Examining Innovation Translation of RFID Technology in Australian Hospitals through a Lens Informed by Actor-Network Theory

by

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Abstract

The use of information technology (IT) in large hospitals is dynamic and multifaceted. Radio frequency identification (RFID) is a rapidly evolving technology that uses radio waves for data collection and transfer, without human involvement. As an acronym, RFID is used broadly for categorising technologies that use radio waves to automatically recognise objects and people. RFID's ability to track signals and store data has made it a useful technology for many industry sectors, including health.

During the 2000s, RFID technology, as an innovation, has been explored for improving the efficiency of workflows, thereby enhancing the quality of care in hospitals worldwide. Existing literature in this domain endorses RFID's ability to track high-value and frequently used equipment in emergencies, critical-care wards and operating theatre settings. This ability makes it attractive for resource-contrained big hospitals, where equipment is shared to limit costs. Moreover, its relative non-complexity when integrating with other clinical systems ensures its appeal to hospital administrators and information communication technology (ICT) operations.

RFID was not easily adopted in large hospitals without contextual customisation. Difficulties in implementation ranged from the technology's dynamic nature to staff reluctance, fearing disempowerment. In the Australian context, issues associated with RFID integration regarding legacy clinical systems and costs involved in large-scale implementation have made large hospitals often reluctant to consider RFID. At the beginning of this research investigation (in 2007), there were only a small number of minimally successful emerging cases reported in Australia involving large hospitals[1]. The aim of this project was to better understand the adoption of RFID technology in Australian hospitals.

During the last decade, academic literature has also begun to emphasise socio-technical approaches to the study of information systems in health contexts. Nonetheless, the literature still remains nascent, with sporadic cases reported globally, in particular

[1] In this thesis, *large hospitals* in Australia refer to the major public hospitals, with a private wing incorporated. These hospitals employ over 3000 staff; has over 600 beds; are teaching hospitals with multiple research centres; emergency services; rehabilitation facilities; and offer a range of speciality services.

departments and restricted to essentialist approaches in Australia. To understand the adoption of RFID in the context of large hospitals within Australia, an approach that guides organisations in adopting technologies was required. Innovation translation is such an approach. It purports that any innovation needs to be customised or translated before it can be adopted into a context. Further, understanding the 'social' aspects involved in this adoption, required a theoretical lens to inform this innovation translation approach. Consequently, the actor-network theoretical lens was used. This reconstructed the implementation process: investigating social networks and relationships that influenced innovation translation of RFID in two large hospitals within Australia. The innovation translation approach to theorisation, informed by actor-network theory (ANT), removed the need for considering 'the social' and 'the technical' in separate modes.

Capturing the essence of ANT and its ability to visualise the 'socio-technical' aspects, the cases investigated in this thesis have been presented in a creative style: a movie script form, with acts and scenes. Information for case studies was obtained through rigorous and sustained data collection, with semi-structured interviews, focus groups and validation supported by secondary data. In presenting the reconstituted data with relevant information (as the thesis a.k.a 'the movie') in acts and scenes, I (as the researcher) have become the 'Cameo actor' who enters the movie set in an investigative mode. RFID has been presented as a 'debut' actor who enters the movie interplayed with all other actors, emerging as a 'star' at the end. RFID sustains itself in the health context of Australia, while other 'actors' came in different roles and left the movie. The thesis describes how the debut actor had been able to 'charm' the initially reluctant 'co-actors', inculcating a sense of empowerment, subtly improving their social networks and eventually becoming a 'popular star'.

The contributions of this thesis are it's addressing of the socio-technical gap evident in academic literature pertaining to health and ICT in Australia. It further augments the body of knowledge concerning innovation translation in health informatics, informed by the ANT analysis. The two case studies in this research reveal the innovation had to, and did, translate itself to suit the hospital environment, negating impediments such as fear of disempowerment and displacement of relationship networks, before it was successfully adopted. Equally, the ANT lens revealed that RFID facilitated the re-negotiation and improvement of network relationships between the people involved, including nurses, orderlies and management, along with non-human participants such as equipment and technology. The changes to social networks that RFID facilitated affected its own success in being adopted into the context. Therefore, the thesis extends the application of ANT in health informatics.

The unique approach of presenting case studies as a movie script format is an academic enhancement to the field of ANT. ANT has been criticised for an insufficiency in explaining relationship formation between actors and changes that occur in relationship networks. This thesis addresses the gap in relation to information systems research, in that it incorporates an ANT lens for visualisation of the innovation translation theory as an augmented filter, enabling an in-depth view of the data. Theory of innovation translation is confirmed with the data analysis, while the augmented framework with ANT strengthens the theory's ability to recommend future strategies for successful translation of technology. The data from case studies was reconstructed as acts/scenes, funnelled to ANT visualisation at the end of each act. Actors responsible were presented, and the relationships formed at each event (end of each act), were recorded in visuals. The entries and exits of actors were captured through tables. This visualisation, using an ANT lens, enabled relationship formation between key actors, and event changes in real time were depicted. Thus, the intrinsic deficiency of ANT was addressed, significantly contributing to the field.

From a practical perspective, it is evident that successful implementation depends on the customisation and translation of this technology. This innovation translation requires commitment from nurses, the key players in Australian hospital operations. When nurses become champions of RFID, clear benefits are made visible to operational staff (orderlies or personal care assistants) and clinical staff (physicians), in their shared language. This enables commitment from all, resulting in the best translation and enhanced quality of care, assisted by RFID technology.

Candidate Declaration

"I, Chandana Rajkumari Unnithan, declare that the PhD thesis entitled Examining Innovation Translation of RFID Technology in Australian Hospitala through a Lens Informed by Actor-Network Theory is no more than 100,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work".

Signature Date

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List of Abbreviations

ACHI	Australasian College of Health Informatics
ANT	Actor-Network Theory
BPM	Business Process Management
BPR	Business Process Redesign
CIO	Chief Information Officer
CHDGP	Central Highlands Division of General Practice
CLIP	Clinical Information Processing Platform
DHSS	Department of Health and Human Services
DTPB	Decomposed Theory of Planned Behaviour
ED	Emergency Department
FDAA	Food and Drug Administration Agency (USA)
GDP	Gross Domestic Product
GP	General Practitioner
HISA	Health Informatics Society of Australia Limited
HIS	Health Information system
ICT	Information Communication Technology
ID	Identification
IS	Information Systems
IT	Information Technology
IMIA	International Medical Informatics Association
IV	Intravenous
LAN	Local Area Network
NEHTA	National Electronic Health Transition Authority
NHHRC	National Health and Hospitals Reform Commission
NIA	Nursing Informatics Australia
OPP	Obligatory Passage Point
PDA	Personal Digital Assistant
RFID	Radio Frequency Identification Technology
ROI	Return on Investment
RTLS	Real-time Location System
SCT	Social Cognitive Theory
SNA	Social Network Analysis
SST	Strong Structuration Theory
SSoT	Social Shaping of Technology
TAM	Technology Acceptance Model
TPB	Theory of Planned Behaviour
TRA	Theory of Reasoned Action
UHF	Ultra High Frequency
UTAUT	Theory of Acceptance and Use of Technology
WHO	World Health Organization
PMS	Patient Management Systems

Glossary of Terms

1. Blood Cooler: Devices for keeping the blood cooled in hospitals
2. BPM: Business Process Management (BPM) is the method of managing the redesign and redeployment of business processes within a given situation and organisation.
3. BPR: Business Process Redesign (BPR) is a process for assessing performance issues of a particular process and conducting radical redesign to the process, by redesigning the process itself and systems, policies or organisational structures.
4. Catheter: A thin tube used for medical purposes.
5. Defibrillator: Electric Shock Machine
6. ED: Emergency Department
7. Exciters: A device that uniquely extends the Real Time Location System of AeroScout, to provide robust and immediate Wi-Fi RFID tag detection capabilities. For example, the Exciter triggers AeroScout's RFID tags as they pass through a choke-point to transmit a message that is received by a standard Wi-Fi Access Point or AeroScout Location Receiver. This provides instant knowledge that a tagged asset or person passed through a gate, doorway or some other tightly defined area.
8. Implants: Something that is inserted into a human body during surgery.
9. Pacemaker: A device that regulates heartbeat
10. PMS: Patient Management Systems

Publications from this PhD Thesis

1. **Unnithan C**, Tatnall A, Burgess S (2014) Information Visualisation and Knowledge Re-construction of RFID Technology Translation in Australian hospitals, International Conference on Analytics Driven Solutions (ICAS2014), University of Ottawa, Canada, 29-30 September**.**
2. **Unnithan C**, Tatnall A (2014) Actor-Network Theory (ANT) based visualisation of Socio-Technical Facets of RFID Technology Translation: An Australian Hospital Scenario, *International Journal of Actor-Network Theory and Technological Innovation* (IJANTTI), Volume 6, Issue 1.
3. **Unnithan C** (2014) RFID Implementation in Australian Hospitals: Implications for ICT Sector and Health Informatics, *International Journal of Enterprise Information Systems* (IJES), Volume 10, Issue 2.
4. **Unnithan C**, Fraunholz B (2014) Radio Frequency Identification Technology as an Analytical Lens and Solution in Hospitals: A novel approach in BPR/BPM, a chapter in the book: *Health care Informatics and Analytics: Emerging Issues and Trends*; Edited by Dr Madjid Tavana (La Salle University, USA), Dr Amir Hossein Ghapanchi (Griffith University, Australia), and Dr Amir Talaei-Khoei (University of the Sunshine Coast, Australia) (For release in the Advances in Health care Information Systems and Administration (AHISA) Book Series), IGI publications, USA.
5. **Unnithan C**, Nguyen L, Fraunholz B, Tatnall A (2013) RFID translation into Australian Hospitals: An exploration through Actor-Network Theoretical Lens, *Proceedings of the International Conference on Information Society (i-society 2013)*, University of Toronto, Canada, June 24–26.
6. **Unnithan C**, Fraunholz B (2011) Strategic framework for developing a process model for maximising the potential of radio frequency identification (RFID) technology integration in hospital, a chapter in Alkhalifa, Eshaa (eds), *E-strategies for resource management systems: planning and implementation*, pp. 118–136, Business Science Reference, Hershey, Pa.
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Chapter 1: Introduction

1.1 Outline

This thesis documents research conducted into the innovation translation of radio frequency identification technology (RFID) technology into two large hospitals in Australia. The thesis deliberates the interacting socio-technical factors that affect the adoption of RFID in Australian hospitals. More specifically, the contribution of this thesis is that: (1) it identifies the key factors (or actors), examines how they interact and negotiate to eventuate adopting RFID to improve efficiencies of certain processes within Australian hospitals (to improve the quality of health service delivery); (2) it uses actor-network theory (ANT) for informing a lens enabling information visualisation (presentation of findings); (3) it innovatively presents case narrations in a ‘script’ format.

1.2 Background

Information communication technologies (ICTs) have infused the world, in almost every industry sector and many daily lives, over the past two decades. Technological innovations are also being adopted by the health care sector, particularly in large hospitals for improving efficiency. The health sector by nature is complex and dynamic: in this milieu, technological innovations often must be adapted for expediency. This research investigation focuses mainly on the ‘emergency’ areas of hospitals, although it does consider the related and peripheral areas that are most interconnected. The investigation spans the few years from 2007 to 2013.

In Australia in 2008, projections estimated that spending on hospital services would increase from AUD 25.9 billion in 2002–03 to AUD 81.4 billion in 2032–33 (Goss 2008). In 2009, the National Health and Hospitals Reform Commission (NHHRC) estimates revealed that hospitals would be one of the fastest growing areas of health spending over the next few decades (NHHRC 2009). Australian governments are now spending almost A$42 billion more on health in 2013 than they did a decade ago

(McGowan, Gregory & Atkinson 2013). Health expenses consumed 19 per cent of state and federal government budgets in 2013. This trend is expected to continue, with government health spending an additional one per cent of gross domestic product (GDP), compared to a decade ago. Health expenses are projected to increase to two per cent by 2023 (McGowan et al., 2013).

In Australia, the Medicare system provides free access to Public hospital services and assists with the costs of a range of medical services (Whetton 2005). While the Commonwealth government has the role of developing policies, research funding, national and international health issues, State and Territory governments manage public health services, deliver public acute care, psychiatric hospital services, community care and public health. While the majority of doctors and allied health professionals are self employed, Private hospitals are owned by both profit and not-for-profit organisations (Whetton 2005; Whetton & Georgiou 2010).

In 2013, The Ministry of Health and Ageing, a Commonwealth government department (Healthgov 2013), administers national health policy at the federal level. Individual Australian states oversee elements of the policy, with specific state-level departments. There is a strong interplay between the Commonwealth and State level governments. The Commonwealth government provides about 70 per cent of health sector finance (Duckett 2007; Duckett & Wilcox 2011). The other 30 per cent is made up from funding agencies and not-for-profit organisations that service hospitals.

In hospitals, any technology implementation needs to consider interoperability with other critical-care equipment (Ryan, Patrick & Herkes 2008). In recent years, Australian hospitals have introduced medical technologies such as radiological scanners and biological therapeutics, which have increased the costs of health care to average citizens (Novak & Judah 2011; Productivity Commission 2006). Some studies in the latter half of the last decade in Australia (Productivity Commission 2006, Gabbitas & Jeffs 2007; Novak & Judah 2011) indicate considerable variation in hospital costs across Australia, with scope for significant improvements in efficiency.

Historically in Australia, the legal environment has restricted technology implementation within hospital environments, particularly innovative technologies

(Crompton 2002; Duckett & Wilcox 2011[2]). The rationale ranges from provisions in the Privacy Act (1988) to hospitals' inability to bear the upfront costs of implementing innovative technologies. While working in a regulated environment of hospitals, technology needs economic viability for long term sustainability (Cavoukian 2008; Productivity Commission 2006). Public and Private hospitals in Australia traditionally have used different criteria for assessing new technologies (Duckett 2007). This unbalanced approach has encouraged the interplay between legacy[3] systems and innovations (Duckett & Wilcox 2011). While Private hospitals are burdened with the costs of deploying ever-changing technologies, Public hospitals (often large hospitals) have to obtain funding and acceptance by government departments (Novak & Judah 2011). As a result, large hospitals are often reluctant to trial an innovation that may not integrate smoothly into their framework.

1.3 Research Motivations

Technology adoption in hospitals is always challenging. From significant academic literature that synthesises technology implementation topics from the last few decades (see for example Coustasse, Tomblin & Slack 2013; Yao, Chu & Li 2012), problems impeding technology implementation in hospitals can be broadly classified into technical, economic, social, legal and other minor issues. Equally, academics have long examined the limiting factors of technologies impeding implementation, and the rate of adoption in hospitals for different technologies. Notably, academics have used technology adoption models, such as the technology acceptance model (TAM), which evaluates user acceptance of computer-based information systems (Davis 1986); or diffusion of innovation (Rogers, 1995 2003). Economic and legal issues in implementing technologies within hospitals have been debated in relevant forums (Duckett & Wilcox 2011; Taylor, Foster & Fleming 2008; Whetton 2005).

This research thesis takes an alternative view: that technology implementation in hospital contexts involves a different challenge. Hospitals are chaotic environments where regular scheduled processes undergo rapid changes in case of emergencies. There

[2] Historical reviews concur with this view from 2002 until 2012.
[3] In this context, Legacy Systems are old technologies that continue to exist in hospitals as they were introduced in different years, as technologies continued to evolve. As innovations are introduced, the old method has to co-exist or made obsolete. In Australian hospitals, more often, they had to co-exist.

is a scheduled set of regular processes, such as operations or outpatient treatment during stipulated hours. The pharmacy area may supply medication as required during scheduled procedures. However, one area that distinguishes this environment from others is the emergency department (ED), where processes are often chaotic. ED is not only chaotic regarding its own operations; it also disrupts other scheduled workflows and human resources (staff) in the hospital.

For example, in case of an emergency it is not uncommon to page all available nursing staff. All procedures that were scheduled, with the exception of critical surgeries, could be postponed at this time. Clinicians posted in the outpatient area may be summoned to assist with emergencies. In this chaotic ED environment, technology cannot be implemented using the standard procedures or techniques used in other environments, such as retail or manufacturing.

While literature is prolific on the technical, legal and economic impediments of technology implementation (see for example, Coustasse, Tomblin & Slack 2013; Yao, Chu & Li 2012), the rather chaotic social environment of hospitals (in which technology is implemented, making it unique) is often ignored (Fisher & Monahan 2006). The frenzied nature of hospitals makes it imperative that medical staff—mainly nurses and orderlies who run the day-to-day operations—have to be relatively familiar with any technologies implemented. These technologies will affect their workflows (Fisher 2006; Nagy et al.,, 2006), so staff must ensure the seamless provision of quality care to patients.

In many industry sectors, such as retail or manufacturing, technology implementation may be perhaps top down, with decision-makers being management-level stakeholders (Azevedo & Ferreira 2009). A regular adaptation is often undertaken to redesign processes, and users are then trained to fit in with the new technologies (Kumar et al., 2009; Sade 2007). This routine view for implementing technologies is rather difficult in hospitals, as health services cannot be interfered with, stalled or put on hold temporarily: this may cost a life!

Given the perilous nature of hospitals, I view that any new technology has to be designed, customised, piloted and implemented with the involvement of all ground level users or stakeholders. A recent recommendation by Day, Roffe, Richardson, Beysari, Brennan, Beveridge, Melocco, Ainge and Westbrooke (2011) supports this view. Day et al., (2011) attributes the success of an electronic medical management system, implemented in an Australian teaching hospital, to the acceptance of major effects on work practices by all staff, and timely system responses to user feedback.

RFID is an accepted technology solution to improve process efficiency in supply chain management. It is well regarded in manufacturing and retail industries (Azevedo & Ferreira 2009). In health care, its introduction occurred through pharmaceutical industries and their supply chains (Degaspari 2011). RFID's ability to track signals, store data and locate objects and people induced interest from hospitals, where the technology was relatively easy to integrate with existing systems (Yao, Chu & Li 2011).

Towards the second half of the last decade (2005–2010) hospitals across the world had begun to realise the benefits of integrating RFID into their operations, enhancing process efficiency and providing better quality of care (Cavoukian 2008; Cangialosi, Monaly & Yang 2007). This was particularly pertinent to tracking high-value and frequently used equipment to optimise use in emergency settings, such as surgeries (Hoskins, 2006; Nagy, George, Bernstein, Caban, Klein, Mezrich & Park 2006). RFID was expected to lead reduction in clinical errors, reduced costs and increased efficiencies (Chen et al., 2008; Fisher 2006; Nagy et al., 2006).

However, during the early years, despite the perceived benefits, RFID systems were not easily accepted by hospitals (Reiner & Sullivan 2005). One major consideration was economic: the initial investment in RFID infrastructure, before Wi-Fi prevalence, was prohibitive for most hospitals. Costs of RFID tags,[4] particularly those of hospital grade quality, were considered unaffordable at the beginning of the last decade, making its use a difficult proposition for many hospitals (Reiner & Sullivan 2005). Other issues in the literature include: the dynamic nature of the technology, resulting in development of disparate standards (Violino 2005); implementation inefficiencies due to uncoordinated efforts between vendors and hospitals (O'Connor 2005); reluctant acceptance or

[4] RFID tags are usually attached or embedded into objects to track them. They contain electronically stored information for automated identifying and tracking of objects that they are attached to. Unlike bar code, RFID tag does not need line-of-sight.

rejection of the technology by staff in hospitals, fearing disempowerment caused by workflow changes (Fisher & Monahan 2008; Reiner & Sullivan 2005) and an overall unwillingness in the uptake of this technology that is regarded as an innovation in health care.

Fisher and Monahan (2008) deliberated on RFID as an emerging technology that was then becoming a standard for hospitals in the United States of America (USA) to track inventory, identify patients and manage personnel. The research involved participant observation and interviews with staff, particularly nurses. Nurses revealed their concerns regarding the tracking technology's surveillance potential. Nursing staff experienced intensified effort from implementing the technology, because the onus to keep systems operational fell on them. In Australia, the nurses are the first point of contact and with the authority/responsibility for the hospital information systems (Duckett SJ & Willcox S, 2011).

Fisher and Monahan (2008) recommended that the social and organisational factors contributing to the success or failure of RFID systems in hospitals must be further analysed. More significantly, they recommended that the deeper implications of RFID systems, such as privacy concerns and work intensification for staff, must be considered during the design stages.

Two literature reviews (Yao, Chu, Li 2011; Coustasse, Tomblin & Slack 2013) ratifies the acceptance of RFID as an innovation that had changed significantly towards the end of the last decade. The global recession accentuated the need for cost efficiencies in resource-constrained hospitals, without compromising on quality of care. In large hospitals where resources are often shared to limit costs, RFID offered an innovative proposition to improve efficiencies. Equally, wireless (Wi-Fi) infrastructure is now being built into hospitals as this technology evolves. Supported by infrastructure, and the reduced costs of RFID tags (along with the location tracking capability of RFID technology that enables it to find high-value and frequently used equipment in emergencies), critical-care wards and operation theatre settings makes it attractive for large hospitals worldwide. Thus, the innovation has begun an extensive diffusion into the health sector.

However, in the Australian context, privacy and health industry regulations have mainly constrained the innovation diffusion (Crompton 2002). Australian hospitals are still transitioning into e-health records and unified health systems. Nine months after it was launched in May 2013, the Australian government e-health system held only 414 patient records and was only a fifth of the way towards its target of signing up 500,000 patient users by 30 June 30 2013 (Dunlevy 2013).

RFID integration issues with legacy clinical systems and the costs involved in large-scale implementation initially prevented wide-scale acceptance of the technology. Subsequently, many large hospitals that considered RFID as an innovation in certain areas—such as emergencies—put implementation on hold as they transitioned into e-health records. At the beginning of this research study in 2007, there were only a small number of largely unsuccessful and abandoned cases or pilot studies reported in Australia involving large hospitals, through biased vendor or technical reports.

Motivation for this research arose from RFID's status as a still nascent innovation in Australian hospitals: while its relative ease of integration with other hospital systems makes it a unique proposition for improving processes within emergency settings, it has yet to be accepted as a potential solution in Australian hospitals.

Academic literature has focused on innovation diffusion and technology-related factors, taking an 'essentialist' approach, which suggests that innovation diffusion occurs because the technology's salient features make it acceptable (Tatnall 2011). While studying technology diffusion in the nursing informatics field, where the use of technologies by nurses as they care for patients and undertake administrative tasks in hospitals was explored, Romano (1990) argued that the existence of technology per se does not ensure it will be adopted or incorporated into the environment. Essentialist approaches negate the fact that every person using a technology may perceive different features as acceptable (Tatnall 2011). I hold the view that in the hospital context, each stakeholder may perceive a different feature of technology as acceptable. This poses a significant problem: unlike other industry sectors, in the hospital context all stakeholders need to be unified in their perceptions. At the least, they need to be working towards at least one feature for using the technology that is acceptable to all, or becoming familiar with it sufficiently to explore its uses.

For example, RFID may be regarded as beneficial for tracking high-value equipment or for tracking patients and staff (Nagy et al.,, 2006). Here, the essential feature is 'tracking'—the perceived benefit and its implications are different in the hospital context. While tracking assets may be well regarded and useful in emergencies, they could disempower part time staff, who may perceive it as a threat or creating additional work (Fisher & Monahan 2008). Tracking patients and staff may be beneficial for hospitals in terms of efficiency; however, this may negatively affect morale and communication within the hospital (Nagy et al.,, 2006). It may also violate privacy and legal requirements (Crompton 2002; Privacy Act of Australia 1988, Privacy.Gov 2013). Therefore, taking the 'essentialist' approach, as with innovation diffusion or technology acceptance models, does not reveal possible and deeply covert human or social factors and perceptions. In other words, the quintessence of 'innovation translation' (i.e., how RFID as an innovation can translate into Australian hospitals, where 'implicit socio-technical factors' play a significant role), is rather deficient from current published academic literature.

This research aims to theorise innovation in large Australian hospitals, where essentialist approaches, such as innovation diffusion studies, may fall short due to non-incorporation of multiple stakeholder views of technology at the design stage, and differing general perceptions of benefits. In this complex environment of health and hospitals, I argue that all stakeholders need to be involved actively for customisation, propagation and successful adoption of technology through a continual negotiation process.

Based on these research motivations, the research questions in the next section aim to answer how socio-technical factors affect RFID translation in hospitals.

1.4 Research Questions

RFID technology in Australian hospitals is still nascent and seemingly viewed with scepticism. Therefore, this study aims to find as follows:

Main Question: What socio-technical factors influence the translation of RFID in Australian Hospitals?

Sub Questions: (1) Are these factors the key actors and and what roles do they play?

(2) How do they interact and negotiate to achieve effective RFID translation?

The main question aims to identify the socio-technical factores that influence the translation of RFID in Australian hospitals. The subquestions stemming from the main question seek to identify if the factors are really actors (human) or technical, as Actors may be human or non-human (in ANT terms), including RFID in this context. Subsequently, the quest is to understand how the actors (or socio-technical factors) interact and negotiate to achieve effective RFID translation. At large, this thesis therefore, uses actors and factors interchangeably, in alignment with ANT principles.

1.5 Relevance of Innovation Translation

In the much-acclaimed diffusion of innovations theory (Rogers 1995, 2003), an innovation is defined 'as an idea, practice or object that is perceived as new' (Rogers 1995: 11). The Australian National Innovation Department (ANID) defines innovation as being about ideas and how to transform them into value-creating outcomes, such as products, processes and services. Roger La Salle (2012), the Australian innovation author and trainer applied this definition to the business world as 'change which adds value'.

Innovation is also different to *invention*, in that invention is the first incidence of an idea, while innovation is the first venture carrying it out in practice (Fagerberg 2004). While innovation is often about creating new products or services, it can also be about how we apply new technologies to a context and solve problems for social benefit. New technologies can induce new business models, or processes that can be more innovative than the technology itself (ANID 2012). 'The process of innovation involves getting new ideas accepted and new technologies adapted and used' (Tatnall 2011:8).

A challenge to adapting a new technology, or applying it to an existing context, is that it is often not accepted in the form first proposed. In geometry 'translation' refers to an object being moved to another place, without resizing or rotating. If a shape is moved by 'sliding' it into another position, it will then look the same, but will fit into another place. In mathematical terms, 'translation' is a transformation in which the origin of a coordinate[5] system is moved to another position, so that each axis retains the same direction or equivalency, a figure (or curve) moved so that it retains the same orientation to the axes.

Drawing on this meaning, this research has taken the approach endorsed by the significant works of Latour (1986, 1996), Callon (1988) and Law (1992), which argue that innovations are not often adopted in their entirety, but only after 'translation' into a more suitable form for the environment. Stakeholders adapt innovations into forms that suit them by modifying some aspects (Tatnall 2009). Translation into a context may be initially partial, and as Callon et al., (1983) proposed, translation involves all the strategies that each stakeholder goes through to identify others and assemble them in relation to each other. Unlike diffusion, 'translation' can only occur if it interests all involved stakeholders. This study addresses the gap in academic literature focusing on RFID as an innovation, and its translation in the Australian hospital context. This investigation considers that socio-technical factors influence the successful translation of RFID into Australian hospitals.

Innovation translation purports that any innovation must be translated before it is adopted into the context. In this research, I studied how RFID technology translated into large Australian hospitals, retaining the essential element of innovation, namely 'location tracking', while adapting itself to the environment. As current literature endorses, towards the end of the last decade, RFID technology had evolved in terms of decreased costs and limitations. At the same time, hospitals in Australia had begun piloting the technology, albeit unsuccessfully, in a few large-scale implementations. The two large hospital case studies in this research have demonstrated that the innovation had to, and did, translate itself to suit these hospital environments, negating impediments such as fear of disempowerment and displacement of relationship networks, before it was successfully adapted.

[5]In geometry, a coordinate system is that which uses one or more numbers, or coordinates, to uniquely determine the position of a point.

The quest was to *determine* the socio-technical factors that affect adoption of RFID in Australian hospitals, and *how* they interact to eventuate successful translation. As will be discussed in Chapters 6 and 7, the research confirms and extends innovation translation theory (Callon 1986) It involves four moments of innovation translation, namely problematisation, interessement, enrolment and mobilisation.

