MEDIATORS OF RFID IMPLEMENTATION IN THE PUBLIC/PRIVATE SECTOR CONTEXT: AN ANT PERSPECTIVE

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Abstract

The majority of studies into Radio Frequency Identification (RFID) based systems focus on the technical and engineering aspects of such systems. Where research expands outside this scope, it tends to focus on single supply chains set either within the private sector, or less commonly the public sector. This research examines RFID based systems, asking the question “what factors or issues mediate the relationship between public and private sector where they are involved in an RFID system?” From an Actor Network Theory (ANT) perspective, in depth interviews were conducted with 38 senior managers in four countries in order to understand the cross-sector implementations in which they were involved. Eleven mediators were found, across three dimensions. Overarching systems mediators were financial, infrastructure, standards, organisational knowledge and security. Inter-organisational mediators were trust, privacy and legislation. Intra-organisational mediators were leadership, data management and benefits. Some differences were also seen in the way the two sectors acted. This research contributes to theory by proposing a model demonstrating the mediators involved in cross-sector implementations. The novel use of ANT also suggests a research approach that may be successful in further understanding complex technology systems.

Keywords: RFID, Actor-Network Theory, Public Sector, Radio Frequency Identification.
1 Introduction

Technology enabled by Radio Frequency Identification (RFID) has an extensive range of uses, and is becoming increasingly common in many areas of business and public life. However, RFID systems seldom cross the boundary between the public and private sectors (Santucci 2010). RFID systems that are shared between public and private sectors include supply chain, identity management programs and animal tagging applications (Miles 2008). The increasing complexity of these systems, along with the rapidly broadening capabilities of RFID technology, has led to changes in the way organisations interact with computers, and with RFID enabled devices. The new possibilities for computer/human interaction offered by these RFID based systems are only just beginning to be explored, and few organisations understand the implications this future may have for the way they do business.

As there has been little research focusing on RFID systems shared between public and private sectors, this research seeks to further understand such systems. Using Actor Network Theory (ANT), our study moves through the public/private RFID network following the various actants around RFID systems, and across countries. The use of the technology inclusive ANT allows for a broad range of actants across a number of cross-sector RFID implementations to contribute to understanding of this network, and the mediators that drive the relationship between the two sectors. The identification of these mediators assists practice by exposing how cross-sector RFID systems operate, thus informing how they might be managed. Further it gives academics a foundation on which future research into cross-sector RFID systems can be based as well as offering an example of how ANT can be used to describe complex technology systems.

The following sections summarise the literature in relation to RFID based systems in the public and private sectors. Relevant literature around cross-sector technology implementation is also considered. The methodology used is then discussed, and findings presented. The study concludes by discussing the findings and outlining limitations and possible research directions.

2 Literature Review

The majority of RFID studies concentrate primarily on either the private or public sector, with few cross-sector comparisons. Analysing 666 peer reviewed academic publications, Irani, Gunasekaran and Dwivedi (2010) found that 60% of published papers were technically focused, 8% of papers dealt with adoption, and 7.5% with the economic, political, legal or social environment. Where literature does discuss public sector organisations, it focuses on areas similar to those found by Irani et al (2010). Reviewing literature in the healthcare sector, Yao, Chu and Li (2011) found that little attention was paid to the legal, organisational or social aspects of RFID systems, with focus instead being on technological or systems issues. Also noting a lack of research, Mukerji and Palanisamy (2011) found that the study of RFID applications in e-government was still in its infancy.

2.1 RFID in the Public Sector

The majority of studies that focus on RFID in the public sector are in the defence and health sectors where RFID technology is more common (Banks et al. 2007). In the healthcare sector, Yao, Chu and Li (2011) examined literature on RFID adoption and found that cost, privacy and technical difficulties were barriers to adoption. Ting, Kwok, Tsang and Lee (2009) highlighted the need to include supply chain partners in the sharing of data as well as better using and securing the data gained from such systems. Further, they found that technical issues, cost, return on investment, and understanding of the technology, were issues that needed to be addressed in constructing RFID projects. Despite literature consistently finding cost was a barrier to RFID systems, Wamba (2012) found that of 22 articles on RFID systems in healthcare, only two focused specifically on financing issues, while the majority discussed security, privacy or data management. Taking an organisational point of view, Lee and Shim (2007) stated that the adoption of RFID was poorly understood, but that the presence of a champion, and the amount of knowledge an organisation had about RFID were key determinants of RFID adoption.
Even though the primary focus of literature is on barriers to RFID, some work has been undertaken looking at the benefits of adoption. Zhou and Piramuthu (2010) in contrasting public and private healthcare institutions, found that the public sector would benefit more from RFID technology due to efficiencies that could offset resource constraints. Similarly, Yao, Chu and Li (2011) found that benefits from RFID systems included improved processes and savings in time and costs.

