerging technologies offering a solution, which can facilitate automating and streamlining safe and accurate patient identification, tracking, and processing important health related information (LandMARC 2002). RFID technology can be used for a variety of functions in a healthcare setting ranging from tracking patients and employees to carrying and transmitting medical information. Little research exists in studying organizational structure changes using RFID in a healthcare setting.

Since RFID technology is a prevailing technology in the healthcare industry it is important to study the organizational structure changes when RFID is implemented in an industry that is slow to adopt new technology and is strictly regulated by the government. Our research objective is to investigate the factors that influence change in an organizational structure when an advanced technology is introduced. To examine the influence of change, we are utilizing a case study approach since this approach allows us to observe these influences from a holistic, outsider perspective. This case study examines a RFID implementation project at a specific healthcare facility in the Midwestern United States. The healthcare organizational structure is described and detailed prior to implementation of the RFID technology. This structure is traced and described using the Actor Network Theory (ANT). After implementation of the RFID technology, the organizational structure is reexamined to determine the changes in the structure using ANT and Adaptive Structuration Theory (AST). We are employing AST as a framework for analyzing the change in an organization structure. AST allows us to examine the influences of organizational structure changes by incorporating technology, existing structure, external influences, implementation factors and other business processes. We then analyze the changes to determine if the changes were due to implementation of RFID or because of institutional directed changes or because of both factors working congruently. To our knowledge the integration of ANT and AST is rarely used to study organizational structure changes.

The contribution of our research is two-fold. First we attempt to clarify the extent to which RFID technology influences the organizational change. Second we endeavor to combine ANT with AST to create a roadmap for future research in examining the relationship between IT and organizational changes.
Theoretical Foundations

There are three perspectives on studying organizational structure change and information technology: decision-making, institutional, and social technology. The decision-making perspective focuses on the decision making itself and believes it a core of the organization. Decision-making theorists believe technology contains structures designed to overcome human weaknesses. Examples of these theories in IS are task-technology fit models (Jarvenpaa 1989) and garbage can models (Pinfield 1986) which stress technologies must match or support tasks or activities.

The institutional perspective uses technology as an opportunity for change, rather than the cause of change (Barley and Tolbert 1997). In this perspective, the focus is less on the technology structures and more on social structures. This perspective is an interpretive approach to research which uses nondeterministic models or pure process models. For example, Fulk et al. (1987), presented a model of how social influences processes affected individuals’ attitudes toward communication media and media use behavior. One widely used theory to explain organizational adoption of technology is structuration theory which is mainly associated with Giddens’ institutional theory of social evolution (1979). Giddens proposes that structure and agency are a mutually constitutive duality. According to Giddens, social phenomena are not the product of either structure or agency, but both together.

The third perspective, known as the social technology perspective, combines both the decision-making and institutional perspectives. Social technologists combine the existing social structures of an organization with the influence of technology to determine the interaction. Two widely used IS theories that use this approach is Orlikowski’s (1992) structurational model and DeSanctis and Poole’s (1994) Adaptive Structuration Theory (AST). Research of this kind looks at all the factors that can influence social structure and uses theory to explain the change. AST is a variation from Giddens’ structuration theory which provides a model of the processes by which organizations incorporate advanced technologies into their everyday life.

In our research, we are analyzing the changes to the organizational structure using the social technology lens. We believe the decision making perspective has a myopic view with regards to technology and does not provide enough emphasis on the social structure. We also believe the institutional perspective does not put enough emphasis on technology as a factor that influences organization structure change. Although Giddens’ structuration theory has been used extensively in IS research it does not specifically address technology (Jones and Karsten 2008). AST attempts to bring IS to light with analyzing social structures with advanced information technology (Jones and Karsten 2008).

RFID technology is used by many different users, groups, equipment, and IT systems throughout the organization. Since RFID is intertwined in the organization, it affects the organizational structure in which it is being used. Because of the emergence of RFID in healthcare, we are using RFID as our advanced information technology to examine the organizational structure changes. In order to examine the organizational structure, we employ a theory that explains the relationships between actors of a network. This theory, known as ANT, is described in the next section.

Actor Network Theory

We employ ANT to trace and describe the organization network prior, during and post implementation of RFID in a hospital. ANT is a sociology theory that explains relationships between ‘actors’. In the early uses of ANT, Callon and Latour (1981) describe how individuals form alliances and enroll other actors, and use artifacts to strengthen such alliances, thus creating heterogeneous networks made of humans and nonhuman artifacts (Callon and Latour 1981; Sarker et al. 2006). They key difference between ANT and other network theories like Social Network Theory (Granovetter 1973; Milgram 1967) is that ANT claims that actors are both human beings and non-human actors (Callon 1986; Callon and Latour 1981). Due to interconnectivity of RFID technology to users, IT systems and equipment, ANT is an appropriate fit to explain these relationships compared to social network theory. Another benefit of using ANT is it does not distinguish between individual and organizational actors and it acknowledges the inherently unstable nature of actors in an organization. This allows the researchers the flexibility of considering a social-
technical collective as a single actor or as a group of individual actors (Sarker et al. 2006). Given the wide interest and interactions of actors in a healthcare setting, ANT brings to light a number of implications regarding technology adoption that are not readily apparent in other theories like resistance (Lapointe and Rivard 2005).