Problematisation is where a group of key actors define the nature of the problem (in this situation, the issue that RFID proposed to address) and the role of all actors in the context. All factors in this situation are regarded more as ‘actors’.

Interessement is whereby the factors or actors defined in the problematisation process impose the identities and roles defined on other actors, thus building a network of relationships where all actors become involved. In this context, the champions of RFID in the context try to negotiate with others in the network.

Enrolment occurs after the success of interessement, when a process of coercion, seduction and consent leads to the establishment of a stable alliance. In this situation, this is the moment of translation whereby the key network of actors enrols all others into accepting an RFID solution, either by imposing it or through influencing them.

Mobilisation occurs when the solution gains wider acceptance. In this situation, RFID gains wider acceptance as a solution for the proposed reason, within the hospital context.

Through these moments of translation, I take an approach to theorising innovation, which has the advantage over essentialist approaches, such as TAM or innovation diffusion. Specifically, the key factors that influenced and negotiated the process of translation are identified.

1.6 Scope

Due to the dynamic nature of the evolving RFID technology, only four to five implementations have so far been significant in Australia. Amongst these, I have reported a partial and a successful story in innovation translation, which may or may not be generalisable to other large hospitals in Australia, but rather is indicative of what might occur. External factors that influence RFID implementation are beyond the scope of this thesis. These include different privacy regulations from State-based ministries (Privacy.Gov 2013). It may be noted that some ICT implementation initiatives at the state level have been cancelled during the progress of this research investigation (Hopewell 2012). As a result, a case study site that was under investigation has postponed their decision to implement RFID.

I focus on the socio-technical aspects and translation of RFID as an innovation in the Australian hospital context. Furthermore, the study focuses on the tracking ability and its benefits for improving processes within hospitals, mainly for tracking assets and assisting staff in emergency and related departments. The literature reviewed focuses on the period from 2002 to 2012: RFID in hospitals gained wider acceptance during the early part of this period worldwide; and in Australia, only towards the latter half of the period.

1.7 Significance of this Research

A succinct review of existing literature relating to RFID in hospitals globally and focused on Australia, made towards end of the last decade (2006–2007) revealed a large gap in the body of knowledge where health and technology adoption intersect. This research was triggered by the knowledge gap at that juncture. It was and remains significant because the findings throw light upon the under-explored, yet critical interplay of, socio-technical factors that have a prominent role in the adaptation of RFID technology in Australian hospitals. The technology itself has the potential to become pervasive in different departments within chaotic hospital environments and improve process efficiencies, thus enhancing the quality of care rendered.

From the time of embarking on this research in 2007, and until 2013, focused research on RFID adaptation in Australian hospitals was still nascent and limited to typical diffusion studies or uses essentialist approaches, which are indifferent to or dismissive of socio-technical factors. While early literature reviews and case study based observations revealed a reluctant uptake of RFID (between 2007–2009), it became clear in the second case observation, and through strong validation from practitioners in the health sector (2009–2013), that the key role of a certain type of actor (factors) and the interplay or negotiation of this type of actor with both the technology and other actors in the hospital, can make or break adoption of RFID.

This study indicates an interplay and negotiation of socio-technical factors, visualised by the ANT lens. ANT has embraced differences in technological, human and non-human actors (or factors) and socio-professional (networking amongst professionals in hospitals) aspects in a non-deterministic manner.

Specific departments within hospitals use RFID in different ways, making it potentially pervasive. This study takes a holistic approach, wherein I observed and analysed the adaptation process of RFID in two different large hospitals, with several departments: this proved revelatory. The study, which has evolved over five to six years, has made significant discoveries through participant and non-participant observations. Further, strong validation from practitioners in the health sector (hospitals, health consulting and professionals) has made it significant. The study sheds light on the limited information propagated amongst peers, to enable adoption of this technology offering vital assistance to improve the quality of health services delivery. The findings and recommendations have been ratified and validated by professionals in the industry sector. This is a substantial contribution of this thesis, offering depth to knowledge and suggestions for practice.

1.8 Academic Contribution of the Research

The treatment of ANT[6] for visualising the interplay that occurred between actors, enabling adaptation of RFID in hospitals, is an important contribution of this thesis to academic knowledge.

Using ANT to explain relationships is gaining momentum in information systems. ANT was developed by Latour (1986), in an attempt to give a ‘voice’ to technical artefacts,

[6] ANT has been presented and explained further in the context of this thesis, in Chapter 2, Part II.

considering humans and non-humans as equally important in the translation of innovative technologies. As Tatnall (2011) purports, ANT offered an advantage over other theories (as explained in Chapter 2, Part II, 2.5). With ANT, there is no dividing line between human and non-human entities, nor have an essence attributed to either that determines the adoption rate of an innovation. However, one criticism of ANT is its inability to explain relationship formation between actors, and over changes of events in relationship networks (Greenhalgh & Stones 2010). In this thesis, this criticism has been addressed in relation to information systems research, in that the conceptual framework incorporates an ANT lens for visualisation to the innovation translation theory as an augmented filter enabling an in-depth view of data.

The theory framework of innovation translation was confirmed using the data analysis and moments of translation. In addition, the conceptual framework presented with the ANT lens strengthens the ability of the theory to recommend future strategies for successful translation of technology.

More significantly, the presentation of data from case studies was reconstructed as acts and scenes (with only relevant conversations that inform the findings of this thesis). In other words, the information was presented as a ‘movie script’. The acts and scenes are then funnelled into a lens informed by ANT, at the end of each Act. In other words, at the end of each Act, there is an ANT-informed ‘information visualisation’. Specifically, the responsible actors in each Act were presented, and the relationships formed at each event (end of each Act), were recorded as information visuals. The entry and exit of actors was captured through tables after this visual. The information visualisation, using the ANT lens, enabled that relationship formation between key actors, and event changes in real time were depicted. Thus, the intrinsic deficiency of ANT was addressed, and I have also extended the theory.

The augmentation to the ANT field of knowledge (i.e. using it for information visualisation), is a significant academic contribution of this thesis.

1.9 Notes on Thesis Style

Throughout this thesis, I have used ‘I’ instead of ‘the researcher’. It is now common practice to talk in first person while talking about self, or where the researcher’s insights and observations are presented in the information systems domain and while following an interpretive analysis method.

The results from the research have been presented with the interpretive case study findings obtained through a rigorous and sustained data collection. Data collection was done through published industry reports, internal reports and documentation, participatory and non-participatory observations, semi-structured and ad hoc interviews, and focus groups. The research itself was conducted over a seven-year period. However, the findings were validated for relevance and currency in the last quarter of 2013, with interviews and focus groups.

The case study investigation and findings are presented in a movie script mode, as they happened. ANT is used as the treatment for analysis, to identify the ‘factors’ involved in the translation process. I have chosen to present the findings in this manner, as one of my personal interests is in writing movie scripts for short films and television serials based on ‘Bollywood’. Drawing from the experience, I believed that the ‘movie script’[7] might be a good scaffold to present this type of data, to reveal insights ‘naturally’, as well as incorporating ANT concepts, thus adding value to the body of knowledge. I also wished to bring the actors to life, for the benefit of the readers. Specifically, the script format was meant to provide the feeling that the reader is in the interviews – enabling a real life experience.

Chapter 2 presents the ANT lens by explaining terminologies and how they apply in this context. In Chapter 3, I have also explained how I used ANT for visualisation.

The two case studies are presented in Chapter 4 and Chapter 5. A table with actors and roles as well as a storyboard is presented at the beginning of each case study chapter,

[7] Writing a movie script involves providing a storyline, a table with acts/scenes, presenting the script in acts and scenes with relevant introductions, writing out the dialogue in each scene and ending with summaries to inform the reader where necessary. The two case studies have been presented in Chapters 4 and 5 in this manner.

outlining the narrative plot. The acts and scenes represent reconstituted observations drawn from the analysis of observations, as relevant to this investigation. In alignment with ANT terminology, the environment or hospitals have been named 'blackboxes'. All stakeholders are presented as actors in a movie—'implementing RFID'. These actors are eventually the 'factors' involved in the RFID translation that has occurred. RFID as an innovation is presented as a non-human 'debut' actor, who interplays with all other actors (factors), and emerges a 'Star' in the end, sustaining itself in adverse conditions. According to ANT, 'actors' are consistent with 'actors in the movie script'. Each actor has a role, presented in the table before the script begins in Chapters 4 and 5.

I present myself as a 'Cameo'[8] actor, who enters the movie site (hospital or blackbox), and establishes an 'investigative' relationship with the actors. All other relationships between actors 'emerged' after every Act in the presentation of case studies. These are presented in a diagram and analysed further. The investigation originally began in 'action research' mode, where I was able to effect some change in Case-1. However, due to various reasons, I had to move into a case-based approach with ANT visualisation. I have explained this in Phase 3 of the methodology chapter (see Section 3.3.1). The journey towards ANT is explained in Chapter 2 (see Section 2.7).

In Chapter 6, elements of innovation translation are used to undertake cross-case comparisons. Specifically, drawing from the two case studies, and using innovation translation 'moments of translation', an analysis is presented funnelling into the factors that influenced the translation and how it occurred.

1.10 Overview of Thesis Structure

1.10.1 Chapter 1: Introduction

[8] Cameo refers to a brief appearance of a person who is well-known in performing arts, appearing as themselves (or lends their voice) to add value to the movie. Often the Cameo is able to provide an independent opinion, on the movie script, endorsing and/or enhancing its value through a brief conversation or simply by being part of the movie. In this instance, I have taken the role of the Cameo to provide independent opinion based on evidence gathered and interpretive analysis.

This introductory chapter introduces the background and research justification. It presents the defining terms, scope and limitations, research questions and notes on thesis style.

1.10.2 Chapter 2: Literature Review

This chapter provides a literature review in two parts: In part one, the health context and ICT are reviewed briefly, with RFID as the main focus. In this part, I tried to highlight what makes RFID different to any other technology implemented in hospitals. Issues that RFID addresses in hospitals globally and in Australia are thematically presented, explicating under-researched areas: this is where this thesis makes its contribution.

In part two, I build the conceptual framework guiding this investigation. Theories I have considered to analyse the findings are presented briefly. Subsequently, I explain why essentialist approaches, such as innovation diffusion and TAM are unsuitable, while rationalising the choice of innovation translation theory within the Australian health context. Subsequently, give an overview of ANT, and how innovation translation informs ANT for visualising the analysis, leading to the findings.

1.10.3 Chapter 3: Methodology

In this chapter, I rationalise a qualitative approach (not quantitative), and interpretive case study analysis. Research design is presented, indicating the process of enrolling actors into the study. Data collection methods are connoted and justified. A brief overview on how collected data was coded and analysed is presented. A table of terms used for both theoretical frameworks is presented.

1.10.4 Chapter 4: Findings and Discussion—Case-1

This chapter presents: a summary of Case-1, a storyline, followed by structured data with diagrams, acts in scenes, and relevant highlights of interviews.

1.10.5 Chapter 5: Findings and Discussion—Case-2

This chapter presents: a summary of Case-1, a storyline, followed by structured data with diagrams and relevant highlights from interviews and focus groups. It is also presented in acts and scenes.

1.10.6 Chapter 6: Cross-Case Analysis/Validation

This chapter draws from the two cases in Chapters 4 and 5, and presents the results in a cross-case comparison through the theoretical elements of innovation translation, as well as the ANT lens. The two case findings are compared, and recent validation is presented highlighting the current relevance of this investigation.

1.10.7 Chapter 7: Conclusions and Future Work

This chapter addresses the research questions, and answers them based on conclusions from the findings and discussion chapters; it highlights this thesis's contributions, as well as offering future pathways for research.

Chapter 2: Literature Review

This chapter presents the literature review supporting the research investigation in two parts: research domain and theoretical framework. I would like to point out at the beginning that, although this review is drawn from global perspectives, the leading viewpoints have been taken from the Australian context, as applicable to this research investigation. The first part is the research domain, which begins within the purview of the health sector and technology; and the domain of health informatics, with pertinent contextual taxonomies. It considers relevant milestones and issues for Australia.

The subsequent section introduces the technology under investigation—RFID—explaining the rationale for the choice of technology and focusing on its progress and transition as an innovation into hospitals globally, and the functions it enables in health applications. Issues addressed by RFID implementation in hospitals are synthesised with global examples. Subsequently, the review looks at the Australian context. In the process, I also posit it is the negotiation and interplay between socio-technical factors that enable effective RFID technology translation in this context; there is evidently a gap in the academic literature focusing on this aspect, particularly in the Australian context.

The second part of the review focuses on theoretical frameworks I considered for this investigation. Beginning with the theories considered and eliminated, along with the rationale, I seek to explain the development of a conceptual framework based on the theory of 'innovation translation', informed by ANT. An overview of these approaches is presented (i.e., 'the moments of translation' that forms the basis for analysis in investigation of findings). Subsequently, my journey towards ANT, and its treatment in this thesis for visualising case analyses, is presented. ANT is used as a visualisation tool for informing the 'moments of translation' using innovation translation theory.

2.1 Part I: Research Domain

2.1.1 Health Informatics Realm

The purpose of this section is to set the scene for the research investigation. The research is placed in the broad domain of health informatics, which encompasses ICT use in the health sector. The review presented in this section is predominantly drawn from Australian perspectives, although it does include global viewpoints.

During the late twentieth century, the experience of an inexorable technological progress in all sectors has created a belief in both its inevitability and allure, with encouraging consequences in social and organisational terms (Cornford & Klecun Dabrowska 2003: 353). Since then, confidence has prevailed that ICTs will improve living standards and quality of life for peoples, breaking down global boundaries and penetrating every industry sector (see for example, Annan 2003: 1; Whetton 2005; Conrick 2006). Although health care was slow to embrace technology, the potential of ICTs, as people began to live more transient lifestyles became apparent, and the ability to communicate effectively in-patient care between all staff became more crucial (Conrick 2006). It is becoming apparent that ICTs offer tools to support the delivery of quality, cost-effective, timely care (Conrick 2006: 9).

According to a pivotal author in Australian health informatics (Whetton 2005: 5) early approaches to applying technology in health emulated those in business. They focused on designing information systems to automate existing tasks and workflows in finance and administrative areas; and applying technologies to health was considered a 'given' (i.e., if a technology is deployed, it will be accepted by users wholeheartedly, not dissimilar to other sectors). However, this approach, regarded as techno-centric (Delucca & Enmark 2000; Conrick 2006), did not work well for the health sector, particularly in the clinical environment. As Atkinson et al., (2001) pointed out earlier in the decade, technology solutions to reforming business processes were no doubt relevant, but could not ignore cultural and organisational factors.

While the progress of ICTs offered tremendous opportunities for modernisation, thereby improving the quality of care in the health sector (Berwick 2008; Cornford & Klecun

Dabrowska 2003: 353), a fundamental change in the health sector itself was required. In a survey of patient satisfaction conducted by Harvard School of Public Health this view, that a fundamental change in health is required, was echoed by 79 per cent of the population in Australia, Canada, the USA; 72 per cent in the United Kingdom (UK), and 89 per cent in New Zealand (Whetton 2005:6; Whetton & Georgiou 2010). The survey suggested overhauling the health system, in that it needed to be completely rebuilt: health-related ICT systems in first world nations were, relatively, working towards this.

At the end of the 1990s, the application of socio-technical perspectives was arguably promoted as a means to appreciate and extenuate the poor uptake and performance of information systems within health sectors (Berg 1999). Atkinson et al., (2001: 1) argued for a socio-technical research and development agenda to undertake participative, multi-stakeholder problem solving within health contexts. Coiera (2004, 2007) supported this view, suggesting that if health care was to evolve at a pace that met the needs of any society it needed to embrace the science of socio-technical design. Evaluations of failed systems accentuated the importance of understanding the complex cultural and organisational aspects in health care, and the way social systems interacted with technical systems (Whetton & Georgeou 2010).

A socio-technical approach to designing health systems was promoted, as this accounted for complexities in health care (Atkinson et al., 2001). As Whetton and Gerogeou (2010) recounted in their pioneering study in Australia, this is when the term 'socio-technical' term made its appearance in health literature. Gradually, over the decade, this techno-centric preoccupation gave way to social and organisational issues (Whetton & Georgeou 2010). Instead, focus gradually shifted to work practices (Balka & Whitehouse 2007), teamwork issues and communication (Clemensen et al., 2007; Creswick & Westbrook 2008), user attitudes, perceptions, reactions, and satisfaction (Gururajan et al., 2008; Knight, Patrickson & Gurd 2008; Parle & Lassere 2008), stakeholder consultation (Balbo et al., 2008) and usability (Kjeldskov, Skov & Stage 2010).

As a researcher reviewing the decade of progress, focusing on Australia, I noticed that the socio-technical perspective appeared in relevant publications such as the *Electronic*

Journal of Health Informatics in Australia. However, these views were more representative of global perceptions, rather than specific to the Australian context. For example, Gururajan et al., (2008) researched the perceptions of health practitioners towards wireless devices from the perspective of a developing nation. Equally, Parle and Lassere (2008) reflected on American perceptions. No doubt, these views were also relevant in Australia; however, the literature indicated to me that sentiments are yet to be embedded into the Australian health care context. There was also another question that emerged in my mind: *are practitioners considering socio-technical factors when implementing technology in Australia*?

In the meantime, emerging socio-technical foci also seem to have influenced research, as more qualitative studies began to emerge alongside conventionally quantitative-focused global health sector research. Nonetheless, the dominant focus of health-related research remains on the performance of any technology system. The social aspect is only considered in the context of adopting or diffusing technologies, and in minimising resistance (Balbo et al., 2008; Morris 2009). As Whetton (2005: 223) noted 'there was an emphasis on health information systems and decision support systems…with far fewer skills drawn from sociological or management domains (the socio in the socio-technical)'. As Coiera (2007:6) commented, the literature was still focusing on 'phenomenological level', seeking to explain what people do when using technologies. The interactions of social and human behaviour with technology may be much more complex, and needs investigation using different methods (Whetton & Georgeou 2010).

Equally, the literature focuses on practical applications of socio-technical analysis; many investigations focus on 'cause and effect' hypothesis testing (Westbrook et al., 2004: 1,125). As a result, most health sector research focuses on technical system performance, rather than socio-technical analysis, which addresses immediate health settings without addressing the broader environment. Lamb, Sawyer and Kling (2000: 1,614) argued for fresh conceptualisations of socio-tech perspectives.

Decriers commented that networked organisations have fluid boundaries between systems and their environments, which results in interaction between information systems and the broader environment. This is also true of the health sector and hospitals. Boundaries of local systems (or hospitals) within the health context are beginning to blur (Mumford 2006; Scacchi 2004; Wood-Harper & Wood 2005; Cartelli 2007). At present, with the beginning of electronic health records systems in Australia, all departments may eventually be connected with others in a hospital; and also with the external world, such as regulators and funding bodies. Thus, from the local hospital's single department, any technology that is deployed will affect the interconnected society (Whetton & Georgiou 2010).

Equally, socio-technical systems will be influenced by external factors. As Brown and Vergragt (2008: 127) discern:

> *it has become increasingly clear that human-IT micro systems are themselves embedded within larger systemic contexts, and that both these contexts, as well as the interactions and change processes both between and amongst them, need to be clearly conceptualised and explored in greater detail.*

The significance of a strong research base to underpin theory and practice has been acknowledged, to certain extent, for over a decade (Coiera 2004). However, the enunciation between socio-technical concepts and health informatics is still uncommon (Whetton & Georgiou 2010).

As interpretation of theories underlying socio-technical perspectives, or particular applications in the health domain is restricted, human technology interaction has a weak theoretic base from which description or study is possible. The outcome of this is the continued focus, at the end of the decade (Whetton & Georgeiou 2010), on the technical aspects that limits researchers to apply socio-technical approaches to the increasingly complex environments of contemporary health care in Australia. My research investigation began from this premise. Specifically, more interpretive studies were required, where a socio-technical approach was prominent and also related to the application of ICTs in Australian hospitals.

The health care environment evidently differed from business, and it demanded an identifiable discipline, namely 'health informatics' (Atkinson et al., 2001: 1). With the pervasive use of ICTs in the health sector, computers began to be leveraged for tracking patient billing, analysing medical statistics and medical information (Hannah, Ball & Edwards, 1999: 28) around the turn of the century. Gradually, basic data processing capabilities gave way to managing clinical information. However, the sophisticated requirements of clinical care analysis and management meant that ICT applications were limited to certain areas and pioneers (Whetton 2005: 29). While medical informatics led the way in decision support and expert systems, the development of controlled vocabularies, taxonomies and classification systems demanded standards and methodology so that health knowledge could be shared (Whetton 2005: 32).

By the end of 1990s, it was apparent that medical informatics needed to draw from other disciplines, particularly the social sciences of information systems and sociology. Thus, health informatics has emerged as an 'evolving socio-technical and scientific discipline that deals with collation, storage, retrieval, communication and optimal use of health data, information and knowledge' (HISA 2014). The term 'health informatics' represents a range of activities, interests and players today; medical and nursing informatics narrows the focus (Whetton 2005: 34).

Moreover, as MacDougall and Brittain (1994) pointed out in early 1990s, medical and health informatics were often used interchangeably. The European Union (EU) more broadly includes the profession, while in the USA medial informatics only refers to physicians (McKenzie 2000: 1). The broad discipline today incorporates a number of sub-disciplines such as medical, nursing, public health, bioinformatics and consumer care informatics (Whetton 2005; Conrick 2006).

In the next section, I apply the context and definitions of health informatics specifically in the Australian context.

2.1.1.1 The Australian Health Milieu

In Australia, drawing from the previous section, the intersection of information sciences, computer sciences and health care is broadly classified as 'health informatics' (Conrick 2006; Duckett 2007; Taylor, Foster & Fleming 2008; Whetton 2005). Occasionally it has been named 'health information management' and 'healthcare informatics'. Depending on the purview—clinical or non-clinical (administrative)—it can also be classified as 'clinical informatics', 'nursing informatics' and 'medical informatics'.

The Health Informatics Society of Australia Limited (HISA 2014) is a scientific society, established in 1992, for people involved with and interested in health informatics. According to them, 'Health Informatics is the science and practice around information in health that leads to informed and assisted health care'. According to this definition, being 'informed' means there is correct information about consumers, patients or populations, together with relevant health knowledge, that is available at the correct time, and in a format able to be used. By the term 'assisted', HISA meant the job of the health care worker is made safer and easier, and the health consumer is supported in their decisions and actions.

Equally, according to the World Health Organization (WHO 2013):

> E-health is the transfer of health resources and health care by electronic means. It encompasses three main areas:
>
> > The delivery of health information, for health professionals and health consumers, through the Internet and telecommunications.
> >
> > Using the power of IT and e-commerce to improve public health services, e.g. through the education and training of health workers.
> >
> > The use of e-commerce and e-business practices in health systems management.

This definition is interpreted by HISA (2014) as the combined use of electronic communication and information technologies in the health sector, and is considered a sub-discipline of health informatics. HISA provides a national focus for the science and practice of health informatics and for practitioners, as well as the associated industry and users.

The Australasian College of Health Informatics (2014) is the professional association for health informatics in the Asia-Pacific region. Formed in 2002, it embodies the interests of a broad range of clinical and non-clinical professionals working within the health informatics sphere through a commitment to quality, standards and ethical practice. Essentially, ACHI sets standards for education and professional practice in health informatics, supports initiatives, facilitates collaboration and mentors the community (ACHI 2014). It sponsors the *Electronic Journal for Health Informatics* in Australia, a key peer reviewed journal in the field.

As there are a number of health informatics organisations in Australia, HISA is regarded as the major umbrella group. It is a member of the International Medical Informatics Association (IMIA) (HISA 2014). It may be noted that historically, nursing informaticians were the driving force behind the formation of HISA, which now has branches all over Australia, and special interest groups such as nursing (Nursing Infomatics Australia (NIA)), pathology, aged and community care, industry and medical imaging (Conrick 2006).

The National Electronic Health Transition Authority (NEHTA 2014) was established in July 2005. It is a collaborative enterprise by the Australian Commonwealth, State and Territory governments, to ascertain and develop the necessary foundations for electronic health. It is aimed at improving the ways in which information is electronically collected and exchanged and is the key force behind implementation of personally controlled e-health records system in Australia (NEHTA 2014).

Over the past decade (2001–2010), it is evident through the progress of varied organisations, such as HISA, ACHI, NEHTA, that Australia is progressing towards a fully electronic health record system nationally (Prgoment, Georgiou & Westbrook 2009). However, this transition is progressing slowly, as hospitals across the nation need to establish fully integrated e-health record systems. For this purpose, a complete revision of manual record systems, interoperability of varied systems used in hospitals and uptake of mobile technologies are required (Prgoment et al., 2009).

Mobile technologies are the fastest growing category of the ICT revolution. Mobile technologies undoubtedly combine the advantages of paper charts and desktop computers in their portability and support for information access any time and anywhere in health care services (Dahl, Svanaes & Nytro 2006). Handheld devices, including tablet computers and personal digital assistants (PDAs) were generally small, portable, lightweight computers with wireless network connectivity (Baumgart 2005; Cole, Pisano & Clary 2006; Garritty & El Emam 2006). Since their introduction in the 1990s, uptake has steadily increased (Kuziemsky, Laul & Leung 2005; Cole, Pisano & Clary 2006; Garritty & El Emam 2006). In the mid-2000s, a review of PDA use by health care providers indicated adoption by 45 to 85 per cent of those surveyed, with hospital-based physicians identified as the most likely users (Garritty & El Emam 2006).

In Australia, both public and private health care providers are increasing their investment in technology, particularly in mobile communication, to enable process efficiency in their workforces (Ho 2012). However, it is still an ongoing question whether the deployment of mobile technologies will have the desired 'snowball' effect, gradually overcoming multiple health care challenges (Ho 2012), such as demand for increased access to high-quality health care, an ageing population, shortage of clinicians, and increasing budgetary pressures in health care institutions.

Debatably, two of the largest issues facing hospitals are enhancing worker productivity and reducing human error (Ho 2012). As most hospitals prohibit mobile phones, as a matter of policy relating to safe practices, communication amongst health professionals occurs with fixed telephones; information is made available through desktop or fixed computers. Time spent on these devices could be more effectively spent with patients. Increased mobility—supported by mobile devices that provide secure access to real time data—for hospital staff means increased productivity, better and faster patient care, and ultimately enhanced patient outcomes (Ho 2012).

Equally, human error is often cited as the cause of serious medical errors in hospitals and other health care facilities in Australia (Prgoment et al., 2009). Royal Melbourne Hospital (RMH) uses handheld computers and an hTrak[9] application in its operating theatres, cardiology and radiology departments (Ho 2012). The solution allows medical equipment, be it a stent, pacemaker or prosthetic, to be tracked and traced during surgery, and provides for item-level billing to patients. Where nurses would previously manually record each item in a book, the mobile electronic system allows extensive amounts of information to be collected by scanning a barcode on the device or

[9] hTrak Application is configured to capture a number of data elements at the point of a procedure. The elements collected can be tailored to meet individual patient requirements allowing a flexible approach to implementation and/or integration with other hospitals business applications. In this context, it refers to collection of data during a procedure through a Microsoft Windows-based barcode scanner such as Symbol MC75 running the handheld component of the hTrak application. Any or all elements can be collected using the barcode scanner incorporated in the Symbol mobile handheld device. Scanning enhances the data accuracy accuracy, simplifies data collection with device identification (www.htrak.com).

packaging at the time of use. This information is then uploaded to a central data store, enhancing not only productivity and efficiency, but ultimately patient safety.

Ho (2012) discusses another example—Queensland's Redcliffe Hospital—an Australian health entity implementing mobile solutions. The hospital recently implemented a kiosk-based patient automated arrival system that has already seen an increase in data accuracy and a reduction in human errors. The system allows patients to scan a barcoded patient appointment letter, received in the mail, at a kiosk to register their arrival at the hospital. The kiosk shows them where their specific clinic's waiting room is, allowing administrative and clinical staff at the hospital fewer manual processes to complete, improving service quality and timeliness. These examples show how providing immediate access to patient data from anywhere in a facility can significantly increase worker productivity. In turn, this helps improve the quality of patient care, ultimately reducing costs.