Outside the healthcare area, similar results have been found when studying RFID adoption. Neuby and Rudin (2008) examined RFID use in the public sector and found barriers including privacy and cost. Mukerji and Palanisamy (2011) studying adoption of RFID technology in e-government found barriers including cost, legal and acceptance issues. In a trend appearing more often in recent studies, they also found that management expertise, and a lack of public sector understanding of the technology limited its potential uses. Going beyond adoption studies, Gogan, Williams and Fedorowicz (2007) looked at a livestock tracking implementation shared between the public and private sectors. They found that different levels of collaboration between the two sectors caused difficulties, and that long-term management of the project was necessary.

Government organisations have also produced a number of publications, focusing on RFID standards, technical guidelines and privacy considerations. Notably, the European Commission (European Union 2009) identified a number of areas where governments should be involved in RFID based systems, including data management, and policy development.

2.2 Public Sector Technology Implementation

A number of authors have studied technology implementation between public sector organisations not involving RFID. Jansen (2011) pointed out that the success of technology systems in the public sector was related to linking project objectives to political priorities and legislation. Further, he discussed the importance of constructing the necessary infrastructure to support reforms. Dawes, Cresswell and Pardo (2009) studying public sector knowledge networks, found that policy and trust issues were barriers to network formation. Hudson, Hardy, Henwood and Wistow (1999) found that trust was necessary before public sector organisations could collaborate, even though they thought collaboration in public sector organisations was “self evident”. Dawes (2008) noted that information was being increasingly shared both between public sector organisations and between the public and private sectors. Her study also found that determining the owner of information in shared systems was problematic and caused delays in information sharing and release. While some of these issues have been seen in RFID based systems, policy and political issues do not appear to have been reported.

2.3 Private Sector RFID Systems

A range of challenges have been identified in private sector RFID systems similar to those found in the public sector. Wu, Nystrom, Lin and Yu (2006) found issues affecting RFID systems included infrastructure standards and availability, technology issues, cost, calculation of return on investment, and problems with migrating systems from bar codes to RFID. Wyld (2005) found that interest in RFID was increasing, driven by reduction in the cost of RFID tags, increasing standardisation, improvements in data processing and rising usage of RFID technology in supply chains. In a study focusing specifically on inter-organisation supply chain collaboration, Rajaguru and Matanda (2012) highlighted the importance of compatibility of cross organisational information systems in successful supply chains. Mirroring the trend seen in public sector literature, Li, Godon and Visich (2010) found a lack of understanding of RFID technology to be a barrier to adoption.

More recently, research efforts focused on private sector RFID systems have moved beyond discussing RFID adoption and started focusing on systems in practice. Quetti, Pigni and Clerici (2012) found that factors mediating the operation of RFID systems changed over time. Thiesse, Staake, Schmitt and Fleish (2011) in a quantitative study based on factors derived from non RFID technology systems, found that management support, cost and the need to improve partner cooperation were significant ongoing factors in RFID based systems.
As can be seen from this literature review, a number of themes are common when discussing RFID implementation, both in the public sector and private sector contexts. Many of these themes such as the importance of cost, standards, privacy and security have persisted over time. Other themes such as the importance of organisational knowledge are more recent. However, gaps remain in the literature especially when considering cross-sector RFID systems. Highlighting these gaps, Lee and Shim (2007) call for more qualitative studies to understand the process of RFID adoption, and Thiesse et al. (2012) call for research using non-adoption or diffusion based theory to study post adoption decision RFID systems. This study aims to fill these gaps, using qualitative methods to study post adoption RFID systems where such systems are shared across the public/private sector boundaries.