Implementation of ANT is not without its problems. The implementers of ANT frequently change or use only parts of the theory. Latour stated that the theory is often misunderstood and hence much abused (Latour 1997). According to Latour (1997) there are misunderstandings due to the common usages of the word ‘network’ within the Actor Network Theory. Latour (1997) mentions that a network does not need to be in a final or stabilized state to be called a network. The “actor-networks” could only be at the beginning of their story (Latour 1997). Another misunderstanding is that actors must be human and in the case of ANT this definition is expanded. To combat these common misuses of the theory, in our research we consider actors to be both human and non-human. We use IT systems and equipment as the non-human actors in our network. We also examine the network in the beginning of their story all the way through post implementation.

A major focus of the theory is to try to trace and explain the processes whereby relatively stable networks of aligned interests are created and maintained or just as important, examine why such networks fail to establish themselves (Callon 1986; Walsham and Sahay 1999). Table 1 is a brief overview of the ANT concepts, definitions and how we adopt it in our study.

<table>
<thead>
<tr>
<th>ANT Terminology</th>
<th>Definition</th>
<th>Use in our study</th>
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<tbody>
<tr>
<td>Actor</td>
<td>Any element which bends space around itself, makes other elements dependent upon itself and translates their will into the language of its own (Callon and Latour 1981)</td>
<td>Steering committee, physicians, nurses, business employees, RFID system, other IT systems, patients, project team</td>
</tr>
<tr>
<td>Actor - Network</td>
<td>Heterogeneous network of aligned interest</td>
<td>Pre-implementation, during implementation, post-implementation of RFID</td>
</tr>
<tr>
<td>Focal Actor</td>
<td>The key actor driving the process of enlisting the other actor’s support for the organizational change initiative</td>
<td>Steering committee</td>
</tr>
<tr>
<td>Translation</td>
<td>The process where actors are identified and the interactions between the actors are defined and negotiated. Translation is comprised of four stages: Problemization, Interessement, Enrollment and Mobilization</td>
<td>Describe entire translation process in detail with case study data</td>
</tr>
<tr>
<td>Problemization</td>
<td>The first stage of translation where key actor frames the problem in its own terms, identifies other relevant actors, and highlights how the problem affects the other actors</td>
<td>Steering committee identifies other actors that will be affected by RFID technology</td>
</tr>
<tr>
<td>Interessement</td>
<td>Second stage of translation where negotiations occur between the main actor</td>
<td>Steering committee negotiates with physicians and nurses, business</td>
</tr>
</tbody>
</table>

Table 1: Overview of ANT concepts and definitions
<table>
<thead>
<tr>
<th>Enrollmen</th>
<th>Third stage of translation is the process of defining roles for each of the actors in the network and that the roles are aligned to the interest of the network</th>
<th>Steering committee and other actors agreed to move forward with caution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>Fourth stage of translation where monitoring is put into place to ensure the final network is sustainable and stable</td>
<td>Steering committee formed a command center</td>
</tr>
<tr>
<td>Inscription</td>
<td>A process in which artifacts are created to ensure the protection of the network’s interest</td>
<td>User and training guides, change management documentation</td>
</tr>
<tr>
<td>Punctualization</td>
<td>Allows actors to be grouped together in a single ‘network package’ because effects/behaviors can ‘more or less be taken for granted’. Treats a heterogeneous network as an individual actor to reduce network complexity.</td>
<td>Physician and Nurses -&gt; Patient care CEO, CIO, COO -&gt; Upper management See Table 2 for full details</td>
</tr>
</tbody>
</table>

1 Definitions adopted from (Callon 1986). 2 Definition from (Law 1992, p. 385)

**Adaptive Structuration Theory**

Adaptive structuration theory (AST) created by DeSanctis and Poole (1994) follows the social technology perspective to examine influences of technology and organizational structure. AST extends current structuration models of technology-triggered change to consider the mutual influence of technology and social processes. AST is rooted in Giddens’ structuration theory (Giddens 1979; Giddens 1984; Giddens 1993) “in which he rejects the extreme positions in the agency-structure debate, positing in the process that human action, while institutionally constrained, also influences and alters institutional arrangements or structures, in the process of ongoing use” (Chin et al. 1997, p 344).

AST provides a detailed account of both the structure of advanced technologies as well as the unfolding of social interaction as these technologies are used. According to DeSanctis and Poole (1994, p. 131), it is possible to develop the proposition, “Given advanced information technology and other sources of social structure and ideal appropriation processes, and decision processes that fit the task at hand, then desired outcomes of advanced information technology will result”. AST has contributed to the IS literature and pioneered the use of structuration theory in the IS field by connecting structuration theory and mainstream IS research (Jones and Karsten 2008). Advanced technologies in this context are defined as technologies that support a business as well as coordination among people and provide procedures for accomplishing interpersonal exchange (DeSanctis and Poole 1994).

We believe AST is a match for our research in analyzing and explaining the factors that influence the changes in organizational structure. Since AST analyzes both the structures of the technology itself and the social interactions of the organization, the theory can encompass many factors to influence change. AST is also in agreement with the social technology lens (DeSanctis and Poole 1994) that we use to analyze the organization under study.

AST provides a framework that describes the interaction between the advanced technologies, organizational structures and human interactions (see Figure 1). Key elements of this framework include the structure of the advanced technology, other sources of structure, group’s internal system, social interaction which consists of appropriation structures and decision processes, emergent sources of
structure, decision outcomes and new social structures. In the next section we use the adaptive structuration theory and actor network theory as frameworks in a case study approach.