It was only towards end of 2006 that mobile technologies were initially explored in Australian hospitals (Cangialosi, Monaly & Yang 2007; Chowdhury & Khosla 2007; Simpson 2007). In 2009, with Wi-Fi evolution, wireless devices and mobile technologies like RFID gained momentum in Australia (Yao, Chu & Li 2012).

In this research investigation, I have chosen to use RFID, a mobile technology that is increasingly pervasive in hospitals. Unlike other technologies, which may address a particular area (such as physicians or nurses with a PDA), or a technological system that is meant for physiotherapy or surgery, RFID is a tracking technology that has the potential to track objects and people in a hospital. By the sheer nature of its tracking ability, it has the potential to pervade hospitals, touching every department dealing with patient care.

I was involved with the pioneering venture of RFID deployment (pilot) in Australia; this study originally began as an 'action research' study. However, in the course of the investigation, my pathway changed, influenced by the comprehensive literature review suggesting a gap in socio-technical approaches and also a need to study how the technology translated into Australian hospitals, rather than 'diffusion or adoption'. This journey is explained in Section 2.5.

In summary, this section has introduced health informatics in the Australian context and explored the beginning of ICTs, particularly mobile technologies in Australian hospitals. Prior to 2001, Australian health context was slow in adopting technologies in hospitals (Whetton, 2005; Duckett, 2007). As technologies had evolved over decades with sporadic funding from federal and state levels, hospitals had legacy systems that did not integrate or rather 'talk to each other' (Foster and Fleming, 2008). It was in the decade 2001-2010 that technology refreshments had begun to occur in earnest, with the imminent national health records system (Muhammed, Teo and Wickramasinghe, 2012). Towards end of the last decade, with the joint efforts of organisations such as Health Informatics Society of Australia (HISA, 2014), National E-health Transition Authority of Australia (NeHTA, 2014) and the Australasian College of Health Informatics (ACHI, 2014), hospitals in Australia began experimenting and implementing technologies that would improve their efficiency of care.

As Ho (2012) indicated, both public and private health care providers are increasing their investment in technology, particularly in mobile communication, to enable process efficiency in their workforces (Ho 2012). However, it is still an ongoing question whether the deployment of mobile technologies will have the desired 'snowball' effect, gradually overcoming multiple health care challenges such as demand for increased access to high-quality health care, an ageing population, shortage of clinicians, and increasing budgetary pressures in health care institutions (Ho, 2012).

At this juncture, before delving into RFID in Australia, I will examine the technology itself and in global context, in hindsight, was considered necessary.

2.1.2 Radio Frequency Identification in Hospitals

During the past decade, ICTs have evolved significantly, in particular mobile technologies. Both academia and industry have conducted abundant research on the diffusion of innovative technologies into the marketplace. In this research investigation, I have chosen RFID, a relatively new technology in terms of hospital environments, because there has been momentum in its uptake during the last decade, for tracking assets. In the next section, I begin with an evolutionary taxonomy of this technology, before entering the context in which the research is situated, namely hospitals.

2.1.2.1 RFID—A Contextual Ephemeral Taxonomy

RFID is a rapidly developing technology that uses radio waves for data collection and transfer, efficiently and automatically without human intervention (Yao, Chu & Li 2011: 3,507; Azevedo & Ferreira 2009). RFID is an acronym and a broad term used for classifying technologies that use radio waves to automatically recognise objects and people (Greene 2005: 30). This innovative concept came into existence in the 1940s (Landt 2001), when it was first used in World War II by British anti-aircraft batteries to identify friendly airplanes returning from missions. It has the ability to track signals and store data, which helped its commercialisation through RFID tags (Mehrjerdi 2008). The most common method used is to store a serial number on a microchip attached to an antenna (Greene 2005: 30). These tags are small silicon microchips, which may be as small as a half a millimetre square, attached to antennae. They can be placed anywhere (Taghaboni-Dutta & Velthouse 2006). RFID tags are able to store unique serial numbers and other information, which can be read few, or hundreds of, metres away (Ngai, Moon, Riggins & Yi 2008).

RFID evolved from bar coding technologies, although they are different types of technologies (H&HN 2004). Bar code technology requires a line of sight: it requires a scanner to 'see' the code to read it, which is not required by an RFID reader (Greene 2005). The technology consists of two components: a tag that acts as a data transponder; and an RFID reader (Wicks, Visich & Li 2006). Four types of RFID tag are available: passive, active, semi-passive and semi-active (Mehrjerdi 2008; Roark & Miguel 2006). In general, low-frequency tags are read from 30 cm or less, while high frequency tags are read from about one metre; and ultra high frequency (UHF) tags are read from about six metres (Degaspari 2011). While the number of tags can range from a few thousand in small RFID systems, the number of readers can increase in large-scale systems, creating a more accurate three-dimensional positioning system for the tags (Shirehjini, Yassine & Shirmohammadi 2012). (See the appendices for more information on the technology.)

In the manufacturing supply chain, RFID was an efficient evolution from bar coding technologies (Greene 2005). RFID systems drew upon their successful utilisation in factory and retail settings (Azevedo & Ferreira 2009), for more efficient management of resources in organisations. They also drew upon military applications to offer potential for heightened identification functions (Fisher & Monahan 2008). RFID improved the efficiency of the supply chain management simply by its ability to track goods from the factory to retail stores (Azevedo & Ferreira 2009).

There was indeed a high uptake of RFID technology into supply chain management, retail and manufacturing industries by 2000. However, as the technology was still evolving, a global standard for RFID was lacking, even until the mid-2000s (Violino 2005; Reiner & Sullivan 2005).[10] In the process of transition up until the year 2005, many organisations had already adapted the previous standards (Violino 2005). The new generation RFID tags were not backward compatible; therefore, those organisations had to upgrade their RFID systems, replace them or continue with the existing standards issues (Reiner & Sullivan 2005). To a large extent, the lack of standards had restricted RFID adoption in various sectors, particularly economically constrained health care and hospitals (Cox 2008).

Equally, RFID implementation worldwide had been driven by vendors from the beginning. A survey based report from Frost and Sullivan (O'Connor 2005), revealed that the vast majority of RFID education for users was vendor driven and lacked technological detail. While process efficiencies were the driving force behind RFID, views of vendors and systems integrators for end-user training were divergent. Most vendors believed user training was the key component to success, while integrators of technology felt that end users could be trained throughout implementation. At that point in time however, neither vendors nor integrators felt the need to involve end users in the design or implementation process (O'Connor 2005).

From 2005, health care providers globally began to realise the benefits of adopting RFID into their operations, to enhance efficiency and provide better services (Cavoukian 2008; Cangialosi, Monaly & Yang 2007). Yao, Chu and Li (2012) pointed

[10] More information on RDID technology is presented in appendices.

out that payback from RFID implementation was less immediately visible than health care organisations had assumed: uptake was accordingly slow. By 2010, RFID systems had been trialled to track medical equipment and supplies more efficiently in hospitals (Page 2007; Degaspari 2011).

2.1.3 RFID in Supply Chain Management

A reflection on other industries versus the health sector was considered necessary to identify the benefits of RFID in hospitals. Hence, in this section, I explore RFID in the supply chain management area. RFID has been widely used in tracking items such as pallets or cartons within a warehouse, resulting in cost reduction, improved process and workflows, decreased equipment cost, improved inventory management and decreased operating costs (Kumar et al., 2009; Sade 2007). Large retailers are encouraging suppliers to tag items with RFID. Chowdhury et al., (2008) report that retailers such as Target, and manufacturers, have adopted RFID in their supply chain, resulting in easier tracking of inventory and increased sales due to better accessibility of stock in stores (Nagy et al., 2006). Significant process improvements are experienced in supply chain management, as evidenced in the literature (Coustasse et al., 2013).

How does this compare to the health care sector and hospitals? In the health sector supply chain, several conditions increase costs. Operating rooms or surgeries use expensive inventory such as pacemakers, defibrillators, catheters and implants. However, due to theft, loss or misplacement, these equipment are often not available, thus driving up costs (Kumar et al., 2010). The complexity of the health care supply chain is another cost driver. According to Lewis, Balaji & Rai (2010) unique challenges include products and devices being extremely expensive, inventory tracking being difficult due to urgent medical emergencies and a high demand of certain types or amounts of products required can be unpredictable, due to diverse patient requirements. In such environments, RFID can help track mobile assets, identify and locate patients, control pharmacological inventories and manage staff efficiently in hospitals (Fisher & Monahan 2008; Bendavid & Boeck 2011).

RFID can track inventories or people in real time, as the tagged item or person travels around the hospital (Davis 2004; Lin 2009). RFID can also track garment and laundry operations in hospitals, enabling cost savings. Swedberg (2012) reports on a system at a children's hospital in Colorado (USA), where RFID was implemented to monitor the temperature of refrigerators, blood coolers, blanket warmers, and other heating and cooling appliances: temperature fluctuation can damage blood, medications and food. The hospital has already been repaid twice over in the investment by reducing staff required to track supply temperatures. No doubt, cost saving, operational efficiencies and process improvements justifies using the technology in hospitals.

The question is then as to why the uptake is slow, as reported in literature (Yao, Chu & Li 2012; Coustasse et al., 2013) or rather has been unsuccessful in the Australian context? Preliminary investigations indicate privacy and legal issues within the Australian health context impedes people tracking to a significant extent (Privacy.Gov, 2013). However, this does not explain the reluctance to deploy RFID for hospital supply chain management. While RFID tags are placed on pallets or boxes in manufacturing, they are placed on boxes of medicines, blood bottles or equipment that needs to be tracked. Essentially, this should not deter deployment or translation of this technology into the hospital context. Accordingly, I sought to answer the question as to how hospitals differ, particularly focusing on Australia.

From retail supply chains to hospital supply chains, the major difference is the level of people's involvement in the processes (Yao et al., 2012; Coustasse et al., 2013). In a retail supply chain, RFID tracking is used for boxed items, following a structured process, through specific staff. Other than an ill-defined occurrence, all processes are carefully laid out. Similarly, in the hospital supply chain, tagged items go from sterile to emergency environments in a structured process through people. Do hospital environments differ in any way?

While in manufacturing or retail, the day-to-day process is repetitive and predictable, hospital processes are never predictable (Balbo, Gogler, Steinkrug, Lee, Scheidt & Hullin 2008). For example, an orderly may find a piece of equipment such as a wheelchair or stretcher in an emergency. If this equipment can be tracked via an RFID system, time and process efficiencies are improved. However, in an emergency, would the orderly rather find a wheelchair or stretcher that is visible immediately, rather than tracking it via a computer screen? On a normal day, nurses who usually page for orderlies and sends them messages regarding what equipment to collect for surgery, may collect that equipment themselves during an emergency (Balbo et al., 2008). In an emergency, all orderlies with a list of current duties may be asked immediately to find equipment and transport people. On any given day, some roles are already structured, but hospital environments are never stable.

People's levels of involvement, whether they are nurses, orderlies or clinicians, are high and often interchangeable according to circumstances (Balbo, Gogler, Steinkrug, Lee, Scheidt & Hullin 2008). The workflow of a clinician and nurse will also significantly affect an orderly. RFID systems influence or change workflows and process flows to make them more efficient. In the process of this implementation, all people in this chaotic environment are directly or indirectly affected. In hospitals, the actors differ, in that their roles can change and are often interchangeable (Balka & Whitehouse 2007). Therefore, in structuring the hospital environment, all stakeholders, or actors, need to be involved when a technology intervention takes place (Clemensen, Larsen, Kirkevold & Ejskjaer 2007). I surmise that the actors or stakeholders in the *hospital* milieu, as compared to a retail supply chain, *differ*.

Therefore, structuring this chaos with an RFID intervention makes the health sector and hospitals different. The impeding factor for deployment is socio-technical: how the technology interacts with the actors or key stakeholders in this environment and negotiates itself into the milieu. The socio-technical *factors* that impede the implementation, or support it, are human *actors*. Rather than deploying technology into the context, an effective innovation translation needs to take place.

While RFID has been an accepted technology since the last decade in supply chain management, for hospitals it is still an innovation being explored. The literature review points to the fact that it was only towards end of the decade that hospitals began piloting RFID into their operations. Particularly in Australia, legacy systems are still being made obsolete in Public hospitals. Disparate technologies and systems co-exist, forming a complex environment where any new technology intervention adds another dimension. Combined with this is strong privacy regulations that almost prevent RFID people tracking. Nonetheless, major Public hospitals in Australia are still considering RFID as an innovation to be explored. Only a handful have implemented RFID even partially.

2.1.3.1 RFID in Hospitals—Global Developments

An Accenture report suggested that in the USA, the Food and Drug Administration Agency (FDAA) had ordered that most prescription drugs and blood products meant for transfusion carry bar codes for some time. The FDAA is encouraging RFID use for safety reasons. According to the agency, converting all US hospitals to bar codes may cost US$2 billion or more by 2014. Nevertheless, with an existing bar coding project, RFID's financial justifications would already have been met, and bar coding technology would have served as a platform to move to RFID (H&HN 2004).

To begin with, RFID-enabled authenticity and administration of drugs, improving patient safety via the use of RFID bracelets (Davis 2004). By 2005, RFID tags took many forms including badges, pendants, labels, cards and even implants (Wicks, Visich & Li 2006). Hospitals globally became interested, particularly in tracking high-value and frequently used equipment, to optimise use in emergency settings such as surgeries (Fry & Lenert 2005; Nagy, George, Bernstein, Caban, Klein, Mezrich & Park 2006; Page 2007a; Ngai, Moon, Riggins & Yi 2008).

The rationale for RFID adoption in hospitals was straightforward (Baldwin & Larkin 2008). In a dynamic world, hospitals are finding it increasingly complex to provide care to adequate standards, due to resource constraints (Pappu, Singhal & Zoghi 2004; Hoskins 2006). Surgical procedures are delayed due to missing high end critical equipment or regularly used assets, as well as clinician time spent on tracking them (Nagy et al., 2006; Chen, Wu, Su & Yang 2008). In an emergency, it is not uncommon to find doctors and nurses hunting for an intravenous (IV) stand or defibrillator, although the hospital may have numerous supplies (Nahas & Deogun 2007). Large hospitals in particular have significant expenditure on stocking frequently used equipment (Tzeng, Chen & Pai 2008). Yet, medical staff spend hours searching for patient care assets, including medical devices (such as infusion pumps, portable x-ray machines and patient monitoring devices), as well as other mobile assets such as wheelchairs, laptops, stretchers and gurneys (Godinez 2007; Baldwin & Larkin 2008).

Low usage and slow device cycle times cause many high-value assets to remain under-used, while hospitals continue to overspend on new and rental assets (Hoskins 2006).

Meanwhile, nurses sacrifice time with patients (especially in surgery) to seek equipment they need; maintenance staff lose productive hours searching for specific items that need maintenance (Wang 2006). As a result, the efficiency of processes in hospitals reduces, while costs and complexities continue to rise (Hoskins 2006, Nagy et al., 2006). Managing processes efficiently, enhancing quality of care and controlling costs are seen as the rationale for adopting RFID systems in hospitals (Fuhrer & Guinard 2006; Simpson 2007; Cangialosi, Monaly & Yang 2007; Cox 2008). Relatively inexpensive RFID technology is perceived to optimise use and support appropriate allocation of scarce material resources (HFM 2006; Lee & Shim 2007).

In the early 2000s, hospitals discovered that tracking equipment using RFID tags took less time, leaving practitioners to spend more time with patients (McCarthy, 2004). By 2005, this rather uncomplicated innovation, which easily integrates with other clinical support systems, began to be rapidly accepted in hospitals globally. Increasingly, hospitals were finding they could lower expenses on rental equipment and over supply inventories, with the implementation of RFID systems. At that time, they were often known as ‘indoor positioning systems’ (Fisher 2006). Due to its multi-dimensional uses, RFID, which was still considered an innovative technology in the context of hospitals, was then trialled to track inventory, identify patients and even manage personnel (Fisher & Monahan 2008).

Formative research into the drivers for RFID in hospitals (Nagy et al., 2006; Chen et al., 2008) indicate that using RFID tags may lead to reductions in clinical errors and costs and increased efficiencies. Many hospitals initiated the use of RFID tags on wristbands (or bracelets), which store data and can be scanned with a reader to identify a patient, and the required surgical procedure (Cangialosi et al., 2007; Thomas 2008). RFID tags embedded in-patient bracelets could help medical staff identify patients before surgery and before administering medications or blood transfusions, reducing possible clinical errors (Dalton & Rossini 2005).

RFID systems have been implemented such that patient movements can be traced through hospital services (Fry &Lenert 2005). Medical staff are often given RFID tags on their badges to collect workflow data to find inefficiencies in current hospital operations (Iadanza, Dori & Miniati 2008). These systems are particularly useful in emergency settings, where there is high patient volume, and a heightened risk of medical error (Nagy et al 2006). RFID has a major advantage that justifies any additional cost: it is automatic and so does not require manual intervention to work, removing much potential for human error (Nagy et al., 2006; O'Connor 2006).

Lai, Chien, Chen and Fang (2008) pointed out that at any given time over 1.4 million people worldwide suffer from infections acquired within hospitals. Annually, approximately 450,000 preventable adverse drug events occur in the USA and patient safety has become a serious global public health issue. Lai et al., (2008) report on an in-patient medication administration system and the re-engineering of medication processes. It was expected that integrating RFID into existing hospital systems would improve the efficiency of hospital management and medication safety, as well as decrease the risk of adverse drug events, thereby increasing the quality of patient care. (Lai et al., 2008; Yu, Hou & Chiang 2012).

According to Scott Wallace, president and CEO of Chicago-based National Alliance for Health Information Technology, systems were not the real problem with RFID implementations (H&HN 2004). Process improvements and cost savings were motivations for investment in RFID for hospitals; the challenge was how quickly workflow processes could be transformed (H&HN 2004). Evolutionary literature regarding RFID over the decade (2000–2012) (Yao, Chu & Li 2011; Martinez-Perez, Cabrero-Canosa, Vizoso, Carrajo, Liamas, Vazquez & Martin Herranz 2012) indicates that RFID systems did not easily adapt to hospital settings because of infrastructure relating to space, equipment, personnel and patients, making it much more complicated than a factory or warehouse setting.

Unlike a warehouse or even pharmacy areas, where the movement of pellets or boxes is tracked in a structured manner, hospital processes are often chaotic (Yao, Chu Chao-Hsien & Li Zang 2011). Workflow processes have to remain fundamentally structured, so that the chaos in an emergency can be handled efficiently. For example, a nurse's workflow for an emergency follows a certain structure; and in an emergency, a nurse will depend on orderlies or nurse's assistants to find a particular piece of critical equipment. Adding RFID to this environment changed the workflow to an extent that nurses could find equipment themselves if needed. This is an advantage. However, the benefit of the innovation also disempowers orderlies, who are regarded as life support systems in hospitals.

Equally, the benefit of tracking a piece of equipment themselves, thus saving time in an emergency, is equivalent to a 'nurse's time' being spent on tracking the equipment, rather than spending it with the patient. Thus, the benefit negates itself (Snyder, Paulson & McGrath 2005). It is equally the case that the patient care orderly then feels disempowered (or if they are trained to track equipment using RFID feels an extra burden) with this addition to their ordinary workflow. A huge change had to occur within the chaotic emergency environment with already structured workflows, before the technology could actually begin to reap benefits (Yao, Chu Chao-Hsien & Li Zang 2011).

From another historic view, Spyglass Consulting Group (2005) argued that uncoordinated efforts between hospitals, vendors, shippers and suppliers are restricting RFID adoption in hospitals. In many hospitals, the implementation of RFID is vendor driven and implemented, often not in consultation with all concerned staff. This view supports those of O'Connor (2005), who argues for a disparity of views between systems integrators and vendors in regard to RFID user education. O'Connor (2005) implies that end-user involvement was largely ignored by integrators and vendors.

Specifically, RFID implementations usually begin with a pilot project (Hoskins 2006; Iadanza, Dori & Miniati 2008). This could begin with a vendor providing the equipment, handling installation and testing; this may be quite sudden and not known to all hospital staff. In a resource-constrained hospital, it is also more difficult to inform everyone (Janz, Pitts & Otondo 2005), as many staff work part time. Effectively, this lack of (or minimal) coordination, results in underutilisation of the system. Specifically, if every employee who works part time is unaware of RFID tracking being available, they may use it during their shift hours. Equally, when a pilot implementation begins, all equipment to be tagged may not be available at the same time. And all tags may not arrive at one time to enable vendor tagging. This results in less accuracy of tracking, poor adaptation of the systems and also encourages a certain level of resistance from users (Kumar, Livermont & McKewan 2010).

In their significant work, Fisher and Monahan (2008) argue it is important to know what effects the technological system has upon organisational roles and relations. Also important is the surveillance potential of the system. The evolving nature of the technology may alter conditions within hospitals, as different groups adapt to and define their roles in relation to the innovation. According to Fisher and Monahan (2008), it was possible that the outcome of RFID implementation would be more invasive and less efficient than intended. For example, RFID systems may tend towards shadowing, such that nurses may feel overtly scrutinised by the tracking technologies.

2.1.3.2 RFID-Enabling Functions in Hospitals—Perspectives on Adoption

A research report from Rand Corporation (2009) summarises RFID-enabling functions in hospitals (see Figure 2.1), which aim to improve process efficiencies. Examples from across the world in all categories and Australia are presented in this section. The most popular of these applications is ‘tracking’, which is RFID’s key advantage for hospital use.

		Healthcare Applications			
RFID Enabling Functions	Tracking	Patient Safety/Quality of Care	Pharmaceutical Application	Management of devices, supplies and biological material	Patient and healthcare personnel support /management
		Tracking vulnerable patients (Demential, MR), Tracking patient whereabouts during treatments to account for time	Easy recall of products	Prevention of left-ins during surgeries Equipment tracking to ensure hygiene compliance, regular maintenance and fast location	Personnel tracking to improve workflow and reduce waiting time in ER
	Identification and Authentication	Mother-baby e-handshake to ensure accurate matching	Auto ID enabled medication administration system	Maintenance of real time clinical information associated with patient within a hospital	Patient identification to reduce incidents harmful to patients (wrong, drug, dose, time, procedure)
	Automatics data collection and transfer	Use of tablet PCs for care coordination	Tracking pharmaceutical inventories	Inventory management for better use of time and faster care delivery	RFID supported automated care pathways, procedures audit and management
	Sensing	Patient vital signs for triggering alerts for medical personnel and remote monitoring at patients home	Patient compliance with prescribed medication treatment (in and out patient)	Blood bags equipped with temperature sensors in hospitals to ensure cold chain and efficacy	Personnel and asset tracking to ensure infection control

Figure 2.1: RFID-Enabling Applications in Hospitals (source: Rand Corporation 2009)

Figure 2.1 represents the main RFID-enabling functions in hospitals. Tracking is considered globally, as it is closely aligned with supply chain management. For example, it is used for pharmacy, devices and equipment, amongst other things. In addition, it is used for tracking people with dementia. The 'identification and authentication' function is used for identifying babies, automatic medicine administering systems, maintaining clinical information and patient identification. RFID is also used for automated data collection and transfer, particularly in tracking pharmacy inventories. The last function, sensing, is a function of RFID yet to become prevalent in Australia due to privacy regulations. Triggering alerts for medical personnel and remote monitoring in patients' homes can be facilitated by this function.

Amongst the enabling functions, I have focused on 'tracking' as the primary application most hospitals have considered. Tracking is an activity in hospitals pivotal to operations (Pappu et al., 2004). Medical staff have always reported trouble when tracking down ventilators, intravenous pumps and similar medical devices (H&HN 2006: 28). With the increased reliance on shared handheld devices and laptop computers, the scenario is further complicated. A growing number of hospitals are beginning to combine their existing wireless communication networks with RFID, to create real-time location systems.

RFID tags can be attached to equipment and people, beginning with newborns whose security can be better ensured with an RFID wristband H&HN (2005: 23) reported early use of patient tracking in the Boston-based Beth Israel Deaconess Medical Centre, which outfitted its 4,459 square metre ED with RFID tags to track clinicians, patients and equipment (H&HN 2005: 24). Many other US hospitals had similar uptakes, such as Shelby County Regional Medical Center in Memphis (HFM 2006), Harrisburg Hospital in Pennsylvania (Cox 2008), Christiana Hospital ED in Newark, Delaware (Cox 2008), Heart Hospital Baylor Pano, Texas (Godinez 2007). Around the world, The Bhagwan Mahaveer Jain (BMJ) Heart Center (a cardiac hospital in Southern India) (Bacheldor 2007) and the Rockhampton Base Hospital in Queensland, Australia (Bacheldor 2006), also had similar uptakes.

Apart from doctors, nurses, patients, visitors and infants, equipment can be tracked and prevented from being stolen or lost, along with medicines that need to be administered on time in the correct proportions from the correct package (Pappu et al., 2004). Clinicians and staff can be traced in an emergency if they are tagged with a wrist band. Emergency departments can use RFID tags to follow patient charts:

> RFID tags could be used by materials management to track portable X-ray machines and also by the pharmacy to track a unit dose of an expensive drug (Greene 2005: 32).

H&HN (2005) revealed that 10 per cent of health care organisations in the USA use RFID tags to track expensive equipment; 45 per cent expect to have systems in place. As reported in H&HN (2005: 23) in 1993, St Elizabeth Medical Centre in Edgewood, Ky, deployed an early form of RFID to prevent baby thefts in the maternity ward. The technology has since been upgraded and its use extended to patients—mainly those with psychological or substance abuse problems—who may hurt themselves or someone else if left untreated.

RFID has a major advantage that might justify any additional cost: it is automatic and so does not require manual intervention to work, which removes much potential for human error. A Frost and Sullivan report (Simpson 2007) indicated that RFID tracking could save hospitals time and money that could be expended in tracking lost equipment. Page (2007b) reported that pilot testing of RFID tracking had already given way to implementation, with hospitals moving ahead with dependable uses of RFID, such as asset-tracking.

O'Connor (2006) reported on the results of an RFID pilot in a Toronto area hospital, Hamilton Health Sciences Acute Care Center, Canada. The pilot implementation tagged 200 pumps, as well as diagnostic equipment and other high-value mobile assets in the nursing ward. Although the upfront costs were substantial, full implementation is expected to bring a high return on investment (ROI), as it extends to infant tracking, adult patients or geriatric patient monitoring. The pilot was successful in identifying the shortfalls and led to broader implementation.

The Shelby County Regional Medical Center in Memphis implemented RFID patient tracking systems to reduce overcrowding in the ED (HFM 2006), thus increasing the department's efficiency. Until that time, the centre could only account for 25 per cent of a typical patient stay in the trauma unit. After RFID implementation, it could account for 80 per cent of patient time. The Heart Hospital Baylor Pano, Texas, has implemented an RFID network, which automates tracking and cataloguing of the hospital's high end equipment (Godinez 2007). Staff in the hospital have embraced this technology well and are very satisfied with its performance. Subsequently, the president of the Dallas Fort Worth Hospital Council declared that all hospitals in the region deploy RFID systems.

Baldwin and Larkin (2008) note that asset-tracking systems help hospitals track their mobile inventories. They state that RFID monitoring can fit a hospital's strategic priority. However, which tracking solution and infrastructure is needed can vary widely, depending on the context. They comment that one RFID solution neither fits all hospitals, nor all countries.

RFID may have much more potential in developing nations where health care systems, even in advanced hospitals, are strained by inefficient use and a shortage of expensive equipment (Bacheldor 2007). The need is therefore higher to find solutions that enable optimum use of assets, resources and that increase the quality of care. For example, in India, there is a multitude of small, medium and large hospitals that are struggling to assimilate and use expensive, higher technology equipment that is increasingly being demanded by both physicians and their patients. This creates significant shortages in hospitals, potentially leading to disruptions to high standards of care, even when, in theory, the device or equipment is part of the hospital inventory (Bacheldor 2007)

For example, since 2006, the Bhagwan Mahaveer Jain (BMJ) Heart Center—a cardiac hospital in Southern India—is using passive UHF RFID tags to assist with maintaining patient records, monitoring patient flows and tracking assets throughout the outpatient department (Bacheldor 2007). An average of 100 patients per day is tracked, which includes returning patients checking into the outpatient department. Patients checking into the outpatient department receive RFID-tagged cards. The unique identification (ID) number on each tag is associated with the patient's electronic records in the clinical information processing platform (CLIP). This system includes software and RFID interrogators and tags. The RFID interrogators or readers are positioned in the waiting room, consultation rooms and laboratories. They document whenever a patient enters and leaves, and how long they stay in the area. The CLIP system is also integrated with the hospital billing system, enabling staff to use patient care and workflow information for accurate billing. The manual effort of paper registration and paper forms has been eliminated. With respect to asset-tracking using RFID, the hospital is attaching RFID tags to stents, pacemakers, wheelchairs, gurney and other high-value items, as well as certain mobile devices used in diagnostic labs. The CLIP 'AssetLIVE' application, which uses a mapping technology, is used to track the location of these assets. The system, instead of tracking tagged objects in real time, documents their location by analysing RFID data reads and renders their last known position in a graphic (Bacheldor 2007). The hospital has benefitted from the technology in that it has increased patient throughput, reduced paper work and added visibility to supplies.