2.4 Research Design and Methodology

Based on the work of Bruno Latour, John Law and Michael Callon, Actor Network Theory (ANT) was considered an appropriate theoretical approach. ANT focuses on tracing associations and relations between members of a network, be they human, material or machine, in order to determine how the network becomes stable over time, if indeed it does (Latour 2005). Although controversial, the inclusion of material things and concepts within networks, acknowledging the place of technology in the construction of the social, allows the researcher to understand how complex networks of social and technological actors are formed, and how they function (Hanseth et al. 2004). As RFID systems are networks of both human and technological actors, including RFID enabled digital devices, ANT was uniquely placed to offer an in depth understanding of how this network might be formed. Further, the place of RFID within the network could be traced, as could the various actors – be they human, technological or conceptual.

ANT has its own ontology, largely based on the work of Bruno Latour, who argues that “the social” is heterogeneous; it is an effect of networks of society, people, organisations and things (technological artefacts). None of these elements can exist apart from each other, and they are formed by the inter-relationships between them (Law 1999). Callon (1987) emphasised the inter-dependence of network and actors, as a network is made up of actors, but is also an actor in and of itself. It is the dynamic interplay between the actors as they jostle for a place, and how they act together and apart in order to form the network in a process called “translation”, that the actor network researcher finds interesting (Callon and Latour 1981). Thus, actor-networks are theoretically boundless as each actor is also a network; the researcher limits the network by studying how a specific set of actors interact with each other (Akrich and Latour 1992).

In this qualitative study, the focus is on how RFID systems interact across the public/private sector boundary. During the process of translation, various mediators come into play causing the system to change or destabilise. Studying the jostling between actors in the network brings these mediators to light, allowing us to understand the process of RFID implementation. Interviewees were involved in, or had been involved in, an RFID system in use between public and private sector organisations. For example, where a supply chain crossed from private sector to public sector organisations; or where private developers were in partnership with the public sector designing and delivering a particular RFID based system. In total, 38 in-depth interviews were conducted in late 2011 and early 2012 with senior staff in various public, private and non-profit organisations. Interviews lasted between one and two hours and were conducted in person where possible, otherwise they were conducted via Skype, and recorded using Express Scribe software. Interviewees were asked open questions about the history of their RFID systems, and the mediators of those systems. Questions were also asked around how their organisation interacted with other organisations or sectors concerning the use of RFID. Interviewees were identified by following the advice of Latour (1999) to “follow the actors”. This meant using the snowballing technique outlined by Creswell (2009), to identify some of human actors. Following Vidgen and McMaster (1996) human representatives who could speak for various technology aspects of the technology were also identified. For example, where issues were identified in the way tags were used, the issue could be followed to a specialist in tag manufacture, who could represent or ‘speak’ for the tag, and how it might act or contribute to the RFID system. Consistent with ANT methodology, all RFID systems “studied” were treated as being part of the same network.
within the public/private sector context. Thus, no particular RFID systems, or individuals associated with RFID systems were targeted, instead the actors led the researchers through the network to interviewees in various locations, associated with various RFID systems.

Data was analysed using codes derived from the literature review, and through open coding (Corbin and Strauss 2008). Coder reliability was checked through frequent review of codes amongst the authors. The HyperResearch data analysis program was used to identify common themes and concepts, and to identify linkages between concepts. Concepts were then aggregated into higher-level mediators.

3 Findings

Based on analysis of the interviews, eleven mediators were identified. These mediators influenced the relationships between and within organisations involved in cross-sector RFID systems. They sorted into three major dimensions reflecting where in the organisational relationship they were most strongly expressed. Systems level mediators operated both within and between organisations. Inter organisational mediators were particularly apparent when relationships between organisations were discussed. Intra-organisational mediators functioned primarily within organisations. The relationship between dimensions is illustrated in the model presented figure 1, and will be discussed in the following sections:

Figure 1: Key Mediators in the Relationship Between Public and Private Sector Organisations Involved in RFID Systems

3.1 System Mediators

Five mediators operated across all parts of the systems both within and between organisations:

1. Financial: By far the most important mediator both within and between organisations, the financial mediator had three main themes. First, and most commonly mentioned was cost, both in pure dollar terms and in relation to return on investment:

   “It’s always cost, right. It’s always how do you show a return on the investment.”