Combining AST and ANT

AST is based off of several premises and these foundations are critical when applying the theory. The first premise is that the AST is rooted in social technology perspective meaning technology has structures it its own right but that social practices moderate their effects on behavior (DeSanctis and Poole 1994). As discussed previously in this section, we apply the social technology lens to study the organization. Another premise of AST is that social structure is based off the rules and resources provided by technologies and institutions. A third premise of AST is that there are structures in technology and structures in action and these two are continually intertwined which iteratively shape each other (DeSanctis and Poole 1994). In the case study we examine the technology and institutional rules and resources as well as the interaction between the technology and the organization. A final premise of AST is that although structural change lies below the surface of decision making it can be captured in the interpersonal interaction at micro, global and institutional levels. In the case study we utilize ANT to demonstrate a network of actors and interactions at the institutional level. Since our case study satisfies the AST premises, we are able to apply AST to explore the role of the RFID technology in the organizational structure change.

AST also has limitations in its implementation to study organizational structure changes brought on by an advanced technology. One limitation is that AST does not address how different sources of structure might interact when used together (Anson et al. 1995). To overcome this limitation we use ANT to demonstrate the relationship between actors in the network and show how these actors interact with each other. Another limitation of AST is that it ‘requires identifying a fundamental shift in the IT system; the challenge here is not only to observe such a major shift in the system, but also to determine whether the system under investigation is actually changing, or whether the researcher is simply observing a steady state where inertia of the past system still dominates the current state’ (Holweg and Pil 2008, p. 404). We argue below that is that there is a fundamental shift in the IT system since the hospital is implementing a new IT technology to replace the existing, limited technology of bar coding. By combining ANT with AST we overcome the current limitations of using AST by itself.
Case Study

A case study approach was applied to a healthcare facility in the mid-western United States. According to Lee (1989), an MIS case study refers to the examination of a real-world MIS as it actually exists in its natural, real-world setting (Lee 1989). Benbasat et al. (1987) stated that the case study is a powerful methodology that allows researchers to study information systems in natural settings, learn about the start of the art, and generate theories from practice. Data analysis was performed at the same time as data collection activities were being conducted to take full advantage of the flexibility of adopting the case methodology (Eisenhardt 1989). We followed an iterative process of data collection by moving back and forth between empirical data, the social technology theoretical lens, relevant literature, and the proposed models until 'theoretical saturation' is reached (Eisenhardt 1989).

We interviewed eighteen employees of the organization who were involved in the RFID project. Among the fourteen people we interviewed, seven are IT managers (i.e., one CIO, one CTO, one project manager, one information security manager, one network manager, and two site IT manager), two are corporate managers (that is, the director of financial services and the director of material management), one is a physician, four are nurses (i.e., the admitting manager, the radiology manager, the manager of the emergency department, and the chief nursing operating officer), and four business employees. We also interviewed an outside IT consultant and 2 patients. Face-to-face interviews were conducted by two researchers. Structured and semi-structured questions were asked during the interviews. Each interview lasted approximately one hour. The interviews were audio-recorded and notes were taken by the researchers during each interview. The interviews were transcribed and analyzed following the case based approach. In addition to the interviews, documentation such as the technical report by the consulting firm on the pilot project and the organization’s website were included in this study to complement the results of the interviews.

Background

This case study examines a radio frequency identification (RFID) implementation at a specific healthcare facility in the mid-western United States. The hospital system described in this case study is a non-for-profit network of hospitals scattered around a large metropolitan city. Although the healthcare system is comprised of many hospitals, physician offices, and labs, our focus is at one of the main hospitals in the system. This specific hospital is the flagship hospital of the healthcare system and is located in the metropolitan area. This hospital was the first facility in the hospital network to implement RFID. If the project was successful then other hospitals in the network would start implementing RFID in their own facilities. The RFID project lasted over a period of 15 months from January 2007 to March 2008. This time frame included the entire length of the project from the requirements gathering phase to implementation in the first hospital department. The scope of this case study will start from the point where RFID was initially discussed as a technology that would be useful until the first department implemented the technology.

Applying ANT and AST to Trace and Explain the Organizational Structure Changes

We intertwine ANT and AST in the following section to explain the organizational structure prior to RFID implementation, during implementation and post implementation. We utilize ANT to outline the structure and the changes to the structure then we utilize AST to identify the reasons for the changes.

Pre-Implementation Network

From an ANT perspective, the organization prior to RFID implementation can be viewed as a heterogeneous network made up of humans and non-humans all with a shared interest. This pre- RFID network consisted of upper management, patients, patient care resources (physicians, nurses), business employees, IT team, and IT systems. Each actor in this network shared a common goal to keep the hospital in business and to provide care for the patients. However, each of these individual actors had their own self interest in the role they played within the organization.
The upper management consisted of the CEO, CIO and COO. Although these three roles were played by different people, their interests were all aligned to the same goal. This goal was to maintain profitability and ensure long term viability for the hospital as stated by the CIO.