Early applications of RFID in the USA include infant tracking and staff tracking, combined with time and motion studies to optimise workflows in areas such as radiology and surgery (Cox 2008). There are a few instances where RFID has been beneficial with reshaping processes within hospitals, resulting in reduced errors, cost savings and better patient care. Harrisburg Hospital in Pennsylvania deployed a range of RFID applications from a patient tracking system for surgical patients to a 433MHx wireless infrastructure able to track wheelchairs and a range of portable medical gear (Cox 2008).

In Christiana Hospital, Newark, Delaware, the emergency department has 76 treatment rooms that handle 100,000 patients annually. Nurses were losing track of where patients were in the treatment process, as they were moved amongst diagnostics and treatment facilities. This resulted in-patient stays spiking above normal levels, and resulted in four to five per cent leaving without treatment. The hospital has combined a tracking system with an infrared sensor network for locating hardware assets. A web based application shows tagged patients, staff and medical assets and creates a visual workflow for patient progress. The data is filtered through various subset views so departments can expect and manage the number of patients and streamline their progress. According to this report, the length of patient stay has been reduced (Cox 2008).

A context aware system, combining RFID and finger print recognition for patient and clinician identification, was reported in Aarhus, Denmark (Bardram 2004). A transfusion system to identify blood bag, recipient and staff was reported in San Raffaele Hospital, Italy (Dalton & Rossini 2005). Aguilar, Putten and Kirrane (2006) reported an RFID system using passive tags, handheld devices and wireless networks to enable patient identification, speeding up access to patient data in the University College Hospital, Galway, Ireland. An ultra-wideband RFID system to track medical assets was implemented in Washington Medical Center, USA (Bacheldor 2007). The items were mainly for moving patients such as wheelchairs and beds, as well as expensive items, such as special radiology scopes. The prominent RFID-based real-time location system, better known as RTLS (Swedberg 2009), was implemented in Richmond Health System, in Virginia, USA. The system used active RFID technology to track 11,000 assets (including IV pumps and stretchers) over five years, and tracked patients in the emergency department for 18 months, at the time this was reported. Large Australian hospitals considering RFID drew on this solution in a major way.

By the mid-2000s, RFID was being trialled for inventory tracking and supply chain management, and some hospitals began pilots for tracking people, including infants (Cox 2008; Swedberg 2009). By end of this decade, these pilots had paved the way to semi or full implementation of RFID in many countries.

Supply costs are a major expenditure for hospitals, accounting for 30–40 per cent of the average hospital operating budget. As such, careful and efficient control of this spending is critical for a hospital's success (Shumaker 2009). Equally, an adequate flow of products and services, meeting the needs of care providers, is required (Callender & Grasman 2010). Several conditions increase supply chain costs. Hospitals spend on expensive inventory such as pacemakers and defibrillators. However, a lack of visibility in the supply chain can result in lost, stolen or misplaced equipment, driving up operational costs (Kumar et al., 2010). Inventory tracking is highly difficult due to emergency medical procedures and the unpredictability of diverse patient needs. While the retail and manufacturing industries have adopted RFID tracking successfully (Choudhury et al., 2008), the hospital supply chain lags behind (Coustasse 2012).

Tracing RFID adoption from 2002–2012, and surveying the decade of literature, Coustasse (2012) argues that despite much discussion of the potential benefits for adopting RFID in hospitals and health care, the body of knowledge still shows a significant gap in understanding current and future possible applications. Therefore, a review of impeding factors, compared to the benefits, of RFID adoption is required.

2.1.4 *Barriers to RFID* **A***doption in* **H***ospitals Versus Enablers*

RFID definitely promised heightened efficiency and cost savings in hospitals. However, the guidelines in academic literature for implementing RFID systems effectively are limited (Fisher & Monahan 2008). Fisher and Monahan's investigation (2008) is academically regarded as a path-breaking and significant study of RFID, as it examines the social context of the technology in the literature. Health practitioners in Australia often refer to it as an epoch-making study. I have drawn from this study because of its relevance to the Australian context towards the end of the decade. In Australia, the pioneering of RFID began towards the end of 2006, when academic studies were few and not relevant.

The early days of RFID implementation touted potential patient safety (Neil 2005), ability to better track drug supplies and real-time asset management of critical assets (Jossi 2004; Neil 2005). Equally, the literature has highlighted the complexity of integrating multiple technical systems when they lack interoperability (Davis 2004; Becker 2004). The proprietary nature of RFID in the early days—that it was vendor driven—is reflected in these arguments. Often the largest constraint on hospitals was the lack of financial resources and technical abilities to implement the technology, in alignment with the standard body requirements (such as the HIPAA in the USA) (Department of Health and Human Services (DHSS), 2003).

Fisher and Monahan (2008), regarded as the significant work in this area in the 2000s, note the disconnection between the solution RFID offered and the clinical problems of hospitals, as the technology transitioned from military to manufacturing and health. More significantly, they pointed out that RFID systems do not adapt easily to hospitals (because of infrastructure in terms of space, equipment, personnel and patients) to improve interactions between patients and clinicians. They commented that RFID might pose a problem with communications in hospitals, rather than offer a solution to existing problems. Vogt, Aickin, Ahmed and Schmidt (2004) offered recommendations for more technical interventions in conjunction with RFID, offered developments that were divorced from social context of its use (Fisher & Monahan 2008).

Singh, Servoss, Kalsmann, Fox and Singh (2004) investigated medical records implementation and effects on patient safety. The social context was considered seriously as a benefit of the system implementation, in that there was improved communication between nurses and physicians. However, there were a host of barriers and unanticipated consequences, such as increased errors in reading patient charts, confusion in interactions between physicians and patients, insufficient training time for existing staff and complexity from multiple systems (Lorenzi & Riley 2004; Lorenzi 2005). In particular, Lorenzi and Riley (2005) argued that the concept of 'peopleware', which accounted for the social component necessary for successful integration of new hardware systems in medical settings, was largely ignored in medical informatics. According to Fisher and Monahan (2008) the developmental studies that investigated implementation of ICT systems ignore the social side of technology use. They suggest that technological systems and devices require considerable organisational and material investment to become standard practice. If a technological infrastructure or system contributes to the quality of existing services, often social relations are normalised, such that systems become invisible for those involved. For this to occur Fisher and Monahan (2008) recommend that hospitals look beyond financial costs. Rather, they should look into staff training, division of labour on realigned responsibilities, identification of labour intensification and correct crafting of policies. They also warned that investigators need to be open to consequent ethical issues.

During the early part of the 2000s, the surveillance modality of new technologies, including RFID, was a great concern. According to Fisher and Monahan (2008), barriers to adopting RFID were the maladaptation of the system itself, and organisational challenges in its use. Even at that time, RFID was a proven technology in manufacturing, but the benefits to the health sector were yet to be proven, with its suitability as yet unexplored. Technology vendors had designed standardised inflexible packages with no thought to the variations that could occur in terms of space, processes and size.

Fisher and Monahan (2008) pointed out that administrators, physicians and nurses expressed the need for customisable RFID systems to fit their sites. The lack of interoperability with other systems, such as simple electronic white boards, was a significant issue. RFID resulted in yet another computer terminal for staff to look at, increasing frustration, while adding costs for the hospital. Fisher and Monahan (2008) presented two key themes: labour intensification of staff, and their frustration from the increased surveillance potential of RFID. For instance, nurses reported:

> we would rather spend time looking for equipment and locating patients than spending it logging in and navigating the RFID system software, replacing RFID tags, and/or calling technology support when the system is not working properly…we feel 'big brother' is watching as we spend time with patients, taking unofficial rest breaks between patients, and take official breaks during shifts (Fisher & Monahan, 2008: 5).

Chen, Wu and Su Yang (2008: 286) alerted that while increasing numbers of vendors, hospital administrators and caregivers advocated the relative advantages of RFID, adoption has slowed. This may be attributed perhaps to technology resistance. Their research that addressed RFID adoption in hospitals from an expectation-confirmation perspective revealed that health care providers with a high perception of the usefulness in front-end interoperability and of performance expectancy affirmed a positive confirmation experience using RFID technology. (Chen et al., 2008: 286). However, for continued use and progress, Chen et al., (2008: 286) argue that:

> hospital administrators and equipment vendors need to address those factors that have been revealed as significant such as increasing the perceived front-end interoperability by using experienced consultants and integrators to implement systems that are proven to be interoperable at the front-end. They may also intervene via training and education to increase caregivers' performance expectancy of RFID.

Yao et al., (2012) summarised a decade of literature relating to RFID implementation and found technical, economic, social and other unrelated issues were impeding RFID implementation. At the beginning of the last decade, RFID had technical limitations in that it had not evolved as a non-interfering technology amongst other medical equipment. Togt, Lieshout, Hensbroek, Bennat, Binnekade and Bakker (2008) pointed to the electromagnetic interference that induced potentially hazardous incidents. Today, when devices share the same frequencies in dense wireless environments, interference is still an issue. The accuracy of RFID readings is still not 100 per cent (Ohashi, Ota, Machado & Tanaka 2008) and the lack of an industrial standard on RFID data structure, air-interface and local interface is still regarded as a major technical obstacle.

Equally, economic investment remained an issue for RFID implementation. At the beginning, RFID costs were already high with tags, equipment and infrastructure costs. Hospitals had to justify not only tags and equipment, but also additional servers, databases, middleware[11] and applications (Yao et al., 2012: 3,516). Significant costs have been outlaid on Wi-Fi[12], which leverages RFID applications. Adding RFID components to existing wireless networks meant that hospitals could reduce the cost of

[11] Middleware is a software that connect otherwise two separate applications.

[12] WiFi is a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves. The Wi-Fi Alliance defines it as 'any wireless local area network (WLAN) products that are based on the IEEE 802.11 standards'. The term today is being used in English as a synonym for WLAN (www.webopedia.com)

building a tracking system with little interference. As Scott Wallace argued, a hospital could track most critical assets by adding RFID to wireless systems, spending US$100,000. It was estimated that a 200 bed hospital could save US$600,000 a year by using RFID. Such use would result in fewer rentals, deferral of new purchases, improved staff productivity and enhanced quality improvements in service (Buyurgan 2009).

However, to ensure RFID's viability, integration with back end systems and data synchronisation of networks was needed. In addition, process redesign, organisational change and labour costs had to be added to potential investments (Buyurgan 2009). After almost a decade of use, health care providers are still unclear regarding the return on investment (Yao et al., 2012).

Equally, with the evolution of cheap wireless networks towards end of the last decade, which enabled RFID integration with health systems, it became relatively easier to deploy the technology without interference with existing systems or critical equipment. However, there was also need to refresh the existing wireless infrastructure. This suited RFID tagging, which meant revised expenses (Yao et al., 2012).

One of the early suggestions (Green 2005) has been that hospitals should adopt the technology in such a manner that it is compatible with different parts of the hospital. The deployment progress of RFID at that time (as pointed out earlier in this chapter) with most hospitals was such that pilots for specific purposes, whether tracking assets or people or pharmacy-related functions, were deployed and only these specific departments benefitted.

Legacy systems in different areas were incompatible with RFID integration in many instances. Disparate standards of RFID continued to be disputed (Fisher & Monahan 2008). For example, a hospital department may have deployed a pilot of RFID tags for equipment tracking. By the time another department took up the technology, the tags had been developed to a higher standard. The dynamic evolution of the technology, and its standards, combined with the transition of legacy systems to modern technologies ensured a lethargic RFID implementation.

However, towards the end of the 2000s, hospitals began justifying the upfront costs due to an economic slow down. Health care is the world's largest industry (Janz, Pitts & Otondo 2005) with expenditures in 2006 accounting for 16 per cent of the US GDP and nine per cent of Australian GDP (AIHW 2006–07). Hospitals continue to seek solutions to reduce rising health costs without adversely affecting patients (Yao et al., 2012).

The early 2000s saw hospitals being sceptical about full-scale RFID deployment, as the evolution also added costs to the investment (Buyurgan et al., 2009). Towards the middle of the decade, costs had reduced and RFID, as a technology, had evolved. While hospitals worldwide began pilots, the economic meltdown shelved most full-scale implementations. Nonetheless, towards the turn of the decade, hospitals continued to look for long term options to reduce their operating costs in the environment of economic slow downs. In turn, this justified long term costs. Still, many continued to be reluctant as the payback was less visible (Yao et al., 2012).

Social and legal issues are disparate in different countries. What is common is privacy concerns. Issues regarding inappropriate collection, intentional misuse, and unauthorised disclosure of information resulting from RFID technology continue (Sotto 2008). RFID systems introduce a key ethical concern regarding privacy because of their surveillance potential, which affects medical staff and patients (Fisher & Monahan 2008). A serious security concern (a legal issue) is the inadvertent transmission or deliberate interception of personal health information left on discarded tags (Ingeholm, Mun & Mun 2006).

There were also other related issues identified in a review of a decade of literature, such as lack of organisational support and trust (Fisher & Monahan 2008). It may be noted that these elements were not really considered significant in the review (Yao et al., 2012).

For the purposes of this research investigation, I considered the main feature of RFID technology, its 'tracking ability', which makes it attractive for Australian hospitals. In large resource-constrained hospitals, RFID-enabled tracking of assets and people is justified because the automation of RFID not only lowers long term operating costs, but is also perceived to improve current processes. Table 2.1 is a summary based on the preceding literature review, capturing the early and later issues in tracking using RFID.

Table 2.1: Asset Tracking—Early *v*. Latest Barriers to Implementation

RFID-enabled functions in hospitals	**Status of pilots *v*. full implementation**	**Early issues (2000–2005)**	**Latest issues (2006 onwards)**
Asset tracking	Mostly successful pilots worldwide	Prohibitive costs of implementation	Initial investment in revising infrastructure with Wi-Fi systems
	Full implementation shelved due to economic, legal and policy reasons	Interference with existing medical systems	Integration with existing legacy systems
		Lack of standardised tags	Need for medical grade tags which are more expensive
		Scepticism from users (medical staff including clinicians, nurses, orderlies)	Reluctance from users to accept the technology as part of their current role/position
People Tracking	Relatively successful pilots	Privacy and surveillance concerns of staff	Privacy concerns and policy regulations in different countries
	Full scale implementations still emerging	Consent requirement from patients sceptical of RFID tags as an intervention	Sceptical staff concerned with their workflow changes in hospitals as process improvements occur

2.1.4.1 RFID in Australian Hospitals

In Australia, health care is heavily affected by privacy regulations (Privacy Act of Australia 1988; Privacy.Gov 2013). While privacy and legal procedures do receive attention in many nations (for example, Fisher & Monahan point out that HIPAA significantly affects technology implementation, as well as health sector compliance in the USA), in Australia, the Privacy Act is more formidable (Duckett & Wilcox 2011). Often it is so doctrinaire that any data regarding an adult patient is not even provided to parents, unless they are named as carers, and if the patients are unable to handle themselves (Duckett & Wilcox 2011). This poses significant difficulties in emergencies, when an adult may be in perfectly good health, but not in a capacity to care about himself or herself at the time. Yet, the details of a condition may not even be immediately revealed to close relations (Duckett & Wilcox 2011).

In such restrictive conditions affecting the health sector, a piece of technology, such as RFID with its surveillance potential, was unacceptable in its original form to Australian hospitals. They had to be compliant with the existing privacy laws and standards. If not, perhaps similar to the USA (Fisher & Monahan 2008), organisations such as the nurse's union would have taken action and protested over the surveillance of people. Additional to this problem is the privacy of patients or individuals who may be moved using a wheelchair tagged by RFID.

The health care sector in Australia has received much attention from the government from the beginning of 2000s (Crompton 2002), when subsequent Productivity Commission (2005, 2006) reports recommended significant introductions of technologies in hospitals to improve processes. The National Health and Reforms Commission (2009) argued in favour of introducing technologies to improve efficiencies in the health sector. Novak and Judah (2011) suggest that the agenda for boosting productivity in the health sector is in progress.

However, it may be noted that in the process of implementing technology agendas, state governments have to implement the policies and reforms enacted by the federal parliament (Gabbitas & Jeffs 2007; Goss 2008). In this continuum, many experiments occur. Often there are significant failures of implemented systems (Ducket & Willcox

2011). For example, the state of Victoria (Hopewell 2012) experimented with the HealthSmart[13] system for refreshing technologies in hospitals; this was eventually cancelled. In the process, many new technologies were introduced, causing a lack of interoperability with existing systems and adding new ones (Dunlevy 2013).

RFID, as an innovation, was still being trialled towards the end of the 2000s, and was not yet fully accepted as a standard way of asset-tracking in hospitals (at the time when this research study was conducted, i.e. 2007–2012). As Australian hospitals were on the pathway to e-health records at a national level, many large hospitals paused their proposed systems implementation projects, including RFID (Duckett & Wilcox 2011).

An early report of RFID-enabled functions in Australia by Bacheldor (2006), reported that the Rockhampton Base Hospital in Queensland, Australia, used RFID to improve nurse safety in mental health ward buildings. Specifically, nurses in the hospital's mental health ward were using 'alarm cards, which combined a long-range wireless duress transmitter, a photo ID and proximity access control in one credit-card size device. The duress transmitter featured a battery-powered RFID tag. Any nurses in danger or in need of assistance pushed a button built into the back of the card, causing the transmitter to send a signal to an RFID reader, alerting co-workers. To make the process convenient, nurses received the cards when they signed in at the beginning of their shifts; the tag's unique ID numbers correlate in a database with the nurses' names and photos.

Chowdhury and Khosla (2007) provided an overview of the main components of an RFID-based patient management system, as illustrated in Figure 2.2, based on a model built for hospitals in Australian context. They argued that hospitals could track patients accurately and efficiently, improve the safety of clients by capturing basic data such as drug allergies, and prevent and reduce medical errors, as well as build a more collaborative environment with varied departments such as wards, medication and payments.

[13] HealthSmart was an initiative from the State of Victoria in 2004, to refresh all ICT eco systems in health. It was killed in 2012 being overbudget and out of scope as a project.

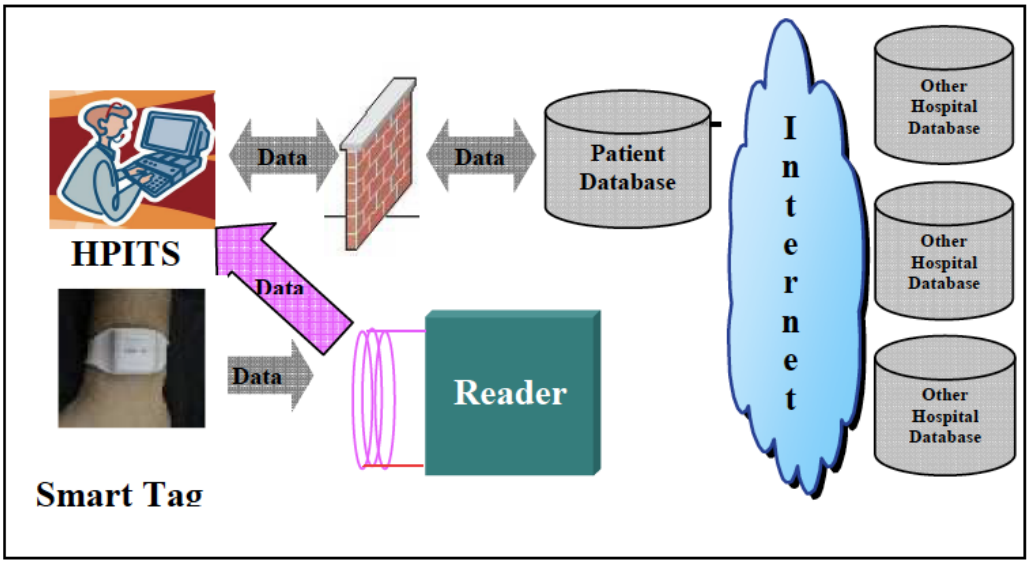


Figure 2.2: RFID-Based Patient Management Systems (adapted from Chowdhury & Khosla 2007)

Many pilot implementations, such as those at RMH and Barwon Health in Victoria (and others in Western Australia and Queensland) were introduced for not only asset-tracking but also patient tracking (infants, geriatrics & intellectually disabled and/or mentally ill). However, most of these pilots did not result in full-scale implementation, or implementation was restricted to certain critical-care areas (Chowdhry & Khosla 2007).

Royal Adelaide Hospital in South Australia partnered with technology specialist Visionstream to deploy an integrated wireless network which will combine tagging and tracking functionality to manage patient intake and care, as well as track availability of health care equipment throughout the hospital. The project is designed in conjunction with the South Australian government's new model of health care, which focuses on using technology to enable safe care solutions, reducing time spent on administration and increasing clinician-patient time (RFID 2012).

Bendigo Hospital in regional Victoria has successfully deployed RFID progressively in all departments across the hospital (Friedlos 2010). Subsequently, they have planned an in-built RFID-enabled infrastructure for the new hospital building to open doors in 2013.

From the limited literature sources, RFID in Australia was still an emerging innovation for hospitals in 2007 (Fisher & Monahan 2008; Yao et al., 2012). When I embarked on this study in 2007, pilots in specific departments were showing success, but without full-scale implementation. While there were vendor reports indicating pilot successes, academic studies were yet to emerge at the time.

Equally, the significant work of academics as they reviewed RFID in the decade (Fisher & Monahan 2008; Roark & Miguel 2006; Hoskins 2006; Yao et al., 2012; Coustasse et al., 2013) (examined in the preceding thesis sections) pointed to mainly technical and economic issues relating to RFID, de-emphasising social and legal issues. Despite Australian hospitals piloting the technology towards the end of the decade, unsuccessful and abandoned examples persisted.

At the beginning of this study in 2006–2007, I found literature de-emphasising social issues concerning the implementation of RFID and focusing instead on technical and economic issues of justification. Studies that focused clearly on social issues impeding the technology were non-existent. Motivated by this gap in the literature, I embarked on an investigation of the socio-technical factors impeding the progress of RFID.

2.2 Part II: Building the Conceptual Framework

2.2.1 Approaches to Innovation Adoption

According to Oxford dictionary (2014), to innovate is '*to make changes in something establishes, especially by introducing new methods, ideas, or products'*. Tatnall (2011) explained that "innovation is the alteration of what is established; something newly introduced" or "introducing new things or method". As against invention, which is creating new things or ideas, innovation involves putting ideas into a commercial or organisational context (Maguire, Kazlaukas & Weir 1994). Innovations are important to every society for progress. It is also important that any innovation is adopted so its benefits are realised. An innovation may be rejected because it is not context ready at that point in time. For example, in the early 2000s, hospitals were rather unprepared for an innovation such as RFID (Greene 2005). Users also perceive innovations differently. In this context, RFID may be seen as a piece of technology useful for tracking equipment, thus reducing costs and improving efficiencies in hospitals (Nagy et al., 2006; Ustundag 2013). However, the users of the system, such as nurses, may perceive it as a surveillance system (Fisher & Monahan 2008). When the user perception is negative or indicates reluctance, innovation adoption may be difficult.

There are many popular approaches to studying technology diffusion and acceptance in information systems. Amongst them are the following.

2.2.1.1 Diffusion of Innovations

Diffusion of innovations (Rogers 1995, 2003) is based on the notion that adoption of an innovation involves the spontaneous or planned spread of new ideas. The existence of an innovation is seen to cause uncertainty in the minds of potential adopters. Four main elements constitute the theory:

- characteristic of an innovation
- nature of communication channels
- passage of time
- the social system through which it infuses (Rogers 1995, 2003).

Characteristics of the innovation are:

- its relative advantage, for instance the degree to which it is perceived as a better idea,
- compatibility with existing values and experience of users
- complexity, for instance the degree to which it is perceived as difficult
- trialability, or the degree to which an innovation may be subjected to limited experimentation
- observability, for instance the more results of an innovation available, the more likely it is to be adopted.

Adoption goes through the stages of awareness, interest, evaluation, trial and adoption. The social system is the boundary in which the system infuses.

The issue that I have with this approach is that it assumes an innovation sparks spontaneity or a planned spread of new ideas. The nature of an innovation in a chaotic environment, such as hospitals, may not warrant spontaneity or spark new ideas. Rather, it may be seen as an additional intervention to existing workflows, that impedes the progress of an already chaotic day. The innovation may be regarded as yet another piece of technology that does not need much attention, or an obstruction that is ignored altogether. The stages of adoption may not occur (Rogers 1995; 2003).

2.2.1.2 The Theory of Reasoned Action

The theory of reasoned action (TRA) (Fishbein & Ajzen 1975) postulates that beliefs, attitudes and social norms shape behavioural intentions, guiding or even dictating individual behaviour. It focuses on behavioural intention, attitude and subjective norms. In predicting and explaining behaviour, while the theory has been applied widely in research, there is often a gap between behavioural intention and actual behaviour (Bonfield 1974). In the already unpredictable environment of hospitals, TRA is an unsuitable model to study technology adoption, as behavioural intention and actual behaviour are always conflicting, due to emergencies. Staff may want to adopt and explore technology, but may not actually use it due to stressful emergency situations.

2.2.2 Theory of Planned Behaviour

The theory of planned behaviour (TPB), as developed by Ajzen (1991) was modified from TRA, and assumes that behavioural action is a function of two determinants: individual attitudes towards behaviour and subjective norms within the social environment. In contrast, the decomposed theory of planned behaviour (DTPB) introduced by Taylor and Todd (1995), suggests that behavioural intention is a primary direct determinant of behaviour, although the three main constructs still exist.

These theories are not efficient to study technology diffusion in hospitals, as the core construct of behavioural intention may not offer meaningful value. Individual attitudes towards RFID may reflect acceptance, and the subjective norm within the hospitals is to perhaps not disrupt the social environment. Behavioural intention cannot be considered primary determinant for technology adoption in such environments.

2.2.2.1 Social Cognitive Theory

Social cognitive theory (SCT) (Bandura 1986) suggests that human functioning should be viewed as the product of a dynamic interplay amongst personal, behavioural and environmental influences. This theory emphasises that cognition plays a critical role in people's capacity to construct reality, self regulate, encode information and perform behaviours (Kripanont & Tatnall 2009).

To a certain extent, SCT offers value to study technology acceptance or diffusion in hospitals. However, levels of cognition within the environment may be disparate. This theory can be used where a group of clinicians or nurses (equals in their roles) are being studied for accepting RFID. In a hospital, where different cognition levels interact, this theory may not be useful for studying technology diffusion.

2.2.2.2 Technology Acceptance Model

Equally, the technology acceptance model (TAM) (Davis 1986: 7) strives to evaluate user acceptance of computer-based information systems. Davis (1986) posits that people adopt a technology because they perceive it as beneficial and also due to perceived ease of use. Specifically, it is based on the notion of user perceptions. There are many augmented models of TAM, including combining TAM and TPB, TAM2 and the unified theory of acceptance and use of technology (UTAUT), where Venkatesh and Davis (2003) provide a refined view of how the determinants of intention and behaviour evolve over time.

In an attempt to refine and extend TAM, Chitungo and Munongo (2013) investigated factors that influenced mobile banking adoption in rural communities of Zimbabwe. The proposed TAM3 model (Venkatesh & Bala 2013) aims to advance TAM with a focus on mobile interventions. To a significant extent, these theories can be used to study user acceptance of RFID in general. However, when acceptance is tested on multiple users with disparate yet significant roles, these models do not offer significant value to already existing literature.