   Managing Director, Private Sector.

Secondly, provision of funding or financing was also of concern. Interestingly this was mainly discussed from the point of view of the private sector looking to obtain funding in the form of
subsidy from the public sector. In two instances, funding had run out and it had halted or seriously delayed implementations.

The third theme was “time”. While costs were often discussed in relation to early phases of implementation, they were found to change over time. It was also common for costs to be underestimated, requiring plans to be revised.

2. **Infrastructure**: The infrastructure mediator refers to the technical elements of the RFID systems. This includes ensuring the networks are interoperable with existing systems as well as partner systems. Hardware elements of RFID systems were often mentioned, including selection and capability of RFID tags. Infrastructure concerns arose in many of the interviews although it appeared these problems occurred primarily in the early stages of implementation and were related to cost, integration, technology choice and practical considerations. Few issues were raised in respect of how the technology worked. It seemed accepted by most interviewees that the technology itself worked well.

   “I think the technology today even though it may not be 100% perfect it works”
   *Managing Director, Non-profit Organisation.*

3. **Standards**: As with infrastructure concerns, hardware and data standards were widely discussed in relation to the early stages of RFID systems implementation. They were seen as being important to ensure interoperability of both internal and external systems. Standards were also viewed as being essential to ensuring data could be easily shared across organisations.

   “You need hardware standards and you need software standards that enable data to be shared.” *Managing Director, Private Sector.*

4. **Organisational Knowledge**: The lack of knowledge of RFID systems capability and functions was also found in this study. This mediator was apparent in the need for education of staff at all levels in the capability of RFID systems.

   “I find you need to hand select who is going to participate and that they need to be educated in some sense. One to understand the project and its implications, but also to have something to encourage participation.” *Manager, Private Sector.*

   It was necessary to provide training in the use of RFID systems from a manual perspective, as well as educating senior staff as to the capabilities of systems. It was important to ensure all parties had a reasonable level of knowledge before the RFID systems could function successfully. Further, organisations faced difficulties when knowledgeable staff left, in one case this led to delays with implementation, in another the implementation has stalled.

5. **Security**: In contrast to other systems mediators security was often considered only after implementations had commenced:

   “The biggest barrier that we see is perception, just the security, and this is true for most information technologies that I know is that security is always an afterthought.” *Company President, Private Sector.*

   Security was also somewhat context dependent. In those areas where RFID systems gathered or held information that could be considered sensitive security was still delayed but considered earlier than in other implementations. However, the cost of securing systems presented a barrier in some instances.
3.2 Inter-Organisational Mediators

Inter organisation mediators operated primarily between the organisations involved in RFID systems, three mediators were identified:

1. **Trust**: Trust showed two forms, one in relation to trust in people and their ability to keep information secure, as well their ability to implement systems correctly:

   “We don’t trust people not to expose competitive information...”, *Project Manager, Public Sector.*

   The second form reflected trust in the technology itself to operate correctly, and to deliver accurate data:

   “…we will only automate to the degree that we trust...” *Vice President, Private Sector*

   In both forms, trust was discussed in relation to the willingness of people and organisations to share data and to collaborate in RFID based systems.

2. **Privacy**: Privacy was frequently discussed by public sector interviewees, and grouped into two themes. One form related to the necessity to comply with privacy regulations in place, especially around using data for the purpose for which it was collected. The second theme related to context with many interviewees discussing the necessity to understand the origin, use and sensitivity of the data being collected before implementing privacy protecting protocols.

   “Mangos have no privacy... they have no feelings. Why would their privacy be infringed?” *CEO, Public Sector.*

   As with trust, where interviewees were confident of privacy being protected they were willing to share information and collaborate, thus privacy was an important component of inter organisational information sharing.