*My job includes developing the strategic technology direction for the hospital, in concert with executive leadership - includes invigoration of the strategy and vision; establishing long-term goals and operating policies for the local IT organization that align with the systems technology policies, procedures and federal/state regulations; participating in budget planning for the organization; identifying the strategic IT implications and opportunities resulting from major corporate strategies and change initiatives.*

In ANT, the concept of punctualization allows us to group the three different actors into one actor called upper management. This is possible because the effects/behaviors of these individuals can “more or less be taken for granted” and therefore be combined into a single “network package” (Law 1992, p. 385).

The patients, who are the customers of the hospital, played an integral role in the network. Their interest was to ensure they received the best care to their knowledge with speed, accuracy, efficiency, hospitality, comfort and effectiveness. According to ANT, patients would be an individual actor and will not be combined with any other actor since their interests are unique to the rest of the network.

Patient care resources consist of physicians, nurses and the chief nurse. In line with the *relativity* tent of ANT (Law 1992) the physicians and nurses’ interests are largely defined as an overall arching goal to provide patient care. To simplify our pre-RFID network, we punctualize these three actors together into one actor called patient care resources. Although the self-interests of physicians are different from the self-interests of nurses they share the same over-arching goal for patient care.

The business employees consist of the receptionist and registration clerks in the emergency room. These employees assist with the logistics of getting a patient through the system. Their responsibilities include greeting, registering, directing, and discharging the patients. These roles are played by many different actors but all share the same interest therefore they are punctualized into one actor called business employees.

The IT team consists of the director of IT and the IT team members. These actors are responsible for maintaining the current systems used in the hospital.

*IT department supports our core philosophies through improving patient safety, allowing appropriate, timely communication of the patient’s medical information, and helping our colleagues become more efficient.*

These systems range from business systems (billing, collections) to patient diagnostic systems (patient records, clinical documentation, medical reporting system) to supply chain systems. They are punctualized into one actor called IT team.

Lastly, the IT systems also play a role in actor network diagram since ANT uses both human and non-human actors. The IT systems include an electronic clinical documentation system, medical reporting system, clinical physician ordering entry system, decision support system, and a bar coding system. Although there are many more systems used in the hospital (e.g., security, HR, PBX, etc) they are not considered in scope for the pre-RFID network. These systems all have the same interest within patient care. They are used by different actors for different reasons, but all share the same interest in providing for the welfare of the patients. Because of this, these IT systems are punctualized into one actor for our pre-RFID network.

<p>| Table 2: Snapshot of the actors in the Actor Network prior to implementation |
|-----------------------------|-----------------------------|-----------------------------|
| Actor                      | Punctualized Actor          | Interest                    |
| CEO                        | Upper Management            | Maintain profitability and ensure long |</p>
<table>
<thead>
<tr>
<th>Role</th>
<th>Description</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CIO</td>
<td></td>
<td>term viability for the hospital</td>
</tr>
<tr>
<td>COO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patients</td>
<td>Patience</td>
<td>Ensure they receive the best care to their knowledge with speed, accuracy, efficiency, hospitality, comfort and effectiveness</td>
</tr>
<tr>
<td>Physicians</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Nurses</td>
<td>Patient Care</td>
<td>Provide patient care</td>
</tr>
<tr>
<td>Chief Nurse Officer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receptionist</td>
<td>Business Employees</td>
<td>Assist with the logistics of getting a patient through the system</td>
</tr>
<tr>
<td>Registration Clerks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Director of IT</td>
<td>IT Team</td>
<td>Maintaining the current IT systems used in the hospital</td>
</tr>
<tr>
<td>IT Team Members</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic clinical</td>
<td>IT Systems</td>
<td>Providing for the welfare of the patients</td>
</tr>
<tr>
<td>documentation system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medical reporting system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinical physician ordering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>entry system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision support system</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bar coding system</td>
<td></td>
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</tr>
</tbody>
</table>

The figure below (see Figure 2) shows an ANT view of the network prior to implementing RFID.

![Figure 2: ANT View Pre-RFID Implementation](image)

From an AST perspective, one of the sources of organizational structure is a construct called “other sources of structure”. These other sources are derived from external sources like governmental influences, competitors, clients and customers (patients). According to the CIO, [The] Health care industry is probably one of most heavily regulated industry. For example, we have to follow HIPAA to ensure the privacy of patient information. People usually won’t like to be watched or monitored in their daily lives, but things are different in the hospitals. Patients have different expectations on their privacy.
During the RFID Project

The initial motivation of the project was spearheaded by the CIO of the healthcare system. One of the organizational strategies of the healthcare system is to utilize technology to ensure patient safety and to stay competitive in the marketplace. According to the CIO,

*To ensure a safe environment for all patients in the provision of their care, we continue to utilize new technologies designed to improve care processes, as well as the analysis and benchmarking of these best-practice standards of care. We always try to stay at the cutting edge of the information technology as a strategic competitive weapon to differentiate us from our competitors.*

In January 2007, the CIO started investigating different types of technologies that could help the hospital stay competitive. One of these technologies under investigation was RFID. Although RFID technology has been around for decades, only recently has the convergence of lower cost and increased capabilities made businesses and organizations take a hard look at what RFID can do for them (Weinstein 2005). After investigating several technologies, the CIO decided to investigate RFID technology more thoroughly.

In August 2007, the CIO engaged the help of IT healthcare consulting firms that specialized in IT systems in the healthcare industry.