Equally, Murthi and Mani (2013) argue that while technology adoption (acceptance) is well appreciated in the literature, the phenomenon of technology rejection is not yet understood. According to them, rejection does not imply in its totality, but varies in terms of its kind and/or intensiveness. Their exhaustive literature study focused on users (individuals), initially discussing the technology-society nexus and providing a preliminary technology-user interface model, leading to a detailed discussion of the determinants of technology rejection.

All these approaches are classified as 'essentialist approaches' (Tatnall 2011), in that some essential capacity or 'essence' is largely responsible for determining the rate of adoption (Tatnall 2011: 28). However, the difficulty is that people often see different essential attributes in specific technologies or human entities. What may be perceived as the best use of a technology by one user may not be the same for another. In this case, the use of RFID by an orderly (or patient care assistant) may be different to a nurse or a clinician. In hospitals, where all actors need to work together, and also accept the technology intervention, the above essentialist approaches fall short of interpretive analysis in the context.

As derived from the literature, the gap in RFID technology acceptance in hospitals is technological, economic and social. The social factors are yet to be explored in detail, particularly in the Australian context. An understanding of the way in which a technology is embedded in its social context helps clarify the interaction between that technology and society (Cerezo & Verdadero 2003). Murthi and Mani (2013) argue that society and technology intermingle and co-evolve, and culture and social structures shape the design and use of technology; in turn, technology influences cultural and social experience (Murthi & Mani 2013:1). In the process of merging a technology into daily routines, an individual offers the technology a physical, symbolic and social place (Silverstone, Hirsch & Morley 1992), thus assigning a position for that technology in agreement with a set of existing rules, routines and processes (Selwyn 2003). Therefore, Murthi and Mani (2013) suggest that understanding the complex relationship between user and technology is important, from social and technical viewpoints. The authors identify technical complexity, technology fatigue, level of flexibility, altering user-base, switching cost and loss aversion as factors for technology rejection.

Earlier in this chapter (Part I), I highlighted that factors (or actors) in hospitals are disparate regarding their roles and perceived advantages of a technology; yet, they need to work together within the health sector. It is evident that technologies have to be 'translated' into the context, rather than just being adopted in the form offered.

In the 1980s, Bruno Latour developed ANT, which argues that humans and artefacts (or things) have equal effect in the process of translating an innovation. The concept of human and non-human actors thus emerged from ANT and in turn, inspired the theory of innovation translation (Callon 1986).

The concept of 'translation' proposed by Callon et al., (1983) and Callon (1986) describes it as the strategies that an actor implements, to identify other actors and to arrange them in relation to each other. Unlike diffusion of innovations concepts, this translation model acknowledges that the original idea and the innovation are not bestowed with sovereign power. Rather, the innovation only translates if it interests the actors (Tatnall 2011). Hence, a model that studies innovation translation is necessary.

Another issue with technology adoption is that not all innovations are adapted in the form in which they are proposed, nor without changing some essential attributes (Tatnall 2011). Innovation translation (Latour 1986) uses a model of technological innovation that involves the concept of heterogeneity in a world with hybrid entities (Latour 1993), containing both human and non-human elements. It also notes that innovations are neither adopted entirely, nor in their original form. Rather, they are translated into a form more appropriate for users (Tatnall 2011).

There are still other approaches studying the creation of an innovation itself. For example, Mumford (2000) argues that organisations should consider multiple interventions that take into account the individual, the group, the organisation, and the strategic environment when selecting interventions intended to enhance creativity. Equally, Checkland (2000) offers soft systems methodology. This is a seven-step approach to uncovering problems with the diffusion of innovation and for taking action to rectify problems.

Against these 'essentialist approaches' to adopting technology, innovation translation approaches argue for identifying key players (actors or factors) and the processes they are engaged in, to better understand the translation process. In the next section, I develop a conceptual framework that will include key socio-technical facts, and stages (or moments) in the innovation translation process.

2.3 Developing the Conceptual Framework

There is a gap in the literature regarding socio-technical issues that emerged from the literature review (2002–2012) as in the above sections. While technical issues relating to RFID technology have been discussed at length, economic issues have also been duly explored. To a significant extent, both these factors impeding RFID uptake have been addressed by hospitals. The costs of deploying the technology has reduced as technology and Wi-Fi networks have evolved. Triggered by the economic slow down, hospitals are now considering cost-effective long term technologies, of which RFID emerges as the best potential option. Standards have also been addressed globally.

When the socio-technical factors are considered, research is still emerging. RFID is almost a non-interventional technology in the health sector for tracking equipment, so it may be accepted for that purpose (Coustasse et al., 2013). However, the socio-technical factors, or actors in the milieu (stakeholders), hold the key to effective RFID deployment in the Australian context. Within hospitals, a business case might encourage management to consider the technology; however, it is rendered useless if abandoned by users. Equally, if the technology becomes semi-interventional (e.g. tracking patients & staff) or even becoming embedded into prostheses or lately, the use of biodegradable RFID tags in oncology (Yang & Halvorsen 2010), users or stakeholders become critical to RFID translation in hospitals.

Therefore, in this research I propose to investigate the socio-technical factors and how the interplay between RFID technology and actors affects successful deployment.

Callon (1986) outlined a novel approach to the study of power, the 'sociology of translation'. Callon began with three principles:

(1) agnosticism (impartiality between actors engaged in controversy)
(2) generalised symmetry (the commitment to explain conflicting viewpoints in the same terms)
(3) free association (the abandonment of all a priori distinctions between the natural and the social).

This pivotal work then describes a scientific and economic controversy on the causes for the declining population of scallops in St. Brieuc Bay, and the efforts by three marine biologists to develop a conservation strategy for that population.

Callon (1986: 196) provides four moments of translation recognised in the attempts of the three biologists to impose themselves and their definition of the situation on others:

> (a) problematisation: is sought to become indispensable to other actors in the drama by defining the nature and the problems of the latter and then suggesting that these would be resolved if the actors negotiated the 'obligatory passage point' of the researchers' programme of investigation;
> (b) interessement: a series of processes by which the researchers sought to lock the other actors into the roles that had been proposed for them in that programme;
> (c) enrolment: a set of strategies in which the researchers sought to define and interrelate the various roles they had allocated to others;
> (d) mobilisation: a set of methods used by the researchers to ensure that supposed spokesmen for various relevant collectivities were properly able to represent those collectivities and not betrayed by the latter (Callon 1986: 196). [14]

In summary, Callon (1986) notes that translation is a process never completely accomplished and that the process of translation may fail. I have drawn from this significant work to build the conceptual framework, through the four moments of translation, described as follows.

[14] Please refer to Chapter 3, last section for a complete discussion on actors, roles, relationships, champions and mobilisation.

Moment 1: *Problematisation* is where key actors define the issues that RFID proposes to address in the hospital and their roles. The issue being addressed is 'translated' in terms of solutions offered by all actors, who then attempt to establish themselves as an 'obligatory passage point' (OPP) (Callon 1986), which must be negotiated as part of the solution. In other words, Callon (1986) refers to an OPP that has to occur for all the actors to satisfy the interests attributed to them by the focal actor. In this situation, I propose to identify the actors, the issues they define and their defined roles. The idea of this *moment* is to foster relationships, to allocate or reallocate power between actors.

Moment 2: *Interessement* is whereby the actors defined in Moment one impose the identities and roles defined on other actors, thus building a network of relationships where all actors become involved. In this context, I study how the champions or key actors negotiate with others in the network. *Interessement* is the set of actions by which an entity attempts to impose and stabilise the identities of actors in the same network for problematisation (Callon 1986). It involves a process of convincing other actors to accept the solution proposed. The actors are engaged in the process of confirming the OPP.

Moment 3: *Enrolment* occurs after the success of Moment 2, when a process of coercion, seduction and consent leads to the establishment of stable alliances. In this situation, I study how the actors enrolled others into accepting the solution of RFID. More specifically, did they coerce, impose or influence others into enrolment? *Enrolment* involves consolidation of alliances through negotiations. It is the successful outcome of the first two moments.

Moment 4: *Mobilisation* occurs when the solution gains wider acceptance. In this situation, RFID gains wider acceptance as a solution for the proposed reason, within the hospital context. I investigate if this has occurred and how. *Mobilisation* of allies is a set of methods used to represent the group effectively or in other words 'who speaks for whom'? (Callon 1986) While some actors are used as initiators, others become spokespersons. This moment leads to stabilisation of the network.

The questions to be answered in each moment of translation, is presented in Figure 2.3.

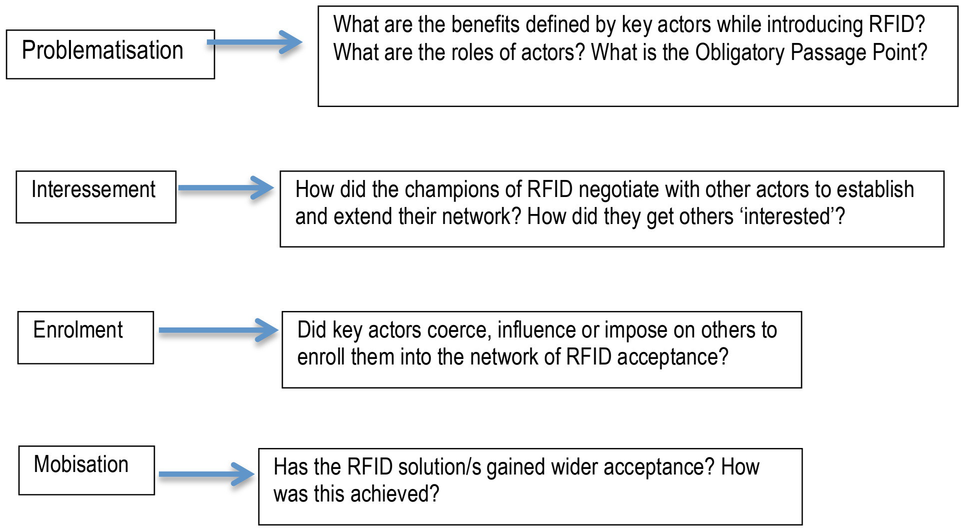


Figure 2.3: Questions for moments of translation

2.4 My Journey to the Realm of ANT

The process of translation through the four moments may also be called a process of negotiation (Muhammad, Moghimi, Taylor, Redley, Nguyen, Stein, Kent, Botti & Wickramasinghe 2013). While the four moments of translation could be drawn from a literature synthesis, and presented as data tables, I considered a novel approach of visualising the data through a lens informed by ANT. Specifically, the presentation of interplay between all the factors (actors), while the solution of RFID as a technology was being considered and deployed, could be visualised using elements of the ANT lens.

The rationale for this approach was influenced by my research journey towards ANT. The research investigation that originally began with a pioneering deployment of RFID in a public and Private hospital in Australia, and as action research, had been restricted as the deployment remained partial. Although I had significantly influenced the deployment over two years, and became a participative observer, the deployment remained incomplete for years due to budget constraints. Subsequently, the methodological approach to the investigation had altered to a case-based approach that undertook a successful *post hoc* investigation at another site, as a non-participative observer. While there was no significant influence that I had made as a researcher in this deployment, its success could create stories of translating technology in the Australian context, focusing on socio-technical relationships. To narrate this story, with visual representation of the inherent, yet subtle or hidden relationships in the Australian hospital context, I needed a theory that lent itself to visualisation of RFID technology translation.

In pursuing a suitable approach, I considered activity theory (Haschim & Jones 2007), which seeks to understand human and technology interactions. In the 1990s, information systems researchers began to recognise the relevance of activity theory for the study human-computer interaction (for example, Bodker 1990; Grifford & Enyedy 1999; Hasan 1998; Kuutti 1996). Hakkinen and Korpela (2006) used the theory to understand the practices of information management within a maternity care activity network (in health care application and software design). They found it useful in understanding user group activities in their development of information systems. It also allowed a multifaceted analysis of the information and its users, and the dynamics between them. Activity theory is useful because it describes activities as hierarchical in nature and provides a model for decomposing activities into actions and operations. It contends that tools mediate activity. To an extent, this helps explain relationships between the user and the tool. However, my approach was to understand the relationships between the users, and the relationships between the users that help to translate the technology into a context. This required a deeper, more holistic theory that enabled visualisation of the interconnected relationships emerging from the subtle or hidden environments in hospitals.

ANT, which was developed in 1980s by Bruno Latour (1986), and Law and Callon (1988), is an attempt to give voice to technical artefacts; they viewed that both social and technical determinism as flawed. ANT offers an advantage over other theories in that it does not have a dividing line between human and non-human entities nor an 'essence' attributed to either (Tatnall 2011).

> By definition, a technological project is a fiction, since at the outset,
> it does not exist, and there is no way it can exist yet because it is in
> the project phase (Latour 1996: 23).

The above tautology by Latour (1996) removes the analysis of technologies from the burden weighing on all scientific analysis. Although the world has become habituated to the idea of a science that 'constructs' its objects, the fact remains that even the science realm discovered a world that came into existence without people and without sciences (Latour 1996: 23). Specifically, there was no distinction between projects and objects. Therefore, the ardent researcher has to be careful not to differentiate between projects and objects (Latour 1996: 24). Latour also argues that mere possession of power by an actor does not guarantee the ability to cause change unless other actors can be persuaded: 'Innovations have to interest people and things at the same time, and that is the real challenge' (Latour 1996: 56).

Latour (1986) contends that it is the number of people who enter into a situation that indicates the amount of power able to be exercised. According to him, the movement of innovation through time and space rests with people who may accede, alter, refract or enhance it.

An actor-network is configured (Grint & Woolgar 1997) by the enrolment of human and non-human allies, by means of a series of negotiations. According to them, 'translation' can be regarded as a means of obliging some individuals to consent to a deviation that takes them along a path charted by other individuals.

There is significant merit in using ANT as a lens within interpretive research. The socio-constructivist ontology of interpretivism allows easy accommodation of ANT, as it is used (like a lens) to locate or extract data. ANT has been used as a lens only because this is the outcome of the theory's constant use in an interpretivist context. Thus, ANT itself has been interpreted and constructed within its use. The use of ANT as a lens is coherent within the interpretative ontological constituency. The interpretivist ontological foundation clarifies that reality does not already exist, but is constructed in the very act of interpretation. Information systems research, which is informed by this stance, relegates understanding of the relational dimension of technology and people mainly to the interpretation given (Tatnall 2011).

In this investigation, a novel way of presenting data extracted from case studies, through interviews and focus groups, has been achieved through using ANT as a lens or visualisation tool. The moments of translation, as specified by the innovation translation approach, are enhanced by the presentation of data through an ANT lens. Specifically, the main research conducted used multiple case methodologies (see Chapter 3). These case studies are initially presented in a movie script mode, as scenes and acts. In each movie, there are human and non-human actors (as per ANT terminology). At the end of each Act, a visualisation using ANT lens draws interpretations from the data.

While ANT has been applied to implementing and adopting different health care innovation studies (Berg 2001; Hall 2005; Bossen 2007; Cresswell, Worth & Sheikh 2010; Wickramasinghe, Bali, Tatnall, 2012; Muhmmed, Zwicker, Wickramasinghe, 2013), it has been criticised for its limitations. Amongst these are a notable inability to pay appropriate attention to broader social structures (Walsham 1997) and macro-environment factors (McLean & Hassard 2004). Another inherent limitation is its inability to explain relationship formation between actors and over changes of events in relationship networks (Greenhalgh & Stones 2010). Hence, many researchers (Muhammad et al., 2013; Trudel 2010; Cresswell, Worth & Sheikh 2011; Tatnall 2011; Walsham 1997) over the last decade have recommended combining ANT with another theoretical lens, such as social shaping of technology (SSoT), strong structuration theory (SST), structuration theory, and innovation translation theory.

In this research, taking into account the key role of RFID as an actor (non-human factor and a technology), combining the ANT lens with innovation translation theory has added a depth to the analysis. The conceptual framework, with the treatment of ANT, is modified as follows. The framework is then used for a final analysis and interpretations to answer the research questions.

Table 2.2: Conceptual Framework—Innovation Translation 'Moments' & ANT

Moments of Innovation Translation and ANT				
	Moment 1 *problematisation*	Moment 2 *interessement*	Moment 3 *enrolment*	Moment 4 *Mobilisation*
Literature review (2005-13) see for example (Nagy et al., 2006; Fisher and Monahan, 2008; Cox, 2008; Cheng and Chai, 2012; Yao et al., 2012; Martinez-Perez, et al., 2012; Ustundag, 2013)	The key actors in hospitals seem to be technology vendors, systems integrators and administrators in hospitals Users of the RFID system such as nurses and orderlies are ignored or forced to use the system. The moment is characterised by the acceptance of technology for tracking equipment, in order to reduce costs and improve efficiencies by hospital administrators and strategists.	As the literature revealed there is little evidence of getting users (nurses and orderlies) interested in RFID solution. Rather, driven by vendor and administrator s of hospitals, other key actors are largely forced into the moment	Enrolment into the RFID enablement network is forced or pushed through by vendors and administrators	The RFID solution has relatively low acceptance or rather scepticism from users. Since the users were sceptical the solution did not get promoted. Literature reveals that despite the scepticism, RFID as a technology was being promoted in the health sector via IT strategists and vendors.

The moments of translation in Table 2.2 reveal that despite the promotion by technology vendors and to an extent, ICT departments or people in hospitals, RFID technology is yet to gain momentum, due to use reluctance and non-acceptance (nurses or orderlies) within the Australian system. To a large extent, this solution is yet to gain wide acceptance in hospitals. It is evident in the 'moments of translation' that the key moments of *interessement* and *enrolment* are often a product of coercion or a top down approach, rather than mobilisation of allies in the environment. This factor makes it imperative to study RFID implementation and its translation into the Australian health context. There is currently a significant academic gap in literature regarding the success of this innovation, which has now largely gained global acceptance in hospitals.

2.5 Chapter Summary

This chapter has two parts. In Part I, I initially provided a relevant domain review of health informatics, with a focus in Australia. Subsequently, I reviewed the RFID implementation literature, as it is a key construct for investigating and exploring barriers to adoption. Approaches from academic and practitioner-oriented perspectives were surveyed for determining the gaps in implementation guidelines. A revealing view that there was a need for more socio-technical approaches from academic perspectives, and a lack of implementation guidelines from practitioner perspectives, further confirms the need for this study.

In Part II, I initially reviewed relevant theory frameworks for this study and explained the elimination of essentialist approaches to adoption, with rationales. The use of innovation translation theory as a conceptual framework was presented in conjunction with ANT for information visualisation and analysis. The next chapter elaborates on my research methodology, with justifications.

Chapter 3: Methodology

In Chapter 1, I introduced the research problem and examined the background of this research, along with motivations. In Chapter 2, a comprehensive evolutionary and relevant literature was presented, highlighting the issues relating to RFID implementation in Australian hospitals. The second part of that chapter focused on building a conceptual framework from the literature reviewed, using the innovation translation framework, and informed by the lens of ANT for data visualisation.

This chapter aims to describe and justify the philosophy underpinning this research, the investigation methods, data collection procedures and analysis techniques. The chapter also discusses issues of reliability and the validity of conducting this research.

To understand how the philosophy and the theoretical framework fit into the overall research process, Creswell (2013) and Denzin and Lincoln (2011: 12) provide some guidelines. These show how the research process can be organised, helping researchers to place philosophical underpinnings and theory frameworks into perspective, aligned with the research process. Drawing from these significant works, I have organised the following sections into phases.

Phase 1 places me, as the researcher ('I'), as a multicultural subject. This phase focuses on what researchers bring to their work itself, which is often overlooked (Creswell 2013: 17–18). Phase 2 discusses philosophical paradigms and perspectives. In this research, I have chosen an interpretive paradigm. The rationale is explained in Section 3.2.

Phase 3 discusses research strategies or the method itself. In this thesis, I have chosen a multiple case method, as propagated by Yin (2003, 2009). Yin posits a 'single case' method, which involves investigating one organisation, area or site in-depth. Since I had investigated two hospital sites, a multiple case method was appropriate. The justification is further explained in Section 3.3.

Phase 4 explains methods of data collection and analysis. In this research, several data collection methods have been deployed, such as interviewing, observing, document analysis and focus groups. Phase 5 focuses on interpretation and evaluation of data. I have explained the method of validation and findings. It discusses how I have ensured rigour, and addresses any ethical issues.

3.1 Phase 1: The Researcher ('I') as Multicultural Subject

From the outset, I have considered my background in information systems (IS) research for a decade, assimilated views of significant authors and domain related researchers (see Chapter 2) and also political issues that affect the research investigation (Chapters 1 and 2). It may be noted that as a technology practitioner in the ICT industry, as well as an academic, I brought certain applicable perspectives to this research. For example, Case-1, presented in this thesis, originally came to me as a project for consultation in the health sector. It was a pioneering study and the hospital wished to have an academic perspective and review of their decision to deploy a piece of technology. In the course of the investigations and as a 'participant observer', I was able to influence certain key changes in the hospital (see Case-1, Chapter 4) in real life. However, not all the recommended changes were effected, and the project was put on hold for a period. Therefore, I did not continue the work as an 'action research' project.[15]

After the research was completed as a case investigation, when I was validating the findings, I applied practical perspectives from the industry, my consultations with the two hospitals and the knowledge gained in IS research over the past decade, presenting them to practitioners for evaluation. As an industry practitioner and academic, I felt that there was a significant contribution I brought into the research investigation that enriched and enhanced the applicability of the research.

[15] Please note the rationale and explanation in Section 3.3.1.

3.2 Phase 2: The Philosophical Perspective

As an IS researcher, I had noted a trend towards softer approaches to technology translation studies over the decade, as technologies evolved and became pervasive in society. It was in the early 1990s that influential researchers in Australia (for example, Parker, Wafula, Swatman P & Swatman PMC 1994) alluded to the fact that information systems research was moving away from technical issues and focusing more on behavioural issues. They argued that so called 'accepted' taxonomies of IS research methodologies characteristic of these trends did not adequately support technology transfer and the diffusion of innovations, essential to effective applied IS research.

Earlier in the 1990s, Klein, Nissen and Hirschheim (1991) criticised the dominance of empirical studies in IS research and consequently, many demanded more qualitative research with greater emphasis on interpretivism (Galliers 1993). According to Parker et al., (1994), IS methodologists called for a move away from scientific/positivist research methods towards interpretivism. This was construed by the IS research community as a call for research into sociological rather than technological issues. According to them, the call for qualitative methodologies resulted in predominantly socio-organisational, rather than technical research topics, in IS. These 'softer' topics have been investigated using increasingly empirical methods, adding objectivity to what is perceived as being insufficiently 'scientific' research (Parker et al., 1994: 7).

Nunamaker, Chen and Purdin (1991) had argued that action research (for medium term research) and field experiments (for long term research) are good methodologies for socio-technical research, as they will enable theory testing. Klein and Myers (1999), significant authors in IS research, had also supported this view towards the end of the 1990s.

IS, as in all fields of scholastic investigation, has its own favoured approaches. Two decades ago, Orlikowski and Baroudi (1991), in their survey of published IS research articles, found that 96 per cent of researchers adopted a *positivist* perspective and the rest favoured an *interpretive* approach. Towards the late 1980s, influential researchers such as Galliers and Land (1987) criticised the predisposition of IS researchers to accept traditional and quantitative approaches, which were more suited to natural sciences than IS in organisations. In alignment with this criticism, many researchers (Hischheim 1992; Nissen et al., 1991; Achterberg et al., 1991) argued for methodological pluralism, which offered a broader perspective. As a result, in the 1990s, qualitative research gained considerable legitimacy (Tatnall 2011). It is now clear to the IS research academic community that technologies and social constructs need to be considered in tandem with researching IS. As Davis, Gorgone, Cougar, Feinstein and Longnecker (1997) pointed out, the problem of handling complexities due to interconnected technologies, how they relate to humans and organisations, and how humans relate to them, has come into focus.

A viewpoint within which a set of methods can be systematically applied is often known as a philosophical framework (Guba & Lincoln 1988; Deely 1990, Tatnall 2011). Huff (2009) articulates the importance of philosophy in research by advocating that it shapes how researchers frame their problem and research questions, and how they seek information or collect data to answer the questions. According to him, assumptions that researchers proceed with are often deeply enmeshed in their discipline-related training and endorsed by the scholarly community. Creswell (2013: 19) supports this view, while inferring that IS may be an eclectic research community that borrows from other disciplines to enrich itself, while other disciplines are narrowly focused with prescriptive methodologies. He also indicates that reviewers make philosophical assumptions about a study when they evaluate the work; hence, it is important to take a stand on epistemology. Creswell (2013) assimilates many views and trends in IS research from the last two decades in his pivotal work. I have integrated these views, as well as considered the view that there needed to be a 'softer' method to approaching technology translation into hospitals, as highlighted in Chapter 2. For this purpose, an underlying philosophical approach was required.

According to widely cited authors in IS (Orlikowski & Baroudi 1991), the commonly used philosophies in IS are positivist and interpretive. The philosophical perspective of positivism is based on the assumption that reality is objectively given and that it can be described by reference to measurable properties independent of 'I' (Myers 1997). My research explored how RFID as an innovation translated into Australian hospitals by creating network relationships and negotiations. This process is open to interpretation.

While results from RFID deployment in hospitals could be objectively measured to some extent (for benefits realised from process improvement), an objective criterion alone would not result in answering the research questions I asked in Chapter 1. These questions relate to a 'translation' of technology, rather than'diffusion'.

My main research question explores how socio-technical factors interact to affect the adoption of RFID in Australian hospitals. The question lends itself to an interpretive philosophy, as I sought a rich in-depth understanding of socio-technical factors based on participants' subjective views, opinions and experiences, tracing how the technology translated into their environments. As explained in Chapter 2, the focus is on 'translation' of technology rather than 'diffusion'. Therefore, essentialist approaches were rendered insufficient and the socio-technical approach with innovation translation informed by ANT lent itself to the interpretive philosophy.

Specifically, in this research investigation, the aim was to explore 'how socio-technical factors interacted to affect the adoption of RFID in Australian hospitals'. The question lends itself to an interpretive philosophy, as the aim is to interpret human interactions in the rich social context of hospitals, and to identify factors that facilitate RFID technology translation. In hospitals, staff share a common language, consciousness and meanings in how they adapt to a dynamic environment, based on the philosophy of care. Based on participants' subjective views, there was a need for 'construction' or rather the data that was extracted from the research investigation had to be reconstructed, interpreting its subjective meaning. From an interpretive perspective, the design and methods used follow a constructivist paradigm, where individuals attempt to make sense of the world through subjective meanings of their experiences. The intent of 'I' is to interpret the meaning others have about the world (Kaplan & Maxwell 2005). Therefore, an interpretive constructivist approach was my final choice.

Creswell (2013) refers to this approach as falling within the purview of post-positivist philosophy, included within the multitude of interpretive frameworks (others include social constructivism, transformative frameworks, postmodern perspectives, pragmatism, feminist theories, critical theorising, queer theory and disability theories) in qualitative research. According to him, post-positivism has elements of being logical, empirical and deterministic, based on *a priori* theories (Creswell 2013: 24) that best suit

IS research. It is a series of logical steps, with multiple perspectives from participants, and espouses rigorous methods of qualitative data collection and analysis. He indicated that the post-positivist interpretive framework is exemplified in the data analysis strategies of case comparisons of Yin (2009). However, not all of this research falls within post-positivist orientations, as I have employed the method of *constructing* meaning from multiple views, an approach also endorsed by McVea, Harter, McEntarffer and Creswell (1999), and Creswell (2013).

I have thus chosen the interpretive constructionist framework and underlying philosophy of post-positivism. According to Creswell (2013) and Lincoln et al., (2011) there are different beliefs or assumptions that link the framework and philosophy namely, ontological, epistemological, axiological and methodological.

With ontology (or the nature of reality), researchers need to report on themes developed in findings. In this research, the reality that existed 'out there' in Australian hospitals in relation to RFID translation, were reported using emerging themes. However, post-positivist philosophy means that these findings are not absolute.