3. **Legislation**: The influence of legislation in relation to hardware standards as well as issues such as privacy was a mediator of implementation. However, interviewees also discussed pressure brought on the public sector by private sector organisations that wished to have legislation enacted to ensure compliance with standards especially in relation to food safety. This pressure was significant and in at least two instances was successful:

   “They’re smart to say “government you have to cough [up] some kind of standard here because one corporation will have one, another corporation will have another etc. etc.,” so, when you have all those standards what you have is no standard, in my mind.” *Company Executive, Non-profit Sector.*

3.3 Intra-Organisational Mediators

While mediators such as cost were seen across all levels of cross-sector RFID systems, three mediators operated primarily within the organisation.

1. **Leadership**: This mediator was found to be extremely important for the progress of cross-sector RFID systems.

   “They have had successes in the past, but the problem with all these things is it depends who is pioneering it and how much leadership that person is showing.” *Senior Executive, Non-profit Organisation.*
In both sectors change in staff was found to affect systems, especially if the staff member who was leading (or championing) the system left the organisation. Change in government also affected systems with funding models being changed as political agendas altered.

2. **Data Management:** This mediator shows a range of elements including data purpose, use and quality. Mostly discussed in an intra-organisational context, data management was essential for realising maximum benefit from the systems.

   “So it is connecting dots now, I suppose, about we can read data coming off a tag, can we align it with a process and then start making better business decisions about that process?” *Senior Executive, Non-profit Organisation.*

Where inter-organisational data management was discussed it was primarily in the form of data sharing and was closely related to the mediators of trust and privacy.

3. **Benefits:** The realisation of benefits from the systems also had a number of dimensions, from the ability to track items at the item level, to business process improvements. These were realised primarily within the organisation. Interestingly, in a number of instances more benefits were discovered as organisations became increasingly familiar with their RFID systems. These gains related primarily to analysis and understanding of data:

   “Also invariably we find that a lot of companies that put in RFID do it for a specific purpose... and what happens is that as time goes on more benefits are found through the use of RFID implementations than they would ever have thought...” *Vice President, Non-profit Organisation*

### 3.4 Public/Private Sector Comparison

There were a number of contrasts apparent between public and private sectors, some of which have already been noted particularly in relation to the use of legislation. While both sectors approached each other through negotiation, the use of legislation in order to ensure compliance was specific to the public sector. The private sector response to this was the use of lobbying to attempt to influence the political process.

   “We do have “a lobbyist” working the government to further our efforts for expanding at their end, so we are working on it”. *Company President, Private Sector*

The public sector was more sensitive to privacy issues and conscious of the need to comply with privacy guidelines. It was also aware of the nature of the data held, and the need for tailored approaches depending on the sensitivity of that data. There was also evidence of tension between the two sectors with public sector perceiving the private sector as focused on short-term gains, and competitive advantage. Conversely, the private sector viewed the public as not working hard and being unable to plan long term due to the political cycle.

   “Also there is a political landscape that you need to have consideration of and a three year cycle that sits within that. So, that can obviously impact a lot of different priorities.” *General Manager, Private Sector*

In terms of funding, the private sector looked to public sector for funding for both systems and technology education. In the systems discussed there was some variance by region in the availability of this funding with Asia and the EU providing funding for pilot and educational activities. The US and Pacific regions provided smaller amounts of financial support. Similarly, a number of private sector interviewees felt they should receive subsidies for participating in government mandated RFID systems.
“...farmers should be paid a premium for participating in [the system] not paying it as a compliance cost.” Senior Analyst, Non-profit Organisation.

In respect of these same systems, public sector interviewees were aware of the compliance costs but saw the benefits of the system outweighing costs imposed.

4 Discussion

This study has identified eleven mediators of RFID based systems in the public private sector context, across three dimensions relating to whether they operate primarily within the organisations, between them or overarching the systems. Though many of these mediators are seen in isolation or combination in prior studies, this study shows the relationship between them and how they fit into the wider context of cross-sector RFID systems, through the model detailed in Figure 1 above. The discovery of these mediators also highlights the ongoing issues facing RFID systems that linger despite the academic literature focusing on them.

Within organisations the intra-organisational mediators relate primarily to the management and leadership of the organisation itself, and highlight the need for both public and private sector organisations to continue focusing on management challenges even after the adoption decision has been made. Though the importance of leadership is discussed in management literature (Yoong 2010), it only begins to appear in more recent studies of RFID systems. Despite this, the need for leadership was strongly expressed in this study, and was related both to decisions made around the initial RFID implementation and the ongoing need to manage and champion the use of RFID systems. Interestingly benefits were seen as coming later in RFID implementations, and were often realised in an unexpected form. It could be speculated that this may be a result of other mediators, particularly data management and cost, not being sufficiently addressed by the implementing organisation.