*There was no one in the IT department had the sufficient knowledge in RFID relative technologies to carry out the whole project due to its complexity. Consultants worked with us from the very beginning including setting up the test lab. They also helped us with the training process.*

These consulting companies (will be referred to as HCC throughout the paper) provided the hospital with equipment of an RFID network so the hospital may experiment and test the technology in a test lab environment.

*We set up the test lab for RFID implementation for two reasons. First, we were using a try and error approach to RFID adoption before going live to increase the success rate. Second, we used the test lab as a training center for end-users’ training and education of the RFID system.*

In October 2007, the CIO decided to initiate a project to implement RFID in the hospital after successful experiments in the test lab and after having a firmer understanding of the potential of RFID in the test lab. A new role, named test lab manager, was created to manage and direct the test lab RFID environment.

In order to examine the organizational structure changes, we first need to examine the structure provided by the technology itself. A construct in AST is the structures of the advanced information technology which can be described by the structural features of the technology and the spirit of the technology. Specific types of rules, resources or capabilities offered by the technology describe the structural features. According to the CIO of the hospital,

*RFID is being used to track and authenticate patients, from new born babies to seniors suffering from dementia and everything in between. It is being deployed to monitor patient wait times in real time and also to ensure the right medication is given to the right patient.*

The spirit of the technology describes the values and goals that the technology is trying to portray. With regard to what kind of goals and values are being supported when the hospital implements RFID, the CIO responded.

*The RFID enables the [IT] systems to be updated without any manual intervention, with the [RFID] readers in place we can track equipment, employees and patients without any manual input or update. RFID will really help improve the efficiency of some our processes, as it relates to bed turnover.*

*One physician responded, I can always know where my patients are, which really improves efficiency in that I don’t have to waste my time to go to a patient’s room when the patient is not there.*

In order to achieve a successful implementation and adoption of the new RFID system in the hospital, the CIO had to ensure buy-in from all of the groups affected by the technology. More specifically, the CIO had
to ensure that all the self interests of the future RFID users aligned to the same goal. According to ANT, translation is the process where actors are identified and the interactions between the actors are defined and negotiated (Callon 1986). The translation process consists of four stages consisting of problemization, interessement, enrollment and mobilization. The sections below describe each ANT translation stage using the case study.

The CIO set up a steering committee consisting of several key players that would help investigate the RFID technology as well as liaise between other actors in the hospital. One of the goals of the steering committee was to select one or two hospital departments as candidates for the initial pilot implementation of RFID.

The RFID Steering Committee decided the project objectives, schedules, and priorities. The Steering Committee was responsible for the overall success of the project effort, and for ensuring that the project effort meets the business requirements for the hospital in the areas of functionality, cost, schedule, and quality.

Although this hospital prided itself in using cutting age technology to stay competitive, many groups in the hospital were hesitant about accepting a technology that would radically change the way they conduct their own job. The steering committee consisted of the CIO, director of IT, test lab manager, and the COO.

The specific members were chosen based on JDA concept (e.g., members are from different functional areas) and based on their domain knowledge.

The steering committee is used as the focal actor in this study since they are the driving force behind enlisting the other actors to implement and adopt the new technology.

The first act of business for the steering committee was to form a project team that would design, implement, test and maintain the RFID system. The steering committee created a new project manager role. This role, filled by an experienced IT resource, would provide the planning, coordinating, communication and oversight to the entire RFID implementation. Parallel to hiring the project manager, the steering committee hired a senior analyst with a skill set both in business and in medicine that could help bridge the gap between the two worlds. Once the project manager and senior analyst were hired, the steering committee engaged the test lab manager and the IT staff. In December 2007, these four roles formed the project team that would design, implement, test and maintain the RFID system.

The current IT systems had to be considered in the RFID implementation. The current IT systems had to be analyzed to make sure they were in alignment with the new RFID system. The IT team was a delegate to the IT systems and could speak and act on the behalf of the IT systems. Since the IT team goals were aligned with the steering committee, so were the IT system goals.

According to ANT, during the stage of problemization, the focal actor frames the problem in its own terms, identifies other relevant actors, and highlights how the problem affects the other actors (Callon 1986). In January 2008, the focal actor (the steering committee) and the project team shared the same interest and common goal. Once these two teams agreed on scope and next steps, the focal actor started reaching out to other actors that did not share the same strategy.

The steering committee started discussions with the physicians and nurses about the RFID technology. The physicians and nurses expressed their concerns with the technology to the steering committee. The steering committee quickly realized that there was conflict between the interests of each of the groups. This conflict would have to be resolved in order to successfully implement and use the RFID system.

The steering committee with the help of the physicians and nurses had to decide what hospital departments would first implement the new RFID system. It was agreed that the emergency department and the radiology department would be the first two departments. The ER was chosen because the department encompassed all of the major hospital areas in one department. ER used patient monitoring, medical staff scheduling, equipment tracking and narcotics tracing. ER was also the most difficult functional area. The CIO stated,

If we can do it in ER, we can do it in anywhere.
The radiology department was chosen because the employees of the radiology were technically savvy. The steering committee felt that the employees had the technical knowledge to implement and adopt the RFID system easily.

The next step for the steering committee was to involve the business employees. These actors were the initiators of the patient RFID experience and were crucial to a successful implementation. The business employees were hesitant of any technology change that could jeopardize the current smooth registration system. The steering committee knew they needed to take further action to make sure that the business employees were onboard with the new system.