With epistemology (or how reality is known), characterised by subjective evidence from participants, where researchers attempt to lessen distances between themselves and participants, I have relied on quotations, and collaborated in the field with participants, becoming an insider. Nonetheless, in alignment with post-positivist philosophy, reality can only be approximated. Validation of findings occurred through the views of peers in the health care sector, and not participants as such. My interaction with research participants was kept to the minimum requirements of interviews and focus groups. Most of the time, I was a non-participative observer.

According to axiological beliefs (role of values), I need to acknowledge that research is value-laden and the biases are present. Researchers can openly discuss values that shape the narrative and include their interpretations in conjunction with others. However, in accordance with post-positivist philosophy, I have controlled my biases in the study.

Finally, in the methodological belief (approaches to inquiry) I need to study the topic within the context and use an emerging design. The study context has been explained in

Chapter 2, and questions were formulated based on experiences in the field. Testing innovation translation theory, using an ANT lens, making comparisons amongst cases with case study methodologies all remained significant.

Thus, in a doctrinaire approach recommended by Creswell (2013), assimilating the views of IS researchers, I have linked the interpretive framework and underlying philosophy of post-positivism.

Klein and Myer (1999: 72) recommended seven guiding principles to conduct and appraise interpretive research within the IS context, also demonstrated by Saundage (2009). The principles, and the way in which these were applied to my thesis to validate the interpretive approach, are described as follows.

3.2.1 Principle 1: The Hermeneutic Circle

This principle argues that all human understanding is achieved by iterating between the interdependent meaning of parts and the whole that they form.

In my research, data analysis in the relevant sections of Chapters 4–6 used the hermeneutic circle.

3.2.2 Principle 2: Contextualisation

Reflection of the social and historic background of research setting is required so that the intended audience can see how the current situation under investigation emerged.

In this thesis, a comprehensive description of RFID, its evolution and use in hospitals is given in Chapter 2. In addition, the background is detailed in Chapters 4 and 5, where the case studies are presented.

3.2.3 Principle 3: Interaction Between the Researcher and the Subject

This interaction requires critical reflection on how data were socially constructed through the interaction between researcher and participants.

The main data collection technique in this investigation was achieved through semi-structured interviews. The type of questions asked changed how the key participants viewed their involvement with RFID implementation. The participants also influenced researcher questions and the language of enquiry. I established a relationship with the participants in each case, and built on it continually.

3.2.4 Principle 4: Abstraction and Generalisation

Abstraction and generalisation entails relating the idiographic details revealed by the data interpretation through the application of principles one and two to theoretical, general concepts that describe the nature of human understanding and social action.

In this research, learning from the two cases will be cross-analysed to find similarities and differences. While findings may not be generalisable, they will be indicative and suggest insights for future in-depth investigations.

3.2.5 Principle 5: Dialogical Reasoning

Dialogical reasoning requires sensitivity to possible contradictions between theoretical preconceptions that guide the research design and the actual findings (the story that data tells), with subsequent cycle revision.

In this chapter, the philosophical assumption of the research investigation was outlined earlier, as recommended by Klein and Myers (1999). While recognising that deft categorisation of any research is challenging (Avison & Myers 2002: 5; Saundage 2009: 75), I have made the intention and procedure principles of research explicit, as recommended by Bourdieu (1999: 7). The influence on my decision to use the case method, the rationale for selecting cases and the details of data collection and analysis were made clear in this chapter.

3.2.6 Principle 6: Multiple Interpretations

Multiple interpretations must have sensitivity to possible different interpretations amongst participants. These are typically expressed by multiple narratives or stories of the same sequence of events under study. This is similar to multiple witness accounts, even if all participants tell it as they saw it.

This principle involves tackling incongruities in the accounts of key participants (or actors in my study) and revising understanding. Accordingly, different interpretations within and between the two cases are taken at face value. Wherever an interpretation could not be accounted for within my conceptual framework, it was revised to adjust current understanding.

3.2.7 Principle 7: Suspicion

Suspicion requires sensitivity to possible 'biases' and systematic 'distortions' in the narratives collected from the participants.

The extent to which social research can be critical is a controversial issue amongst interpretive researchers (Klein & Myers 1999). For this reason, they caution that all principles recommended should not be applied mechanistically; researchers need to use their own judgement. In my research investigation, it was significant to accept key participant experiences as binding, so the theory that emerged from their narratives was free of another layer of researcher bias. Therefore, this principle was de-emphasised.

The de-emphasis does not taint my findings as such, because the narratives from the participants lend themselves to be accepted without interpretation, and there was evidence to support this. For example, if a participant quoted a particular issue for non-acceptance of the technology, there was sufficient evidential support from other narratives to support the same. There was no further need for interpretation; the emerging data was supported by reality as it occurred.

3.3 Phase 3: Research Strategy

I have chosen a case study methodology for this inquiry, using two landmark case sites (hospitals) in Australia. The choice was based on an Australian milieu being different for implementing RFID technology, as it touches every department in terms of 'tracking' ability, as well as people. While other nations, such as the USA, Singapore or Malaysia, where the technology has been deployed successfully, Australian hospitals were still reluctant (as explained in Chapters 1 and 2). The pilots deployed may have been successful, but did not result in full implementation. Therefore, there was need for in-depth investigation of this technology translation (and not diffusion) problem, as RFID was an otherwise accepted technology in sectors such as manufacturing.

Creswell (2003, 2013) recommended that every researcher should consider three questions: (1) what are the knowledge claims; (2) what strategies of inquiry will inform the procedures?; (3) what methods of data collection and analyses can be used. The choice of approaches is based on the nature of the issue under investigation, personal experiences of the researcher and the intended audience (Creswell 2003: 5).

The issue under investigation is innovation translation of RFID in a complex socio-technical context. This is not well understood, and the aim is to gain an in-depth understanding regarding 'actors', their opinions and relationships, and changes to their relationships and interactions.

Hence, in this context, I have opted for a qualitative approach to better understand an under-researched phenomenon (i.e., RFID innovation translation into hospitals, which relies on a first-hand account of personal experiences). As presented in Chapter 2, the purpose of this research was not only to identify the factors involved in the translation, but also to better understand how the interplay between them occurs, affecting successful translation. Quantitative methods would have been more suitable if the research evaluated the cost-benefits of RFID as a technology in Australian hospitals. However, RFID is still at a nascent stage of deployment in Australian hospitals, as highlighted in Chapter 2. Technical and economic issues have been discussed in the literature, while the socio-technical issues impeding RFID implementation are largely absent. A qualitative strategy was more suited to understand the processes that were occurring, as well as the outcomes (Strauss 1990; Creswell 2003). Morse (1991) argued that if a concept is immature due to lack of theory and previous research, and there exists a need to explore and describe the phenomenon and to develop theory, the nature of the phenomenon under study may not be suited for quantitative treatment, as there are no predefined measures, constructs or criteria for success.

The research questions involve understanding how the actors in the network of translation negotiate with each other, to effect successful RFID translation. The process of negotiation and translation involves complex issues in hospital context: a chaotic environment where people continuously negotiate with each other. Information relating to these issues of translation is best obtained through qualitative fieldwork (Creswell 2003, 2013; Merriam 1998). Fieldwork in this research meant that I had to approach people in their settings, interview them, observe and record behaviours in hospitals. I had to become the primary instrument in data assembly.

Case Study, with an interpretive stance, as explicated by Walsham (1993, 1995) advocates a middle course involving a combination of qualitative and quantitative methods of investigation. The story can be told either by me as a participant, reporting the story as it unfolds using ethnography (Suchmann 1987), or by me as an observer, interviewing members of the project and re-narrating the story from the participant perspective (Klein & Myers 1999; Creswell 2013). The choice of this strategy is justified by Yin (2003, 2009) as an appropriate method when I tried to answer 'how' and 'why' questions, and I had less control over events being observed, and when the project was a contemporary phenomenon with a real life context. All of the above elements are present in this research that investigates RFID translation into Australian hospital contexts.

Yin (2009) claims that case study research involves studying cases within real life contemporary contexts. Other pivotal authors (Creswell 2013; Denzin & Lincoln 2005: Merriam, 1998) present case studies as a strategy of inquiry. I have followed Creswell's (2013: 97) definition, as follows:

> case study research is a qualitative approach in which the investigator explores a real life, contemporary bounded system (a case) or multiple

> bounded systems (cases) over time, through detailed in-depth data collection involving multiple sources of information (e.g., Observations, interviews, audiovisual material, documents and reports), and reports a case description and case theme

The defining features of a case study strategy include: *identifying* a case or multiple cases that can be bounded by time and place; stating the *intent* such as studying an issue or group of people; presenting an *in-depth understanding* of the case via varied data collection methods; deciding how to *analyse* the data collected; describing and presenting themes gathered and strong *conclusions* elicited from the analysis (Stake 2005; Yin 2009; Creswell 2013).

Yin (2003: 13–14, 2009) suggests that case study inquiry handles unique situations in which there will be many more variables of interest revealed by the data. Every result relies on multiple sources of evidence, with data needing to converge in a technique. Another result benefits from prior development of theoretical propositions to guide data collection and analysis. In Chapter 2, I proposed the conceptual framework that guided this research. Accordingly, the four moments of translation were informed by my literature review. The research motivations were strengthened by the gaps in literature on the moments of translation. The case study observations in Chapters 4 and 5 drew out different moments of translation, from a partially successful and a successful case study, thus addressing gaps in the moments of translation. Assimilating the multiple sources of data allowed me to validate the re-iterated participant narratives in Chapters 4 and 5.

Further, I have chosen a multiple case strategy, wherein in the pursuit of one problem for research, two case study sites are used for comparing data, and are validated by views from peers in the health care industry sector, to ensure the findings are current.

3.3.1 Consideration and Elimination of Other Strategies

Farhoomand (1992) classified varied strategies for research into case study, survey, field test, experimental and non-empirical research, based on articles in the 1980s. Myers (1997) offered the most accepted classification in IS broadly as: case studies (developed by Benbasat, Goldsten & Mead 1987; Kaplan & Duchon 1988; Lee 1989; Orlikowski & Baroudi; 1991, Alavi & Carlson 1992; Yin 2009; Walsham 1993, 1995), *Ethnography* (developed by Suchmann 1987, Zuboff 1988); grounded theory (developed by Martin & Turner 1986); and action research (developed originally by Lewin 1946, and subsequently by Rapoport 1970; Checkland 1991; Baskerville 1998). Taking into account another decade of IS research, Tatnall (2011) added soft systems methodology (developed by Peter Checkland from 1981–1991, and further developed by Finegan 1994; and Rose 1997) and ANT (developed by Latour 1986; Callon 1986; Law 1992) into this milieu.

I did not use an ethnographic approach because I could not be part of the translation over a sustained long period. Observation alone would not have provided in-depth understanding of issues. I had to become an observer, interviewing the 'actors' or participants of the case, recording their narration and reconstructing it from their perspective to tell the story.

It is worthwhile noting in this section that I originally considered action research as my inquiry strategy.[16] I had chosen a hospital that was pioneering RFID, and was to be involved in the steps leading to planning, action and evaluation. However, the applicability of action research was invalidated, as full implementation was mired during 2009. As a researcher, I could not be part of the change process that would then be continuously deployed.

Subsequently, I focused on the hospital 'in-house', examining some departments only and considering the structured case approach, propagated by Carrol and Swatman (2000), based on the concept of learning cycles and resulting conceptual frameworks.

[16] Please refer to also Chapter 1, Section 1.9 where I had noted that I am presenting myself as a Cameo Actor. It is due to the fact that originally this investigation began as Action Research. However, the research journey then continued to the realm of cases study and ANT based information visualisation.

The structure case approach consists of three main elements: (1) the conceptual framework; (2) the research cycle and; (3) the literature-based analysis of theory built (Carroll & Swatman 2000). There has been much discussion about the conceptual framework structure used to direct the initial stages of qualitative research projects (Strauss & Corbin 1990; Miles & Huberman 1994). Recently, I have also used the structured case method to study the implementation of scanned medical records in Australian hospitals (McAauley, Unnithan & Karamzalis 2012).

The structured case strategy is based on the idea that there are cycles of learning resulting in conceptual frameworks, with each spiral feeding into the learning. Based on this, the methods of data collection may be different for each cycle (Carroll & Swatman 2000; McAuley 2009). This series of conceptual frameworks results in better interpretation of research themes and data, and more efficient learning for the organisation. This method builds on the case study research method (Yin 2009), which provides a pathway for conducting case study research. This strategy was also rendered infeasible, as the hospital in the first site I chose had temporarily shut down implementation altogether.

In 2009, I had reached a *cul-de-sac,* and was contemplating a pathway to research the problem as such. This is when I met with the second hospital and realised I had to use multiple case strategy of inquiry to approach the socio-technical issue of RFID translation, timeboxing the first case in 2007–2009 and the second case in 2010–2012. The strength of cross-case comparisons in this strategy lent itself to revealing insights. While timeboxing the cases was necessary, the findings' validity was confirmed through a series of interviews in 2013, with peers in the health care sector (including Australian hospitals, practitioners & consultancies).

At the same time in 2009 I was also introduced to the realm of ANT and innovation translation theories (as presented in Chapter 2), enhancing the case-based strategy insights.

I considered the variant of action research, SSM (Checkland 1981), which attempts to give due recognition to human and technological aspects of IS. However, Checkland (1991) has explicitly identified this method with action research. This method was not suited to my research quest, as SSM begins with a detailed study of the system and how it might work, followed by model development as to how it might apply in any given situation. It then compares this to real situations to become a basis for how the system could be improved. The basic intent of my study is not an improvement of RFID technology; rather, it is an understanding of how the technology has been translated into this context. Equally, SSM would have also considered humans as taking positive action, and technology a passive instrument. In my research, active interplay between both technology and humans, as they negotiated the innovation translation, was significant.

3.4 Phase 4: Methods of Data Collection and Analysis

There exist numerous procedures of data collection for case studies, as recommended by Yin (2009), Stake (1995), Merriam (1998) and endorsed by Creswell (2013). According to them, once the first step, (appropriateness of the case study approach) is rendered suitable, the next step is to identify the cases. The case may be single or collective, within a site or multisite, an intrinsic or instrumental (Yin 2009; Stake 2005). While there is an array of possibilities for purposeful sampling or case selection, in this research, I have chosen accessible cases.

> The concept of purposeful sampling is used in qualitative research. This means that the inquirer selects individuals and sites for study because they can purposefully inform an understanding of the research problem and central phenomenon in the study (Creswell 2013: 156).

I have chosen to undertake maximum variation sampling strategy to undertake purposeful sampling. This strategy consists of determining in advance some criteria that can differentiate sites and participants. In this investigation, the determining criteria were that RFID implementation was partially or fully completed or at least initiated in the hospitals. I was able to find a pioneering, partially complete and a successful, fully completed situation, to draw cross-case comparisons later.

As recommended by Yin (2009), I have used documents, records, interviews, participant and non-participant observations, focus groups and physical artefacts for this study. Further, as recommended by Yin (2009), I have used the embedded analysis strategy, which is studying a specific aspect of the cases selected. In this situation, I selected studying RFID translation in the hospitals.

Creswell (2013) details a corpus of data collection approaches for qualitative research. Yin (2009) recommends six different sources of evidence for case studies. Drawing from these significant authors in the field, I have chosen observation, interviews and documents for data collection. For observation purposes, I have been a semi-participative observer (Case-1) and a non-participative observer (Case-2) and have gathered field notes. For interviews I have mainly used a semi-structured approach. For Case-1, I was able to take field notes, partially audio taped and transcribe (where permitted). For Case-2, I took a focus group with participants; this was audio taped and transcribed the proceedings. Subsequently, semi-structured ad hoc interviews were conducted on phone for confirmation without audio taping, but supported by field notes. Interview protocols were designed using Kvale and Brinkman (2009), as provided in the appendices. It may be noted that the first set of interviews (for Case-1) was different to others: Case-2 being a focus group. Follow-up interviews and validation with peers was also done using focus groups and follow-up interviews.

For analysing the interview data, Kinchin, Streatfield and Hay (2010) recommend using the concept mapping technique. Rather than the radical approach of presenting summaries of coded data, as recommended by Strauss (1987), the concept mapping technique transforms data into visual formats, emphasising links and relationships. However, the authors warn that the technique is useful only when the researcher has sufficient understanding of the context and relationships, and the interviewees can also present an accurate picture of the relationships involved. In this investigation, I have used concept mapping techniques to reveal hidden patterns. These were then presented using ANT based information visuals, thus abstracting the data to the next level of information. This technique helped abstraction of real information without breaching the confidentiality and did not affect the sensitivity of the health environment.

For documentation, I was able to access many public and internal reports and records for analysis in both cases. Due to privacy regulations and confidentiality reasons, these are not revealed in detail within the thesis. Yin (2009: 1,118) also prescribes three principles for data collection as follows:

Principle 1: *Use multiple sources of evidence and triangulation to reach conclusions.* In this research, I had varied sources of evidence that was triangulated to undertake the analysis and present the findings.

Principle 2: *Create a case study database* consisting of data and the report of I separately. This database has four components: notes, documents, tabulated material and narratives. From the beginning of investigation, the database has been maintained in accordance with university ethical procedures as well as assisting me in the investigation.

Principle 3: *Maintain a chain of evidence.* This is for increasing the reliability of information. Accordingly, I had stated research questions (Chapter 1), which were then built on by a conceptual framework that emerged from literature (Chapter 2), established methodological procedures (Chapter 3), collected data, presented it as a reconstituted, 'as it happened' cases (Chapter 4,5), cross-case analysed the data (Chapter 6) using theoretical lens in an effort to answer the research questions and build on the conceptual analysis, to draw themes and presented the findings with validation (Chapter 7) answering the research questions.

In the rest of this section and sub-sections, I explain the way I selected cases, participants and the choice of data collection methods, such as interviews, observations, focus groups and via documents or records. Multiple data collection methods were required for the two different cases, which were undertaken at two different periods (2007–2009 & 2010–2012). In 2013, a set of validation exercises was conducted with interviews with peers in Australian hospitals and consultants in health care sector. Subsequently, I also explain the data analysis methods drawing from ANT concepts and the theoretical framework of innovation translation 'moments', as described in Chapter 2.

3.4.1 Selection of Cases

The case study technique prompts researchers to pick one or more examples from a wide range of the class of things being investigated (Saundage 2009: 78). As pointed out in Chapters 1 and 2, there are studies that investigated RFID as a technology using TAM and diffusion of innovation theories. However, I would like to explain my choice of two particular cases chosen for investigation, as recommended also by Denscombe (2003).

My research was specifically in the context of Australian hospitals. At the beginning, I made a list of Australian hospitals considering RFID deployment. The entries on this list were mainly obtained through the internet and statistical data available through federal and state level government department publications—namely *Health and Ageing*—in Australia. Based on the progress of technology implementation these hospitals had made, the list was narrowed to those hospitals that were largely public (or broadly a hospital group usually incorporating public and private), and which had piloted RFID technology or had successfully implemented it, in relation to EDs. I chose large hospitals to obtain rich data, which could be theorised from interactions between the technology deployed and staff, within varied hospital departments. A smaller hospital or a single department setting may not have revealed the wider interactions or negotiations that occurred in translating the innovation. Equally, as the Public hospitals were situated in different states of Australia, and had deployed RFID in multiple departments, there was scope for triangulation, and to an extent, generalisation.

The rationale for choosing EDs as anchor points is that they encapsulate the chaotic environment in hospitals, where RFID was deployed as an important innovation. The literature review also noted that RFID deployments were mainly associated with emergency settings. As I found from the preliminary research, hospitals in Australia were not very different, as emergency settings required greater innovations that could make processes smoother and more efficient, improving quality of care.

The names of hospitals that I chose have not been revealed in the thesis, for confidentiality. Instead, I have used fictitious names for continuity of flow: *The Pioneer Group* and *The Victory Group*. Similarly, participant names have not been revealed.

Rather, their narrations are based on their roles, without revealing individual identities. In a nutshell, the first case is considered a pioneering but unsuccessful case of innovation translation; the second case, a successful one. Comparing the unique insights obtained from the two cases reveals how the innovation was translated into Australian contexts, negotiating though the different actors (or factors) responsible.

Case studies accept and encourage multiple methods of data collection procedures, to increase rigour and credibility, offering triangulation of collected data (Yin 2009). In this research, I used documents, interviews and focus group to collect data. In addition, I attended seminars organised by health informatics forums and conferences where hospitals participated, along with RFID vendors. In each of these avenues, I have been a passive observer. I also presented the preliminary findings from cases in academic forums, such as conferences, with the support of the hospitals concerned (see the list of publications in the preliminary pages of this thesis).

Yin (2009) argues in favour of documents and other data sources, as information contained in documents are secure, so they can be reviewed repeatedly; inconspicuous, as they were not created for this research investigation; precise, as the information contains actual names, references and detail of events; offers wide coverage spanning long periods; and is able to collaborate and support details given in interviews (see Saundage 2009: 82). I have also collected sufficient documents as sources of information, presented in the following sections.

Specifically, in the following sections, I am presenting a case-by-case narration of description of hospitals, selection of participants and data collection procedures, with rationale. It may be noted that for each case study, there were different methods for data collection, as explained in the relevant section.

3.4.1.1 Case-1: The Pioneer Group[17]

The Pioneer Group of Hospitals initiated RFID implementation in Australia in 2007, beginning with a pilot study; it was considering full deployment. There was a Public hospital and Private hospital at the location of the larger hospital, with a network of

[17] The name is fictitious to preserve confidentiality

relationships significant for RFID technology translation. Specifically, any deployment of RFID had to successfully translate into the Private hospital emergency area, before it was considered reliable in the Public hospital. This aspect offered a unique proposition to study the translation of RFID into this context. The second interesting facet was that even after a successful pilot in 2007, RFID was held back from full implementation at this hospital.

As an independent researcher, I had opportunity to investigate the rationale, interviewing the stakeholders and analysing their viewpoints, and pass this back to the hospital for consideration of an effective RFID implementation within the entire hospital. A detailed description of the hospital and related environment is given in Chapter 4, as it directly relates to the narratives presented in the case.

3.4.1.2 Selection of Participants

Key participants were selected after considering what information they could provide, to enable answering the research questions. The focus of this research was on the interplay and negotiation between actors in the RFID deployment process. Therefore, it was important to interview those who were involved with RFID initiatives actively and were affected by it. In this case, I approached the chief information officer (CIO) and the hospital's ICT department, as it was regarded as the pivot for deploying the technology within the hospital. Beginning from this focal point of contact, I chose participants for my enquiry.

For this case, I established contact directly with the CIO, from details available on the hospital's website. When the purpose of the research was explained, the CIO provided me with a post-pilot implementation report that indicated all people directly involved. From this list, I carefully prepared a 'role-based' classification of participants. A mixture of technical, strategic and user representatives was selected. These included strategists (including management & department heads), technologists (project managers in charge of implementation), and users (nurses & orderlies). I selected at least two representatives from each group. It may be noted that some users (for example, nurses) were also in charge of certain departments, positioning them as management. Therefore, they played a dual role in the participation from the viewpoint of management (strategists) and as end users interacting with the technology (nurses).

The CIO facilitated the interviews by putting me in touch with the selected participants and organising interviews with them on-site. The interviews were semi-structured, with a set of questions given to the participants (see Appendices), in preparation and then probing further. I conducted the interviews through 2007–08 at periodic intervals and used key participants as a member check to validate the findings throughout 2008 and 2009.

The plausibility of the data has been established through selecting key participants for interview. The acknowledgements of these participants offered a much higher degree of credibility. Equally, the hospital involved me in an RFID redesign process, which augmented the confidence they had in the observations. I also considered what information they offered for answering my research questions. The distribution of key participants was considered sufficient for triangulation in providing an accurate story of RFID translation, as described in Chapter 4.

3.4.1.2.1 Data Collection

In this case, data collection was primarily through semi-structured interviews. Many authors have recommended interviews (see for example, Berg 2004; Kvale 1996) as efficient techniques to ascertain how someone makes sense of or explains important events. In this case investigation, I initially used semi-structured interview techniques, which allow sufficient flexibility to structure interviews in advance, and to elicit meaningful information from interviewees.

3.4.1.3 Interviews

Table 3.1 lists the role-based classification and details of participants interviewed for data collection.

Table 3.1: Case-1 (Semi-Structured Interviews—Participants List)

CIO	Overall in charge of all technology based strategic decisions for the group of hospitals.
PM (technology company)	Project manager and lead architect of the core team that deployed RFID pilot at the Private hospital.
Head (SSD) (management team member)	The manager of sterilising services department (also a senior trained nurse).
Head (CSU)	The manager of the nursing unit which supports critical-care and emergency.
Orderlies (2)	Users of RFID for tracking equipment and moving patients.
Nurses (2)	Nurses interact with orderlies to track equipment and get them to a location.
Systems analyst (implementation projects)	This actor was the technology implementer who has been present from inception of RFID. He is regarded as the enabler for RFID infrastructure, who continued to change and remodel the infrastructure of the hospitals to suit the RFID evolution from 2007 until 2011, when infrastructure needed revision including WLAN, exciters, location and tags.
Business analyst	The linking person between ICT division, management, technologists and department managers.
Wards-in-charge (public)	This actor is a head nurse, who heads the wards in the Public hospital, with particular focus in 'wound care wards' that support ED.
Head (ED)	The nurse-in-charge of the ED the Public hospital.

The hospital stalled RFID deployment in 2009. I undertook data collection at different stages of deployment from 2007 to 2009, tracing participant experiences. Specifically, implementation was relatively abandoned, and was being reconsidered while I was conducting interviews. My data collection ended in 2009, and hence the experiences are frozen in time. Every participant listed has been interviewed three times.

During the interviews, I made extensive notes; some were recorded with participant permission. Not all interviews were recorded, as not all participants were comfortable with audio recording. Transcripts were prepared after each interview with reflective notes and demographic information such as time, date and location. Typical of qualitative research, I changed questions after reflection, readjusting them to probe deeper into issues identified by earlier interviews and the focus group. A typical interview lasted an hour and a half.

3.4.1.4 Documents and Other Data Sources

Initially, documents such as implementation reports from the hospital internally helped me identify participants who could provide significant answers to my research questions. The interview data was then supplemented with internal hospital documentation (where revealed).

The hospital provided me with internal documentation where possible, including presentations at various seminars, meeting minutes and internal re-engineering process documents. I collected vendor-related publications, as well as other promotional materials, giving additional dimension to the research. Extensive notes were made, reconstructing data from seminars and presentations.

Initially, I reported 'reconstituted' interviews from a report, as a 'conversation with a 'non-human actor/actant', as per ANT terms. However, these interviews were then re-confirmed by the real participants once I had interviewed them specifically. Therefore, the first reconstituted interviews are those 'voiced' by real participants.

In addition to the documentation provided internally, I worked with the hospital to successfully publish their RFID implementation experiences and insights at academic conferences, and in research books (please refer to publication list from this thesis in the appendices). Thus, I was able to use documents to validate the data collected periodically.

3.5 Case Study 2: The Victory Group[18]

This was a large regional hospital incorporating many departments and mental health facilities in the state of Victoria. This hospital was a successful case in RFID deployment, in that it had successfully piloted RIFC. The innovation had visibly translated well into the entire hospital across many departments, beginning with tracking the patient journey in emergency settings.

[18] The name is fictitious to preserve confidentiality.

The unique proposition here was that a new building for this hospital was being built, with RFID blended into the architectural plans from the very beginning. In addition, this hospital had the advantage of being the first successful Australian site for RFID deployment.

3.5.1 Participant Selection

The key participants were selected after considering what information they could provide, to enable answering the research questions. The focus of this research was on the interplay and negotiation between actors in the RFID deployment process. Therefore, it was important to interview those who were actively involved with RFID initiatives and were affected by it.

Similar to the first case, I had to approach the CIO and the hospital's ICT department, as these were regarded as pivotal in deploying the technology within the hospital.

I contacted the CIO after meeting with him in a health informatics seminar in Melbourne, Victoria. After hearing my requirement regarding the research investigation, the CIO invited me to visit the hospital site and also gave me the contact details of a key participant who was the deputy head of ICT. At the time when I embarked on the investigation with this case, the hospital had already been in discussed in news forums as a successful first case in Australia. Since the implementation of RFID was successful and apparently seemed positively accepted, I had an opportunity to gather key participants into one forum, to conduct a focus group.