Between organisations it was interesting to note the appearance of legislation as a mediator as it is seldom seen as a mediator of technology systems. In this context it is easily apparent as it was a tool used to ensure compliance in participation. While issues around legislation and policy were highlighted in the non-RFID based technology literature, this is the first time it has appeared in relation to RFID systems. Legislation was also a consideration of the public sector, especially when designing RFID systems, as the public sector was sensitive to the need to comply with legislation that was in place especially privacy legislation. This was of lesser importance in the private sector. The sensitivity of public sector organisations to legislation, alerts private sector organisations thinking of entering into data sharing arrangements with public sector organisations to be aware of this focus. The occurrence of privacy and trust together is logical and expected as both are antecedents of information sharing (Dawes et al. 2009). As such, these are well placed to mediate the data sharing relationships necessary between organisations for RFID systems to be used efficiently.

Overarching the inter and intra organisational dimensions were those systems mediators that acted both between and within organisations. Financial considerations, both cost and funding related, were more important than any other consideration within the RFID systems. The private sector often looked to the public sector to provide funding for various aspects of shared systems, something that is not seen within exclusively private sector systems. The management of infrastructure and standards was important both within and between organisations, with decisions regarding these often being made before systems could proceed; although infrastructure mediators particularly could and did act throughout the course of implementation. Security was related in part to the criticality of the application and the cost of securing systems. It was also an afterthought in some systems, a finding that could be further researched. While it might initially seem that organisational knowledge should operate primarily within an organisation, it was important across all parts of the systems. For example, representatives of one organisation often needed to persuade another organisation of the importance of a certain course of action. This frequently had an educational component as part of the
act of persuasion. Within organisations, staff changes and the loss of knowledgeable staff led to difficulties in some systems.

5 Conclusion and Contribution

Current RFID systems are complex, and this complexity is seldom appreciated by organisations entering into RFID systems. Moreover, these applications are already breaking down the boundaries of organisation and sector. Organisations need to understand the issues they are likely to face with their RFID systems, especially as wide reaching technology systems are becoming more common. Thus, it is important to have a framework on which to base understanding of these systems (Bardaki et al. 2010). This study provides such a framework in the form of a model demonstrating mediators in the relationship between organisations within the context of cross-sector RFID systems. This model contributes to practice by making clear the issues that they need to consider when organisations plan and manage RFID systems. Further, this research contributes to practice by highlighting areas organisations need to consider when entering into cross-sector RFID systems, as well as assisting in understanding the pressures that encourage, and sometimes force, businesses to participate in such systems.

Methodologically, the ANT framework proved very fruitful for this study, allowing for the tracing of actors through the RFID systems themselves. This allowed for a much richer picture of RFID based systems to be developed, rather than the narrower view that would be found in a more traditional approach where the technology was not able to act, or to ‘speak’ through human representatives. It also allowed for a broad identification of mediators relating to RFID systems in the public/private context, rather than limiting the study to bounded cases. This approach contributes to research by highlighting a method that may well assist in understanding other complex technology systems and will certainly prove insightful as more work is done on such systems.

5.1 Delimitations and Future Research

The model detailed in this research is based on qualitative interviews. Further investigation of a quantitative nature will assist in understanding the mediators seen and their relationships to each other, and where in the time dimension they may fit. It would also allow a more granular understanding of the circumstances surrounding some of the interactions between the different mediators.

Although as broad a cross section of RFID systems as possible was studied, it is not viable to study all possible cross-sector RFID systems. Thus, systems in different countries may have different mediators, or the mediators may not be as strongly expressed. Also, it is possible that some of the mediators will change as RFID systems become more mature. All these aspects provide a rich area for future study. More specifically, the interaction of some of the mediators is of interest, and could be further researched. In addition, the nature of the relationship between privacy, trust and the nature of the data being shared is interesting and could be further studied, as could the difference in the treatment of privacy between public and private sector organisations.

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7 References