Once the steering committee framed the problem in its own terms, identified other relevant actors, and highlighted how the RFID implementation affects the other actors the problemization stage was complete. The next stage according to ANT is the interessement phase which negotiations occur between the steering committee and the other actors.

From an AST perspective, a group’s internal structure influences choices in how technology or other structures are used (DeSanctis and Poole 1994). These internal structures factors can include member’s styles of interacting, degree of knowledge and experience or leadership styles. One of the project team members commented on the leadership style of the CIO,  

\textit{Brenda [CIO] is very democratic and open-minded.}

From an IT team perspective, the CIO commented,

\textit{There is a very strong IT user group base. Last few years IT has been continually working with users to bring their knowledge level up, so that they can support more and more different IT applications.}

Observations from our case study demonstrated that the different groups worked well together and the leadership style of the CIO propagated open dialogue between the user groups of the technology.

Around January 2008, the interests of the physicians, nurses and business employees were misaligned with those of the focal actor (steering committee). All other actors agreed on implementing the RFID technology and wanted a successful user adoption. The physicians, nurses and business employees needed further convincing before they agreed that this new technology would benefit them.

In order to align the interest of the physicians, nurses and business employees the focal actor had to negotiate with these actors. One of the hesitations of these actors was they need to learn a new technology. The focal actor worked with the IT team as well as HCC to create extensive training documentation and training classes.

According to the CIO,

\textit{Technical reports by the third-party (HCC) were used as the basic material for the training and an IT staff who was involved in the entire RFID project was designated as the trainer.}

Physicians, nurses and business employees agreed that if the training documentation and classes were adequate then it would ease some of their concerns.

Another hesitation from the physicians and nurses concerns the patient care. Since the consultants had previous experience in implementing RFID successfully in other hospitals, it was easier for the consultants to convince physicians and nurses that RFID technology is a safe and reliable technology in the hospital environment. The focal actor relied on the consultants to “win-over” the physicians and nurses.

\textit{We brought them [physicians and nurses] to the test lab and showed them what the RFID system was able to do for them (patient tracking, scheduling, and device and drug monitoring and controlling).}

\footnote{The names of informants have been changed to ensure their anonymity.}
The last concern for the physicians and nurses were that they were going to be tracked with the new system. This was one concern that the steering committee could not alleviate. In fact it was the intention of upper management to better manage the medical staff. According to the CIO, 

*People usually won’t like to be watched or monitored in their daily lives, but things are different in the hospitals.*

Training, education and change management were promised to the physicians and nurses, but the concern still existed. Although the concerns were not completely alleviated, the physicians and nurses agreed to move forward with caution.

Jeopardizing the smooth registration process was a concern from the business employees. Once the business employees were shown the test lab and what the RFID system could do for them, they were less concerned. HCC also provided successful case studies from peer hospitals which eased their concerns about the registration process.

During this ANT process of interessement, the actors in the network had to agree on how they were going to use the RFID system. There are many different uses and types of implementations of RFID so the project team and users had to decide what features would work for them. This is explained by appropriation of structures using AST which includes four aspects: appropriation moves, faithfulness of appropriation, instrument use and attitudes (DeSanctis and Poole 1994). For the appropriation moves, the hospital had to integrate the RFID technology into the existing patient location tracking software and other IT systems.

*We knew that we had the wireless infrastructure in place, and we had undertaken the basic implementation of the patient location tracker software. RFID applications, however, are usually not stand-alone systems and compatibility with existing systems is a very important issue. For example, the organization we studied has over 47 different applications and over 600 servers in its data center. Substantial effort had been made during the pilot project to make sure the RFID application could be integrated with the existing systems (e.g., non-RFID–based patient tracking system).*

Faithful appropriations are consistent with the spirit and structural features of the technology (DeSanctis and Poole 1994). In this case, the hospital implemented RFID faithfully which aligned with the structure and spirit of the RFID technology. This means the post-adoption of the RFID project matches with the original intent of the use of the technology. According to the IT project manager,

*RFID helps us improve the quality of patient care by allowing our hospital to track and identify patients and also to limiting their departure or access to certain areas and by storing information about medical allergies or other health history of the patients and thus.*

Instrumental uses of the RFID are well detailed in the case study. According to the CIO, 

*This [RFID application] is certainly the next group of IT capability which began to eliminate the redundancy of human intervention in processes, then you can be measuring by leaps and bounds what those changes could be [from eliminating the human intervention]. I think the RFID has the potential to do all of these, tracking supplies, tracking assets, tracking where the wheelchairs are, where the beds are all that.*

Attitudes are the final aspect of the appropriation construct in AST which can include 1) the extent to which groups are comfortable with using the technology, 2) the extent to which groups perceive the technology to be of value, or 3) the group’s willingness to work hard at using the system (DeSanctis and Poole 1994). The attitudes for the RFID implementation were mixed.

*Most our IT people, hospital administrators, other non medical staff were very supportive of RFID implementation. Among medical staff, some of doctors and nurses felt indifferent about the RFID adoption.*

By January 2008, the focal actor had negotiated with the actors that showed concern in the new technology. According to ANT, the interessement phase was now complete and the next phase was
enrollment. The enrollment phase is the third phase of translation which is the process of defining roles for each of the actors in the network and that the roles are aligned to the interest of the network (Callon 1986). All of the actors agreed to move forward with the implementation, albeit some actors were moving forward with caution.