A set of six key representatives were selected. The focus group was conducted in 2012; subsequently, telephone interviews were undertaken with key representatives to validate the findings of 2012. During the focus group, the hospital CIO also provided me with documentation indicating positive translation of the technology into the context.

The plausibility of the data was established through selecting key participants for the focus group. The acknowledgements of these participants offered a much higher degree of credibility. I also considered what information they could offer for answering my research questions. The distribution of key participants was considered sufficient for reconstructing the narration, and for providing an accurate story of RFID translation as described in Chapter 5.

3.5.2 Focus Group

In this case, data collection was mainly through a structured focus group. The focus group enabled transparency, where the participants were open to discussing the topic. Berg (2004: 126) argues that focus groups are highly flexible as they permit observation of interactions. They allow speedy results where participants are on an even footing with each other and the investigator.

I could access the substantive content of verbally expressed opinions, experiences and attitudes. Rubin and Rubin (1995: 140) explained that in focus groups, the goal is also to encourage people to 'spark off' each other, suggesting nuances of the original issue that one individual may not have considered. As a result, a totally different understanding could occur from the group discussion. I used a moderator for the focus group, and became an observer in the discussion. The data gathered were further validated through individual telephone interviews.

Table 3.2 details the roles of participants in relation to the research. Please note that the focus group had representation from varied departments as listed, and was further validated by telephone interviews as required.

Table 3.2: Case-2 (Focus Group and Follow-up Interviews—Participant List

CIO (1)	The CIO who is now retired, but was instrumental in RFID implementation.
CIO (2)	This CIO was earlier the deputy head of ICT, second in command to CIO. He is currently the CIO
Deputy pharmacist	Deputy head of pharmacy operations and also a pharmacist
Head of pathology	Head of the pathology department and trained pathologist
Head of engineering	Head of the department who deployed RFID for staff welfare
Simpkin House head	Head of the high-care facility who deployed RFID tags for tracking staff in need of help
ED nurses [Three Nurses]	Heading the department as a nurse, pioneered RFID in the hospital for tracking the patient journey to emergency department and then recommended it to be implemented in ICU

In this case, the hospital had already successfully deployed RFID and therefore, a focus group and follow-up validating telephonic interviews were sufficient to obtain insights. The focus group lasted five to six hours, with an hour break in between sessions.

Transcripts were prepared after the focus group, along with reflective notes and demographic information such as time, date and location. During telephone confirmation interviews, these were acknowledged by participants for validation.

3.5.3 Documents and Other Data Sources

Much of the documentation in this case was in the public domain, on websites, in medical journals and trade publications. Some internal documentation was given to substantiate the successful implementation (as presented in the Chapter 5). Extensive notes were made reconstructing data from the seminar presentations.

3.5.4 Notes on Scope of the Cases

I was involved in different stages of implementation with both hospitals. In Case-1, I became involved after the pilot implementation while the hospital was considering process redesign using RFID. Thereafter, I continued to be involved for three years. In Case-2, I was involved with the hospital post-implementation of RFID in various relevant departments, and thereafter for another year, while the new hospital site was being constructed. Therefore, I was not involved in the process redesign stages using RFID. However, validating data showing successful implementation was provided in the second case narratives.

Although the cases are narrated from two different timelines, this disparity was not significant for cross-case analysis using moments of translation. Each case presented unique moments of translation that are drawn and presented in Chapter 6, completing the conceptual framework and answering the research questions, (for this, see Chapter 7.

In Case-1, I was a participative observer to some extent, while in Case-2 I was a non-participant observer for data collection.

3.6 Phase 5: Data Analysis and Interpretation

In this section, I present the interpretation and evaluation of data analysis. First, I present the way in which data was coded into themes, presented and then interpreted. Subsequently, evaluation is presented using interviews as a validation method.

In alignment with interpretive research, I have used 'meaning interpretation' (Kvale 1996; Kvale & Brinkmann 2009) to analyse the data collected. In this type of interpretation, the researcher already has a perspective on the phenomena and interprets data from this perspective. Specifically, I probed the meaning of data to work out a structure and relation of meaning not immediately apparent. Motivated by hermeneutical philosophy, which suggests that the world can be interpreted as a narrative where meaning is obtained through iterative readings of any situation (Klein & Myers 1999), and also keeping in mind the need for distance from what is directly said, a theoretical stance (to reconceptualise what was said) was required.

A conceptual framework was developed in Chapter 2, from the literature review and using innovation translation theory. The moments of translation needed to be visualised to better understand emerging patterns in RFID translation. As indicated in Chapter 2, translation is the negotiation process where actors assume the authority to act or speak on behalf of other actors (Callon 1986). Specifically, to discover and understand patterns in a symbolic discourse, called 'translation', I use the lens of ANT to initially visualise the data. By coding and visualising the data through this theoretical lens, I was able to distance myself from the data collected, to ascertain the structure and meanings that were not apparent.

3.6.1 ANT to Inform Findings

ANT, or 'the sociology of translations', is concerned with studying the mechanics of power. ANT offers many advantages over other methods to handle the complexity of human and non-human entities: it avoids the difficulty of finding a dividing line between the two, and avoids having to assign either humans or technology an 'essence' (Tatnall 2011: 25). In this research, I have used ANT as a lens for visualising the data interpreted from cases.

ANT has been used in conjunction with innovation translation theory in IS research as it handles complexity (Tatnall 2011) by treating human and non-human actors in the same way, based on the principles of agnosticism (analytical impartiality towards all actors in the project, human and non-human); generalised symmetry (offering to explain conflicting viewpoints of different actors in the same terms by use of an abstract and neutral vocabulary); and free association (elimination and abandonment of all *a priori* distinctions between the technological, the natural and the social) (Callon 1986; Law 1987; Callon 1999; Singleton & Michael 1993; Tatnall 2011). I have used ANT as a lens for presenting data, as it assigns equal importance to technology and humanity, considering them as actors responsible for translating the innovation into the context.

As is the case with this thesis project, ANT has been used to investigate the success of a number of innovations and to describe notable failures. In the health informatics domain where my research is situated, Singleton and Michael (1993) have written about the part played by general practitioners in the UK's cervical screening programme. Moi and Law (1994) and Prout (1996) have applied ANT to hospitals and medical informatics. Deering and Tatnall (2008) used ANT to investigate how general practitioners (GPs) in the Central Highlands Division of General Practice (CHDGP), in regional Australia, considered the adoption of ICT.

Wickramasinghe and Bali (2011) combined ANT with social network analysis (SNA) to analyse levels of complexity in modern health care delivery. I find this approach more suited to a macro-level study, where the environmental complexity of health care operations is magnified by the multiplicity of actors such as agencies, government bodies and global organisations, which use a variety of independent and non-interconnected platform centric tools. The development of an interconnected grid for information and decision support was the basis for the query (Von Lubitz & Wickramasinghe 2006). However, I have used ANT as an instrument or lens to view the data, and analyse it, to inform the conceptual framework created using innovation translation approach.

Iyamu and Tatnall (2011) have used ANT in conjunction with an innovation translation framework to augment socio-technical perspectives. They deployed ANT to investigate the effect of a network of actors on the development and implementation of IT strategy in an organisation. ANT was employed to provide a useful perspective on the importance of relationships between human and non-human actors. Specifically, ANT offered the framework of relationships between actors and networks, treating human and non-human actors as 'factors' in the translation of an innovation. I find this approach closer to my investigation here, and have built further on this, taking on a different dimension. I have used ANT as a visualisation tool for presenting the findings and informing the lens built through the innovation translation conceptual framework. ANT is not an ontological approach, but a visualisation tool. It is also an instrument for informing the innovation translation theoretical lens used for meaning interpretation in this investigation.

The ontological foundation is interpretivism, which considers interpreters in a position to construct reality in their minds. Instead, ANT proposes that reality is constructed by the interplay of more than one actor. An innovation translation approach to theorisation informed by ANT as an interpretive lens, removes the need for considering 'the social' and 'the technical' in separate modes.

3.6.2 Visualisation Through ANT-Informed Lens

As proposed by ANT theorists (Callon 1986; Latour 1991, 1996), I decided to 'follow the actors' involved, letting them set the framework and limits of the study. As recommended by Tatnall (2011), an approach similar to investigating a homicide mystery is applied. The following definitions and terms for ANT relevant to my research are drawn from varied significant authors (Latour, 1996; Tatnall, 2011, Wickramasinghe and Bali (2011), Iyamu and Tatnall (2011). The essentials in the table may or may not be relevant to each moments of innovation translation as explained in Chapter 2. However, an understanding of these terms was required before using ANT for visualisation.

Table 3.3: Some Relevant ANT Terms in Context

ANT terms	Definitions	Examples in the context
Actors	A term for human and non-human artefacts that can be acted on and move the action on to some other. Heterogeneous entities that form a network	Non-human actors, RFID tags, related equipment are voiced by human actors
	An actor has been given a character by 'I' or by an actor in the situation	ICT operations head, CIO, Nurses etc. are human actors
Heterogeneous networks	A network of aligned interests formed by the actors.	RFID enablement network is formed by aligned interests of different departments, and controlled by ICT department.
Tokens/quasi-objects	Successful outcomes or functions of actors that are passed on to other actors within the network. When the token is increasingly transmitted, it becomes increasingly punctualised and reified.	RFID-enabled network implementation with 'word-of-mouth' propagation.
Punctualisation	Similar to abstraction. An incorrect passage of token can break down the network. The sub-actors are normally hidden from the view.	The champion actors such as ICT and department heads are visible, while the users are hidden from the view in the abstraction. Success stories are passed on.
OPP	A place or procedure that actors in a network must pass through or interact with to become part of a network	Tracking of equipment using RFID

Irreversibility	The degree to which an association of elements in the network cannot be undone, or reversed. The degree of irreversibility depends on the extent to which it is subsequently impossible to go back to the point where that translation was only one amongst others and the extent to which it shapes and determines subsequent translations	Both hospitals have firmly accepted RFID technology, it is irreversible in the network. It is impossible to go back to the point where it began (only tracking for emergency)
Enrolment	Means by which a set of roles are defined and accepted by the actors	When the network alliance was established with CIO, outside entities and certain departments for trial. Subsequently, alliances are formed with departments. RFID also forms an alliance with all actors
Blackbox	A network or network element that has been frozen or accepted as a complete [100]stabilisation	Hospital, departments (a blackbox can be a composite of many blackboxes)
Delegate	Actors that stand-in for or speak for particular viewpoints. The viewpoints may be inscribed on them	An ICT head could speak for others. A document could speak for many actors (nurses for example)
Immutable mobile	An element or inscription that does not change or changes little through space and time	RFID technology
Inscription	An actor has certain properties, policies or viewpoints embedded. So that is may act as delegate for one or more actants	Policies of departments
Material heterogeneity	Networks are composed of a variety of social, technical, human and non-human actants. All elements are treated as having a similar status	The hospital (blackbox), technology (RFID) and human actors have similar status
Stabilised	If the actants have reached some kind of accommodation or agreement and become assimilated to the network	RFID implementation has been agreed as stabilised by all departments concerned
Translation	A product of continuous negotiation during which the actors reach a set of compromises that allow them to become allies in the actor-network	For example, ICT head negotiates with department heads continuously to enable them become allies into the network

The first step in the visualisation process was to identify the human and non-human actors in this study; this is presented in the following tables. These are further explained in Chapters 4 and 5, where the visualised data is further interpreted. As a researcher who investigated the case, I have assumed the role of 'Cameo actor'.

While thinking about RFID as a non-human and yet the key actor in this milieu, I proposed that the 'voice' of RFID is heard independently so as to clearly understand the socio-technical issues involved in its translation into hospitals. This view is proposed by Kennan, Cecez-Kecmanovic, Underwood (2010) that we are more likely to hear human and non-human alike, when they are given the opportunity to speak for themselves. For this purpose, in the two case studies, there are sections in which RFID speaks for self – as the debut actor.

Table 3.4: ANT Table 1—The Pioneer Group

Actors/ Black Boxes	**Name**	**Details (Non-Human Actors have been given a voice as proposed by Kennan et al., (2010) and also by Human Actors)**
Non-human Actors	RFID tags and equipment The debut actor	Independent Voice given to RFID Voiced by all human actors
	RTLS Report	Voiced by the lead architect and project manager of the technology company
	Web based clinical system	Voiced by CIO and BA of the ICT department of the hospitals
	Bo-Beep Interface	Voiced by BA of the ICT department of the hospitals
	Touch screens	Voiced by BA of the ICT department of the hospitals
Black boxes	The private hospital	The first site where RFID entered into the context.
	RTLS Company	Strategic partner of the technology company in Australia which supplied Tags, Instruments, Exciters (RFID infrastructure)
	The public hospital	The second site for RFID implementation which is underway
	Funding group	This group was responsible for funding for ED—not visible otherwise and hence considered blackbox, rather than human actor
Human actors	CIO (the champion)	The CIO is overall in charge of all technology based strategic decisions for the group of hospitals. The 'Godfather' of RFID, who launched its career as the non-human actor, in the group
	PM (technology company)	PM and lead architect of the core team that deployed RFID pilot at the Private hospital or supported the debut of RFID by entering the blackbox, on the invitation of the CEO
	External company teams	The teams which came together for RFID pilot deployment
	Head (SSD)	The manager of SSC, who met RFID as debutant and

		continued to promote it in its evolution, finding new opportunities
	Nursing unit manager-private	This actor favoured the recommendation from Head (SSD) to promote RFID actively in the Private hospital
	Orderlies (private)	The orderlies were key in supporting RFID deployment
	Nurses (private)	The nurses were the first to be consulted in the private hospital for evaluating RFID deployment
	SysAnalyst (Implementation Projects)	This actor was the technology implementer who has been present from inception of RFID. He may be regarded as the enabler for RFID infrastructure, who continued to change and remodel the infrastructure of the hospitals to suit the RFID evolution from 2007 until 2011, when infrastructure needed revision including WLAN, exciters, location and tags
	Business Analyst (BA)	This actor i has been instrumental in the continued career progression of RFID within the hospitals
	Wards-in-charge (Public)	This actor is a head nurse, who heads the wards in the Public hospital, with particular focus in 'Wound-Care Wards' that support ED
	Head (ED)	The nurse-in-charge of the ED at the public hospital
	Cameo	This actor is myself as I, who was instrumental in re-examining the site, after the initial pilot and triggered continuity in the innovation translation

Table 3.5: ANT Case 2—The Victory Group

Actors/ Blackboxes	**Name**	**Details (Non-Human Actors have been given a voice as proposed by Kennan et al., (2010) and also by a Human Actor)**
Blackboxes	The regional hospital	The site where RFID entered into the context and has propagated successfully
	New site	The new site of the regional hospital under construction
Non-human actors	DHS	The external entity which funded RFID implementation via a grant
	Symposium article	Voiced by CIO (Past)
	RFID tags/eqpt, external entity (includes temperature tags)	Voiced by CIO (past and present)
	RFID results	Voiced by CIO (current)
	RFID maps	Voiced by CIO (current)
Considered on-human	Nursing staff/orderlies	Voiced/represented by CIO in the focus group

actors	Pathology Food Services Engineering ICU OHS Infection control	Voiced and represented by CIO (1) and CIO (2), Dpty pharmacist
Human actors	CIO (1) (the champion)	The CIO is overall in charge of all technology based strategic decisions and drove the cause of RFID. The 'Godfather' of RFID, who launched its career
	CIO (2) (The reigning champion or current CIO, named as CIO)	This CIO was earlier the deputy head of ICT, second in command to CIO. He is currently the CIO and also the champion of RFID who coxed all the departments into trialling RFID and was successful
	Deputy pharmacist	Deputy head of Pharmacy operation who drove RFID pioneering and propagation in the focus group
	Head of pathology	Voiced through CIO (2)/Dpty pharmacist in the focus group, and further telephone interview with Cameo
	Head of Engg Services	Voiced through CIO (2) in the focus group and further telephone interview with Cameo
	Simpkin House head	Voiced by CIO in the focus group, followed up for confirmation by Cameo on telephone
	Cameo ('I'/self)	Cameo did the first direct interview with old CIO. Focus group was run by a moderator, who then became the voice of Cameo (presented in the chapter as Cameo)

The above tables represent the participants of the two case studies, through the ANT lens. Their roles and explanation in the context is provided. These roles are presented at the beginning, as I have presented the data in Chapters 4 and 5 (similar to a movie), with acts and scenes, in the manner 'as it happened'.

Specifically, Case study 1 (in Chapter 4) and Case study 2 (in Chapter 5) are presented as 'movies'—in acts and scenes with actors (participants in this study, as well as people involved in the translation of RFID in these hospitals). The acts and scenes occur as I (the investigator, in a 'Cameo' actor role) interact with participants in the two hospitals, collecting data through interviews and focus groups. Similar to unravelling a homicide mystery, after interviewing the actors, I present the data reconstituted as a narrative. These narratives have been logically grouped into themes representing each Act. For example, the initial entry and pilot deployment of RFID is enacted through various scenes, namely ‘RFID debut at the hospital’. At the end of the Act, a visualisation through an ANT diagram is presented, showing the relationships as they occurred. In addition, at the end of each Act, there is also a table representing ‘actors’ who entered or exited the movie.

In the ANT visualisation, RFID translation into the context of hospitals is a continuous negotiation between the technology and the varied human actors in their departmental contexts. The ANT lens magnifies the actors who entered and exited the context in this negotiation. I have hypothesised that RFID, as an innovation, was sustained over a significant period within both hospitals, although there was entry and exit of different actors (shown in Chapters 4 and 5 tables), who influenced its long term translation .

Using ANT terminology, RFID is a non-human actor, regarded as a ‘debut’ actor. The hospital is known as a ‘blackbox’, within which there are other ‘blackboxes’, namely different departments. Human actors are mainly users, strategists, technologists and external vendors. I placed myself as a ‘Cameo’ actor investigating the scenario. The movies, in Chapters 4 and 5, represented in the acts and scenes are therefore in ‘flashback’ mode.

At the end of each Act in the movie, in addition to ANT visualisation through tables and diagrams, I have added ‘meaning interpretation’ and tabulations where applicable. These interpretations add a further dimension and validate the hermeneutic cycle of iterative analysis, which then validates the data analysis in Chapter 6 through the conceptual framework presented in Chapter 2.

In Chapter 6, the four moments of translation outlined by Callon (1986), namely problematisation, interessement, mobilisation and enrolment, are informed by the ANT lens diagram, summarised at the end of Chapters 4 and 5.

3.6.3 Analysis and Interpretation of Data

Many authors provide guidelines on analysis strategies. I have drawn from Miles and Huberman (1994), Wolcott (1994), Yin (2009) and Creswell (2013) as influential authors with the longest tradition in analysis and interpretation strategies. Some of the strategies include: sketching ideas, taking notes, summarising field notes, thematic coding, creating a point of view, and displaying data. I sketched original ideas, summarised field notes and transcripts, thematically coded the data collected with emerging themes and then, using the ANT visualisation lens, displayed the data for audiences in acts and scenes. This visualisation technique is an enhancement I made to ANT field and information systems, linking the two, as well as using the innovation translation theoretical framework.

The above steps are aligned with Creswell (2013: 101) and Yin (2009), who recommend a typical format for case presentation and interpretation, providing a full and rich description, drawing themes from each case, best known as within-case analysis, followed by a thematic analysis across the cases, known as cross-case analysis as well as claims or interpretations of the meaning.

3.7 Confirming Rigour

Creswell (2003, 2013) pointed out that as the 'I' in the primary data collection instrument, it is critical to identify personal values, assumptions and biases as early in the research as possible. I must also develop skills necessary to be a human instrument. The credibility of qualitative reports relies on the reader's confidence in the 'I's' ability to be sensitive to data and to make appropriate decisions in the field (Patton 2002; Saundage 2009).

In Chapter 2, I achieved theoretical sensitivity through a systemic literature review. In addition, I used multiple sources of data such as interviews, document analysis and observations, and participant validation throughout the project. At each milestone in this investigation, there have also been publications (with permission from the case sites), ratified by academia and industry, which has further strengthen the validity of the research and its rigour.

Further, in 2012, a series of interviews was conducted with industry experts to validate the findings' currency (see Chapter 7). This is reflected in the final chapter. Creswell (2013: 251) posits peer review or debrief as an external check of the research process (endorsed by Merriam 1988; Lincoln & Guba 1985; Glesne & Peshkin 1992; Erlandson et al., 1993; Ely et al., 1991). The peer reviewer is defined as a 'devil's advocate' by Lincoln and Guba (1985). In my research investigation, which has been a prolonged exercise from 2007 to 2012, the technology itself (because of its evolution) had to be evaluated and validated by peers or experts in the field of health care and hospitals within Australia. In 2013, a focus group with the findings that emerged from the research was undertaken, as well as individual unstructured interviews with peers. As such, the findings have been validated for currency, reliability and validity of findings, as of 2013. Although technology has evolved, due to slow progress in the health care field in Australia, the findings are still very relevant and applicable to the field today, as endorsed by the validation process.

3.8 Ethics

The ethical considerations for this research were met at the beginning through relevant approvals at the university level, as well as special forms in health informatics required by Australian states. For example, in Victoria, a set of different criteria was applicable particularly for any human-related research within hospitals. Although the interviews were not conducted with patients or staff in their workplaces, they were still regarded as human research in the health sector.

The main issue in the investigation was whether it is regarded as an intervention affecting patients, or staff in service within the hospital (namely, nurses & orderlies). I studied RFID technology deployment within emergency and related departments that are tumultuous. Questions about how 'interventional' the study was have been raised, even though it is passive observation. Special permissions had to be granted for physically visiting the locations and observing what occurred in each situation. These permissions were granted by both hospitals, as the interviews were not conducted in emergency settings. Individual interviews with staff were conducted in office settings within the hospital, separate from their work areas.

However, I had seen what occurs in ED as a passive observer, occasionally taking snapshots of equipment that was RFID-tagged. As patients were being moved around within the hospital, snapshots had to be taken without people being filmed. This was signed off at the beginning in the agreement.

At the beginning, when the ethics application was made, I made it clear there was no new technology intervention I was experimenting with, and I was only interviewing those staff involved in the deployment of RFID, which had already occurred partially or fully in both hospitals. Both hospitals also ratified that findings from my research can be revealed for academic research purposes. The names of hospitals *could be* revealed in publications, as both hospitals had already been visible in many public forums regarding this pioneering technology in Australian hospitals. Hence, publication did not expose any ethical issues. People's names were hidden, revealing only their roles in the context.

Five publications (see Appendices) have emerged so far from this research investigation; these are in the public domain for academic and industry information. This was encouraged for knowledge dissemination in this area with significant research gaps. Both the case study hospital sites, as well as the university ethics committee, were informed there is no 'technology intervention', but rather an investigation into the factors for successful translation of the technology in the hospital.

The reference to this project is 2012–158 at Deakin University, which contains the latest approval for ethics. The project is regarded as low risk, as it has been unobtrusive throughout the period of research.

3.9 Chapter Summary

In this chapter, I have described the design and methods used in the thesis, to answer the research questions presented in Chapter 1. I have embraced a qualitative approach, and have taken an interpretive perspective as the research epistemology. By taking this viewpoint, I also wish to acknowledge the constructivist paradigm of inquiry. Data was analysed using the ANT lens for visualisation, and moments of translation in innovation translation theory, for meaning interpretation. I attempted to understand patterns that emerged in the 'translation'.

The multiple case approach added dimension, to draw some conclusions about the translation of RFID through the social networks in hospitals and the process of negotiation.

In the next chapter, I present the findings from the first case study in a narrative mode with acts and scenes, which is the outcome of the carefully constructed and executed research design.

Chapter 4: Case 1: The Pioneer Group: Findings and Analytical Discussion

4.1 Introduction

This chapter explores innovation translation of RFID technology in a large Australian hospital via a case study investigation. I sought to understand: (1) if the technology has made improvements, as perceived at the time of deployment; and (2) while doing this, whether it influenced and re-negotiated the relationships between the actors involved. ANT concepts have been used as a framework in narrating this case study.

RFID is considered the key actor (non-human) who enters the scene as a 'debut' actor or 'innovation' at the time of entry and translates or 'integrates' itself into the context, re-negotiating the existing network of relationships within the hospital, establishing and sustaining its presence, while evolving and emerging as a 'star', holding much future promise. I contend that RFID technology enters the hospital (blackbox) as a key non-human actor, and retains a position while enabling varied networks. In the continuum, it translates or integrates into this blackbox (hospital), transitioning and evolving over time, yet sustaining its position while other innovations make their entry (and exit), perhaps delaying its own diffusion. Although invisible (non-active) at times, it has become pervasive by its versatility and transformational ability. Thus, it has emerged as a 'star' amongst the technologies deployed in the context, enabling alignment of strategy and technology within the hospital.

This chapter narrates the story in significant 'acts' and 'scenes'. I had numerous unstructured or sporadic interviews with human actors, due to the frenzied nature of the hospital, as well as deployment of the technology and its events. I also met with non-human actors[19] voiced through the human actors at the site for data collection. However, only relevant episodes where significant changes occurred in the established networks have been highlighted for the purpose of this narration. In Table 4.1, I note the key actors and blackboxes in this study.

[19] In this context, non-human actors are documents, reports, software interfaces etc.

The narration is presented in three acts, each with multiple scenes, similar to a film, and in flashback mode. The duration of this story is over three years, and over multiple interviews conducted and limited to the large hospital group with two sub-sections: a private and public hospital. At the time of this study, this hospital had provided me with a comprehensive document, detailing workflow analysis and redesign, which is presented in this case narration through a report.

4.2 The Milieu

The case site is a large co-located, private and public hospital in New South Wales (NSW), in Australia.[20] It is owned by a not-for-profit health care system operating in the Australian States of Queensland, NSW and Victoria. It owns and operates two private and three public hospitals in NSW with approximately 50:50 private and public beds, employing approximately 4,500 people. A specialised clinic is co-located with the hospitals, an Institute of Medical Research, a Cardiac Research Institute and a Medical Research Institute. The hospital also provides medical and nursing education via two major universities in Sydney. Regarded as one of Australia’s leading providers of private health care, it has built a reputation for treating the highest patient acuity levels of any such hospital in Sydney, NSW. Key services include in-patient facilities, day surgery, cardiac catheter suite, endoscopy unit and medical imaging services.

In the context of this research, it has a strong commitment towards information technology being introduced to improve quality of care. In 1980–1984, it developed the first health information system, in conjunction with the ICT department, which eventually became an internet based clinical information system, with relevant modules to support the hospital. A key module of the clinical system is the clinical support resource management system that books, tracks and manages patient orderlies to efficiently move patients and equipment between wards, operating theatres and clinic appointments. In 2007, it was proposed to integrate a real-time location system (RTLS) with this module to provide a more efficient real-time view of hospital resources. At the time this ‘pilot’ was proposed, the tracking technology (RFID) was new to large hospitals within Australia, as well as overall health care. The in-house expertise of the

[20] The information presented in this context is sourced from the organisation. Due to the confidential nature of the case, the source cannot be named.

hospital, along with ICT department in 2007, when the technology was introduced, spanned 14 years. While they were open to innovations, hospital operations were not prepared to upset the daily operations before a trial.

The CIO of the hospital who headed the ICT department (which oversees the whole hospital), was approached by a large technology organisation that was also a strategic partner of a company specialising in real-time location systems, to trial RFID. The CIO and the board of hospitals were open to new technology to be deployed for improving quality of care in the hospital. RFID as a technology was new to hospitals in Australia at the time, hence the decision to trial it, with a view that it would be most beneficial in EDs (or Private hospital theatres). Specifically, any innovation was usually trialled at the private hospital, before the hospital board approved it for implementation in emergency-related departments in both hospitals. Equally, the CIO had authority to trial any technology, and a certain level of discretionary funding with the ICT department to be used for any such trials. These did not require prior approval from the board.

The trial was initiated through discussions with the technology organisation and their partner, who supplied all RFID-related tags and equipment, and CIO of the hospitals group. It was then decided that the pilot would be enabled by the organisation with the real-time location system, which would provide RFID tags and tracking equipment and *MobileView*, an interface for users. Specifically, the level one integration of RFID tracking would be via wireless local area network (LAN) configuration by the hospital and RFID tags, *Exciters* and software deployment provided by the company with the RTLS. The level two extensive integration with hospital IS would only be undertaken if the pilot was successful in establishing the value of RFID for the hospital.