One of the problems is that the focal actors never fully engaged the radiology department. It was agreed that they would be one of the two departments in the initial implementation. The project team concentrated a great deal of effort on the ER department but never fully engaged the radiology department. Because of this the radiology department ran into some technical issues with the RFID technology in their department. The walls of the radiology department were thicker than other departments due to the radiology equipment. This resulted in the weak or non-existent RFID signals in the radiology department.

The radiology department was very enthusiastic about the project at the beginning. However the signals transmitted from RFID tags could not go through the thick interior walls of the radiology department to receive the RFID servers and we tried to put in the battery-powered fixed location beacons (wireless receivers) to cover the Radiology Department but they still failed for most of the time.

Until these issues could be resolved, the radiology department withdrew from the initial RFID implementation in February 2008.

Since all actors agreed to the roles for each actor and the roles were aligned to the interest of the project, the enrollment phase is complete. According to ANT, the network could move to the final stage of translation. This final stage of translation called mobilization is where continued monitoring is put into place to ensure the final network is sustainable and stable (Callon 1986). The physicians, nurses and business employees were still hesitant and cautious with RFID technology. The focal actor had to ensure methods were in place to ensure that these actors would not betray the interest of the focal actor.

The focal actor with the help of the IT team and consultants created a command center. This command center was able to monitor and track the status of the RFID technology in real time.

The command center was created to use the RFID system to direct the “traffic” – locating patients, nurses and physicians in real time and it also helped with scheduling for medical staffs (e.g., doctors and nurses).

The command center could detect problems in the hardware, software or middleware in the technology as well as monitor the normal day to day operation of the RFID technology. This functionality helped ensure that the physicians, nurses and business employees were adhering to the business processes and using the RFID system correctly.

The focal actor also instructed the IT team and consultants to create documentation to ensure the continued use of the RFID system. This documentation included instruction manuals, road maps, system specific documentation, business process procedures, change management procedures, and architecture and network diagrams. The documentation was shared and signed-off by the interested parties in the technology. This inscription of artifacts ensured the protection of the focal actor interest by ensuring all other actors agreed on the implementation and shared the same interest.

I (CIO) think that the RFID enables the system to be updated without any manual intervention, with the readers in place we can track equipment, employees and patients without any manual input or update.

I (an ER doctor) can go anywhere and immediately know where my patient is.

Now that mobilization was complete, the translation process overall was complete. The actors involved in the RFID project were now in a new network of aligned interest. In February 2008, each actor in this new network shared a common goal to use RFID technology in the hospital to provide care for the patients.

One of the desired outcomes of any implementation is to create efficient decision making processes. These decision processes are a construct in AST that occur during normal business operations which include idea generation, participation and conflict management (DeSanctis and Poole 1994). The desired decision process is most likely to occur when appropriation patterns are faithful, appropriation moves are
high, instrument uses are task or process oriented and attitudes are positive (DeSanctis and Poole 1994). As explained earlier in the case study, the hospital was faithful in their implementation and use of RFID, the appropriation moves were high, the technology was task based and attitudes were either positive or indifferent for most of the users. This led to a desired decision making processes as described by the CIO, 

*I think that we did well in the RFID implementation process and the reasons include a well thought out plan (e.g., creating a testing lab and user training program), strong upper management support, finance backing, expertise from consultants, and user participation. The whole process was a real team work. It involves with users from every department including doctors, nurses, administrators, IT people, other non medical staff (e.g., receptionists and financial analysts) and even patients.*

An admitting nurse also commented, 

*I feel that patient identification and location assistance are often needed to ensure patient safety when urgent medical attention is needed. Patient tags with RFID chips will meet this need as I see it.*

**Results and Discussions**

There are obvious differences between the pre-implementation network and the post-implementation network. These differences include adding new actors to the new organizational structure, changing the roles of existing actors and eliminating some actors in the final network.

The table below (see Table 3) represents an overview of the additions, changes or deletions of roles or actors after the RFID technology was implemented.

<table>
<thead>
<tr>
<th>Actor or Role changed</th>
<th>New, Deleted or Changed</th>
<th>Description of Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient</td>
<td>Changed</td>
<td>The patient had no direct interaction with IT systems prior to RFID. Now that RFID is implemented, the patient must wear the RFID tag in order to ensure the system will work correctly.</td>
</tr>
<tr>
<td>Command Center</td>
<td>New</td>
<td>The lynch pin in the entire RFID operation. Without the command center, physicians, nurses and business users might not adhere to the correct RFID system specifications and business processes.</td>
</tr>
<tr>
<td>Project manager, System Analyst, Consulting Companies</td>
<td>Deleted</td>
<td>Once the system was installed, their roles were complete. The project manager and system analyst roles were dissolved and the employees returned back to their respective departments to start a new role. The consultants left the hospital and were no longer part of the final actor network.</td>
</tr>
<tr>
<td>Steering Committee</td>
<td>Deleted</td>
<td>The steering committee completed their tasks of implementing RFID and ensuring buy-in and user adoption of the RFID system. The steering committee was then dissolved once their role was complete.</td>
</tr>
<tr>
<td>IT systems</td>
<td>Changed</td>
<td>The IT systems encompassed the RFID system.</td>
</tr>
<tr>
<td>Physicians and Nurses</td>
<td>Changed</td>
<td>Increased interaction with IT systems. Actors could verify and double-check patient records on site in real-time (i.e., in operating room).</td>
</tr>
<tr>
<td>Business Employees</td>
<td>Changed</td>
<td>Increased interaction with IT systems. Employees did not need to locate hard copies of patient records since records were tied to the</td>
</tr>
</tbody>
</table>
patient through the RFID tag.

The figure below (see Figure 3) shows an ANT view after implementation of the RFID system:

![ANT View Post RFID Implementation](image)

**Figure 3: ANT View Post RFID Implementation**

Eliminated actors in the final organizational structure included the project manager, system analyst, consulting companies, steering committee and project team. These five actors were involved during the entire project and were integral in the success of the project. Once the system was installed, their roles were complete. The project manager and system analyst roles were dissolved and the employees returned back to their respective departments to start a new role. The consultants left the hospital and were no longer part of the final actor network. The steering committee completed their task of implementing RFID and ensured buy-in and user adoption of the RFID system. The steering committee was then dissolved once their role was complete. The steering committee was no longer part of the final actor network. The project team was also dissolved for the same reasons mentioned above.

Two outcomes of AST are the new social structures and the decision outcomes created by implementing and adopting the new technology. The new social structures, according to AST, emerge in interactions as the rules and resources of the advanced technology are appropriated over time. The roles of some actors changed in the post implementation RFID network. One of the changes is the RFID system is now part of the IT systems actor since it shares the same interest and interactions with the other network actors. Another change is the interaction of the patient actor with the IT systems actor. Now that RFID is implemented, the patient must wear the RFID tag in order to ensure the system will work correctly.

Patients were used to wearing the bar code wrist band around their wrists for ID purposes and the RFID wrist band is not a surprise to them at all. So far there were no complaints from patients. We do inform them about the RFID tag before they are wearing it.

The roles of physicians and nurses also changed in the post implementation network. These two actors must now interact with the IT systems which include the RFID technology. Their interaction with RFID technology is both from the employee perspective (tracking their location) and from a patient care perspective (retrieving medical records and patient information). Decision outcomes, according to AST, are defined as efficiencies, quality, consensus and commitment of the organization to the new technology. The physicians and nurses can retrieve the patient’s medical records in real time and double check the records prior to surgery, consulting and diagnosing.

RFID enhanced connections between medical staff and patients (e.g., medication monitoring and outpatient treatment). We felt that RFID improved communications between administrators and medical staff and also among medical staff themselves.

Since the RFID tag is with the patient at all times, the patient records are mobile. The physicians and nurses do not have to rely on business employees to retrieve hard copies of the patient medical records.
The command center was a new actor that was created during the implementation process. The command center is now an integral actor in the RFID actor network. In terms of relationships with other actors, it is the lynch pin in the entire RFID operation. Without the command center, physicians, nurses and business users might not adhere to the correct RFID system specifications and business processes.

**Implications**

From a managerial perspective, hospital administrators can use this study as a framework for a successful RFID implementation. First, change management is crucial in any technology implementation and the findings from the case study showed that the hospital actively involved the physicians and nurses in this process. Aligning the interests of these actors was pivotal in a successful implementation. Another key take-away from this study was the formation of the steering committee and command center. These two actors also played a vital role in the success of the project and hospital administrators should consider these actors when implementing RFID technology. Lastly, the importance of education and training should be emphasized. More specifically, training and education programs include RFID lab session, lecture session (e.g., RFID basics and case studies), change management education, and advanced course of RFID. These tasks helped actors reduce the uncertainty in the system by hands-on training thus making the project and technology an overall success.

From a theoretical perspective, an objective in our research is to combine ANT with AST to create a roadmap for future research in examining the relationship between IT and organizational changes. Generally, technology adoption has been studied in diffusion perspectives. In this study, we applied network concepts by considering human and nonhuman actors. Especially, we bring ANT for explaining the behavior among the actors who engage in formulating the network. It is an advanced approach in terms of not just looking at the diffusion of technology, but also connections between technology and other actors. Furthermore, we apply AST to explain how technology and network changes the structure of organization in healthcare industry. Based on our knowledge, it is the first attempt to apply both theories to a case.

**Limitations and Future Research**

One of our limitations for this study is we only used a single case study in our analysis. The hospital we analyzed was a non-for-profit private hospital which is quick to adopt technology and uses technology to stay competitive. Our future research will include multiple case studies using for-profit or university-based hospitals. This will allow us to draw comparisons between private and public hospitals which may have different technology adopting strategies. Another limitation in our research is we only used an exploratory method (i.e., case study) to test our results. In the future, we will combine our exploratory methods with an empirical survey to confirm our findings. This will allow us to compare perceived measurements with actual case study data.

**Conclusions**

One of our research purposes is to clarify the extent to which RFID technology influences the organizational structure. There are many factors that influence organizational structure changes when advanced technologies are introduced, adopted and implemented. We examine the hospital’s organizational structure prior to implementation, during implementation and post implementation employing ANT. Our findings suggest that there are significant organizational structural changes that occurred during and after RFID in the healthcare organization. This is evident in the changes of the roles and interactions of physicians, nurses, business employees and IT systems. The other significant changes include the creation of an entirely new actor, the command center, and the reduction of functionality of the bar coding technology. We apply AST to analyze the role of RFID technology in the organizational structure change.
References