Table 4.1: ANT Depiction of Actors (human and non-human) and Case Site

Actors/ blackboxes	**Name**	**Details (Non-human actors have been given a voice by a human actor)**
Non-human actors	RFID tags and equipment The debut actor	Voiced by all human actors. Specifically, the function of the non-human actors was revealed by the human actors.
(These non-human actors are drawn from published and unpublished confidential reports, documentation, images provided in conjunction with interview data)	RTLS Report	Voiced by the lead architect and PM of the external technology company (Vendor)
	Web based clinical system (Web deLacy)	Voiced by CIO and BA of the ICT department of the hospitals
	Bo-Beep Interface	Voiced by BA of the ICT department of the hospitals
	Touch Screens	Voiced by BA of the ICT department of the hospitals
	MaQs (The tracking system of SSD)	Voiced by head of SSD
Blackboxes	The private hospital	The first site where RFID entered into the context
	RTLS Company	Strategic partner of the technology company in Australia which supplied tags, instruments, exciters (RFID infrastructure)
	The public hospital	The second site for RFID implementation which is underway
	Sirens (funding group)	This group was responsible for funding for ED in hospitals in NSW. Researcher has not met with them, but their presence is notable as they brought in funding for RFID in the end, for deploying it in emergency department of public hospital. Hence I name them as blackbox, rather than human actor or non-human actor
Human actors	CIO (the champion)	The CIO is overall in charge of all technology based strategic decisions for the group of hospitals. The 'Godfather' of RFID, who launched its career as the non-human actor, in the group
	PM (technology company)	PM and lead architect of the core team that deployed RFID pilot at the Private hospital or supported the debut of RFID by entering the blackbox, on the invitation of the CEO
	External company teams	The teams which came together for RFID pilot deployment
	Head (SSD)	The manager of SSD, who met RFID as debutant and continued to promote it in its evolution, finding

		new opportunities
	Nursing unit manager (private)	This actor favoured the recommendation from Head (SSD) to promote RFID actively in the Private hospital
	Orderlies (private)	The orderlies were key in supporting RFID deployment
	Nurses (private)	The nurses were the first to be consulted in the private hospital for evaluating RFID deployment
	Technologist OR SysAnalyst (implementation projects)	This actor was the technology implementer who has been present from inception of RFID. He may be regarded as the enabler for RFID infrastructure, who continued to change and remodel the infrastructure of the hospitals to suit the RFID evolution from 2007 until 2011, when infrastructure needed revision including WLAN, exciters, location and tags
	Business analyst (BA)	This actor i has been instrumental in the continued career progression of RFID within the hospitals
	Cameo [21] ('I', the researcher)	This actor is myself as 'I', who was instrumental in re-examining the site, after the initial pilot and triggered continuity in the innovation translation.
	Wards-in-charge (head nurse, public)	This actor is a head nurse, who heads the wards in the public hospital, with particular focus in 'Wound-Care Wards' that support ED
	Head (ED)	The nurse-in-charge of the ED at public hospital

The actors (blackboxes) are presented with the actors, their specific roles and some details in Table 4.1. It may be noted that the hospital ICT departments are responsible for all technology decisions across the hospital group. All technologies are introduced, deployed and monitored by key staff in this department. The hospital is considered one blackbox, and within the blackbox, the two hospital entities (private/public) and four relevant areas (two each), where RFID has been introduced, are covered in this analysis. Specifically, although there is a co-located private and public hospital, it is considered one large hospital, as they share resources, particularly in relation to RFID deployment. The deployment experience from the private hospital has influenced the acceptance from the relevant departments in the public hospital.

[21] This is not suggesting action research, as explained in Chapter 1 and Chapter 3.

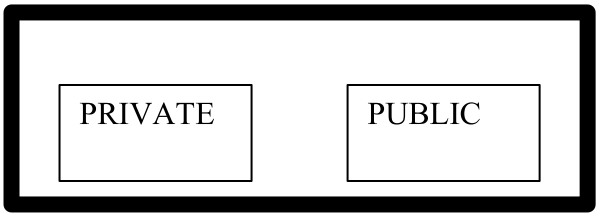


Figure 4.1 Case Study Site: The Large Hospital Complex

The interviews were recorded over a three-year period from 2007 to 2009. These were semi-recorded and complemented by diarised notes. The initial interview is regarded as a conversation between the non-human actor, namely the RTLS report and me (the researcher). The information was clarified (or voiced) by all the human actors. Subsequently, in 2008 and 2009, three different sets of interviews were held with all the key actors, at different times. All interviews were one-to-one conversations with individual actors. Where there was a conversation with a nurse, all nurses had one voice, in that they spoke for all nurses in the hospital. This was an interesting point that I noted at the beginning of interviews.

Recorded interviews held with all the key actors in 2008 and 2009, at three different times. The interviews were transcribed completely, and analysed using a concept mapping technique, and reconstituted for presenting this analysis. Note that only relevant snapshots of the conversation have been presented in the narration and for subsequent discussions.

4.2.1 The Storyline

In this case, I am narrating the story of the Australian hospital that pioneered RFID for asset-tracking in 2007. The hospital itself had two distinct areas, a public and a Private hospital. RFID was piloted in the Private hospital originally, as it was smaller and rather specialised structurally, with mainly elective surgeries. The original idea was that if the implementation proved useful in two key departments (sterilising services that supports all theatres including emergency, and has to service the entire hospital, with all equipment needing sterilisation; and clinical support services, which caters to the whole hospital in terms of resources, including nurses and orderlies who move patients using wheelchairs or stretchers: day-to-day hospital operations). The assets included all equipment and movable items, such as wheelchairs and gurneys.

The story begins when a large manufacturing company wants to pioneer RFID in Australian hospitals. This manufacturer approaches the hospital CIO with the offer of some equipment for trial. The CIO is open to the decision and decides to deploy the pilot, top down. Through Act-1, I present the relevant areas in this implementation and its reverberations as a summary. Subsequently, I present the ANT visualisation and analysis through a lens informed by ANT. The first Act is reconstituted from published and unpublished reports and document analysis.

In the second Act, I approach the hospital, as a 'Cameo actor' or researcher to investigate the outcome of the RFID pilot, which was unsuccessful. Through this second act, I present the relevant discussions I had with departments, users and also observations in scenes. At this stage, as a 'participative observer', I have made suggestions for the hospital to consider, particularly in two departments. These suggestions were no doubt taken into account and implemented by the hospital in the long term. However, despite small attempts, budget constraints, coupled with the beginning of e-health records deployment, stalled the redeployment of RFID. By this time, two years had passed since the first pilot. In the summary, I presented the ANT visualisation and the analysis based on the observations at that stage.

In the third Act, there was redeployment of RFID that began in the public wing of the hospital. At that time, as an earlier participant in this process, my presence was solicited to revisit the people, departments and the new wing where the deployment was proposed, to provide advice and also understand the requirements. During this time, the scene was being set for RFID; however, deployment would only occur after the implementation of e-health records. However, there were signs of momentum as an independent organisation had made funding available for the ED, which no doubt wanted to deploy RFID for tracking crucial assets. My story ends after this Act, where the deployment stage was being set, but the process was yet to begin.

The pivotal point in the story is the role of a nurse, who headed a department in the public wing, to enable the redeployment of RFID in this hospital. Despite the fact that the CIO and the external powerful organisation initiated it, a successful pilot occurred, and the technology was pioneered and championed by two departments critical to the hospital. It took three years to be recognised as a useful piece of technology. The catalyst for this redeployment initiative was a nurse who headed one of the departments; no other powerful forces could even begin the initiative.

Table 4.2: Outline Table of Acts and Scenes

Section	**Act**	**Scene**
4.3	**Prelude**	RFID in conversation with Cameo
(2007)	Act-1: RFID 'Debut' at the hospital	Scene-1: Concept discussion between PM(Tech.co) And CIO hospitals
		Scene-2: Introductions
		Scene-3: CSU Workflows Analysis and Mapping
		Scene-4: Workflow Analysis and Mapping at SSD
		Scene-5: Meeting with the nurses
		Scene-6: Post-Implementation Review
4.4	Act-1 Through the ANT Lens	
4.5 (2008)	Act-2: Tracking the Disappearing Debut Actor (RFID)	Scene-1: Meeting with ICT/Strategists at the Hospital
		Scene-2: Meeting SSD
		Scene-3: Meeting CSU Head, Orderlies and Nurses
		Scene-4: Meeting technologists/strategists (including CIO)
		Scene-5: Revisiting SSD and meeting with Head-SSD
4.5.1	Planning Paucity	
4.5.2	Act-2 through the ANT Lens	
4.6 (2009)	Act-3: RFID in the Public hospital	Scene-1: Meeting with CIO and ICT department
		Scene-2: Meeting with Wound-Care Wards in Charge
		Scene-3: Meeting ED Head and BA (ICT)
4.6.1	Act-3 through the ANT Lens	

4.3 Act-One: RFID 'Debut' at the Hospital

The Act begins as a flashback in time and has been reconstituted from document analysis of unpublished RTLS reports and documentation provided by the hospital for analysis. This Act has information about what occurred before I entered the case site as a 'Cameo' to review the site for RFID implementation. There were reports and documentation based on the pilot implementation that took place. I reviewed these documents as a precursor to interviews that begin in Act-2, to draw insights from 'what had occurred in real time'. Subsequently, I am presenting this material as 'interviews' with non-human actors. It is reconstituted with my reviews, drawing out the human/non-human actor interactions. It may be noted that this Act contains views that were confirmed by the human actors when I interviewed them in Act-2. It was after that endorsement that I reconstructed Act-1.

Before I begin this section, I am having a conversation with RFID, where the non-human actor speaks for itself and then the scene-1 begins.

4.3.1 Prelude: A conversation between RFID and Cameo

Cameo: *As I understand, this is your debut. Could you tell me more about yourself?*

RFID: *I am commonly known as the Radio Frequency Identification or RFID technology. Currently I am still evolving into this role as I am trying to understand my key performance indicators. I do understand that in few years time I will have to adapt to become a hospital grade tag. My intention is to become more versatile, so I can take on more roles and perform to the best of my ability.*

And now the Act begins. At the beginning, the discussion (as below) took place between the project manager (technology company) or the vendor, and the CIO of the hospitals. This was information I reconstituted, as a dialogue between the two actors. The scene was endorsed by both participants as a true reconstituted representation of what had occurred.

4.3.2 Scene-1: Concept Discussion between PM (Tech. Co) and CIO (Hospital)

PM: *We have teamed up with a strategic partner, for trialling location tracking systems in Australia. Are you interested?*

CIO: *Well, we are open to new technologies in this group that helps improve our process efficiencies. But, there is already our health information systems and our people are working further on tracking possibilities. Finding equipment is an issue for our clinical staff. We do know these are available, but never there on time. We have shared arrangements, loan assets, etc., yet…often doctors and nurses spend so much time looking for critical equipment. We spend extra money in loaning or buying them again…so, yes—we can definitely try it, if it is found to be useful, it will help us.*

PM: *We can bring in the technology and related equipment. The solution integrates well with WLAN. We have an interface, MobileView, which can easily plug in, and not interfere with the existing HIS. We are happy to provide these and the implementation team.*

CIO: *In such case, let us trial at the Private hospital. We cannot deploy anything in Emergency Department or public hospital, without approval of the board. However, trial at the private is under my discretion. Let us do it. You meet with our technology manager, and the head of Sterilising Services Department (SSD)—which supports the Clinical Services Unit (CSU) at the Private. These are the two departments that are transporting equipment with patients (bariatric wheelchairs*[22]*) around the building. They need to be consulted and in agreement. Also, you can do a business analysis of their workflow, and map out the real problems.*

[22] These are heavy duty wheelchairs, with ability to carry more weight.

Subsequently, the technology company sends teams to the hospitals. In consultation with the technologist in the ICT Department, they agree that the infrastructure can be integrated with the new RTLS.

4.3.3 Scene-2: Introductions

Technologist: *Can you please elaborate on what is proposed?*

The team: *Our company provides enterprise visibility solutions based on Wi-Fi and pioneered first Wi-Fi-based Active RFID tags. The Visibility System uses standard Wi-Fi wireless networks to accurately locate and track valuable assets, using small tags or any 802.11b/g enabled wireless device (such as laptops and barcode scanners). By operating over popular wireless data communications standards, the solution added minimal incremental cost to a communications network and enabled a broad set of applications.*

Technologist: *Ok, let me talk more about the Private hospital. It is one of the many buildings within the medical campus, located between the public hospital and the Clinics Building. It has ten levels with four levels under the street level. The main entrance to the building is at level 4 and the top five floors are dedicated to in-patient rooms.*

Subsequently, they arrived at the following diagram for distribution of building levels for the pilot. The diagram reveals different levels of the Private hospital, and exit points marked in red circles. Tracking occurs via the system placed at every exit point.,

Patient tracking equipment, such as wheel chairs, and other essential equipment was tagged so that their movement can be traced between the operating theatre and radiology departments. It may be noted that some assets are loaned and shared between the two hospitals, such as infusion pumps and electro-cardiogram (ECH) machines. The tracking took place through five in-patient floors of the Private hospital, theatre complex and radiology department, a storage area on the fourth floor and the sterilisation department. There was no expectation to distinguish a patient's room location during the trial; however, floors six to nine are divided into three zones, and floor 10 into six zones for comparative purposes, to assess accuracy.

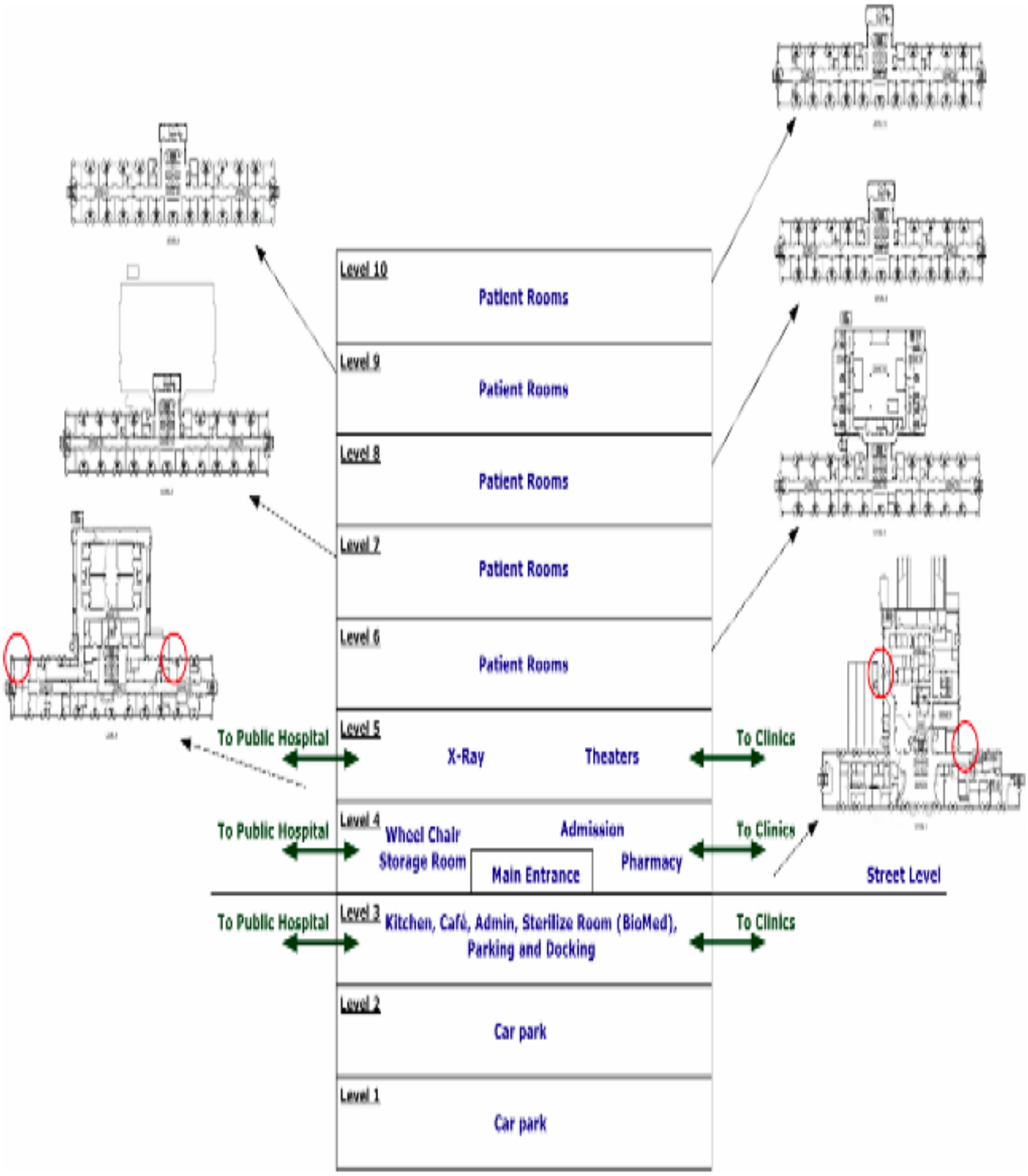


Figure 4.2: RFID Deployment Plan in 2007 (source, RTLS report)

In general, the pilot's objective was to evaluate the capabilities of deploying RFID within the private hospital. Subsequently, based on what was learnt, a similar solution for the public hospital (particularly in ED), would be provide Active RFID tags were attached to high-value and high-utilisation assets, including patient moving equipment such as bariatric wheelchairs, and monitored the effects of workflows in two specific departments, SSD and CSU. The SSD is in charge of sterilising all equipment that goes into the hospital, particularly those attached to surgeries and emergency wards. CSU is concerned with movement of equipment and patients to surgery, operation theatres and emergency wards. They are both closely interconnected to emergency and operating theatres. The equipment tagged was high-value and shared.

The PM of the technology company, along with a team of technologists, deployed the solution. The team came onto the site, tagged the assets, set up the equipment and gave a briefing to selected staff, which did not include users of the system, or orderlies who usually transport the equipment based on pager messages from nurses or clinicians. The team members met with the head of SSD and CSU to map their workflows. It may be noted that the team only met with the head of departments, who already approved of RFID deployment as a trial. The commitment from them was that the current processes would not be disturbed, and the solution would run parallel to the existing methods of tracking equipment.

4.3.4 Scene-3: CSU Workflows Analysis and Mapping

External co team: How are the assets tracked in the department, can you elaborate on the flow?

Head-CSU: The end-to-end workflow is described below in three different stages 1) equipment order and local search; 2) equipment search across the campus (if necessary); and 2) equipment delivery and patient transport.

In Stage 1: equipment order and local search

1. *the process is initiated by a request entered online by the nurse using Web deLacy*
2. *the operators and the Clinical Paging Unit receives the request via deLacy*
3. *the paging operator then assigns the order to a Patient Care Orderly into the system and triggers a pager text message with the order description*
4. *the orderly receives the text message and reviews deLacy request if necessary using CSU workstations*
5. *the orderly then goes to the CSU's storage rooms and searches for the assets to complete the work order*

External team: Ok, so it is mapped as follows.

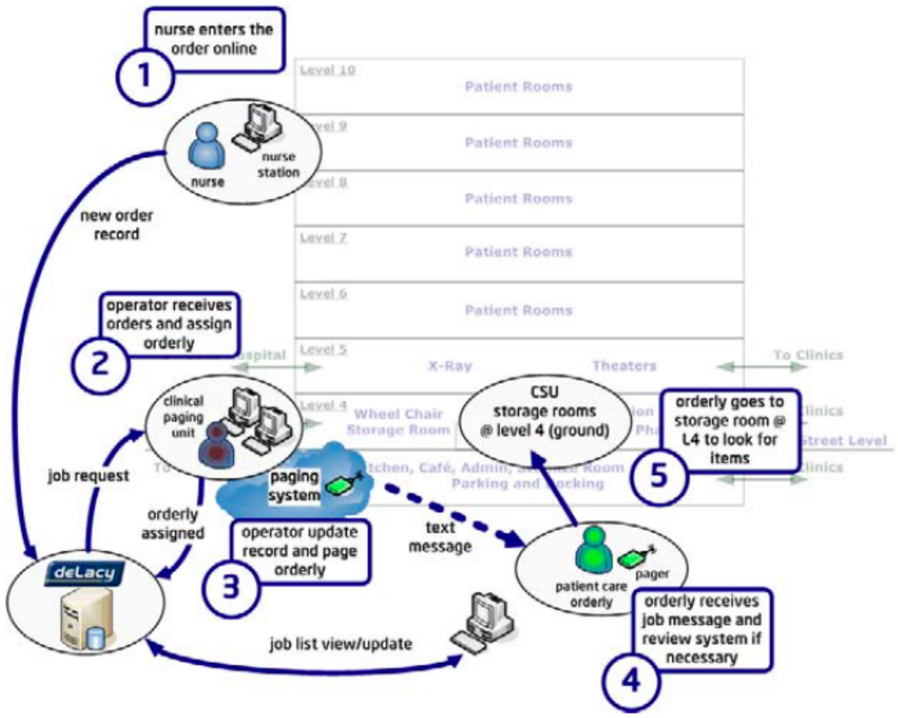


Figure 4.3: CSU Workflow mapping: Stage1 (source: RTLS report)

Head-CSU: *Yes, that is right. And then in stage 2, the equipment is searched across the campus*

6. *if the equipment requested is not found in the CSU storage area on level 4, the orderly commences the search from the top floor (level 10)*
7. *the orderly then moves down through every floor looking for the assets*
8. *if the asset is not found - the orderly searches across the public hospital building (this happens once in every couple of weeks)*
9. *if the asset is not found at the public hospital the orderly continues the search into the Clinics building until the assets are found.*

External team: *Ok, so stage 2 is mapped as follows.*

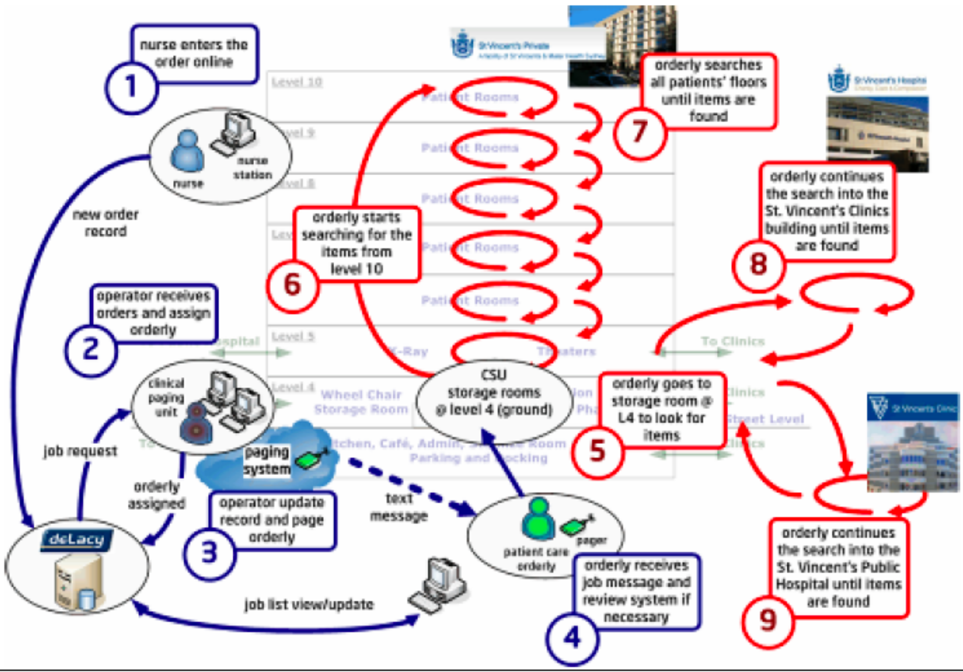


Figure 4.4: CSU Workflow mapping: Stage 2 (source: RTLS report)

Once Head-CSU: Yes, If the assets are not found within the storage room the CSU staff commences a search within the entire building. The first place to look for the assets are the in-floor storage areas beside the staff lifts on every floor, including L3 theatres area. In some cases the search for the assets is extended to the actual wards including the corridors, small storage rooms and even patients' rooms. If the assets are not found within the Private hospital the search continues into the Public hospital and Clinics adjacent buildings. Then we move to stage 3 where equipment is delivered and patient transported:

10. *all the assets are found the orderly assembles the ordered kit*
11. *orderly delivers the kit or collects the patient for transport at the wards*
12. *orderly transports patient if required (this does not happen usually)*
13. *orderly returns used assets to CSU storage at level 4*
14. *orderly update data record and becomes available for the next order*

External team: So let us map stage 3 as follows.

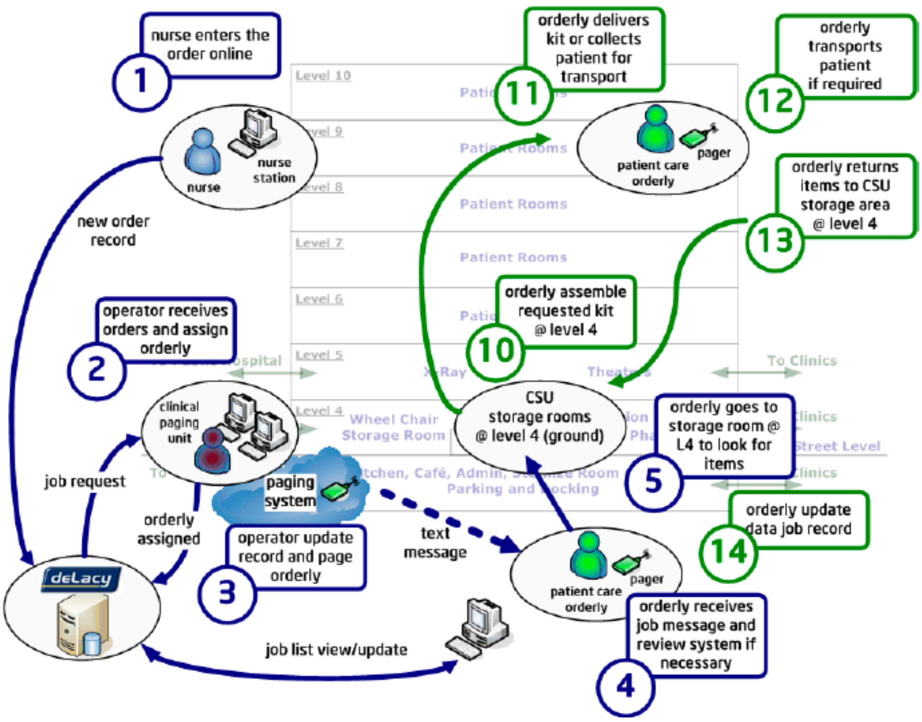


Figure 4.5: CSU Workflow Mapping: Stage 3(Source RTLS report)

External team: *So let us understand the real issues here, which can be addressed.*

Head-CSU: *Ok. Mainly, the asset location data is not available. More than one job is assigned to orderlies at a time, as the paging unit assumes that all equipment is available in the storage room and dedicated areas. However, more than 80 per cent of the orders require orderlies to search for the assets and often, around the campus, which results in delay in equipment delivery. The nurse needs to call to check the status of the order and they can spend up to 60 minutes per day on this alone. When it is a non-critical case, nurses start looking for equipment themselves, if waiting time exceeds two hours. On average, CSU loses four oxygen regulators and 10 wheelchairs per year, which costs approximately AUD12,000 each to replace. Overall, there is no visibility on the asset utilisation rate for each equipment, and we are unsure how many assets are there in total. In many occasions, CSU knows where the asset is, but someone takes them without reporting usage or final location.*

External team: *What are the variations to this workflow?*

Head-CSU: *Between 80 and 90 per cent of orders are via pagers, only ten to 15 per cent are via workstations. Not all the jobs are closed by orderlies when completed… sometimes paging officers close them at their discretion. This result in a lot of variation in the workflow, every orderly takes between 30 to 40 orders approximately per day.*

External team: How are the rosters–we know that there are shifts?

Head-CSU: *The roster is as follows:*

12 staff per day + 1 night, shifts:

7am–3.30pm = 2 Orderlies

8am–4:30pm = 4 (8am–6pm = 1 @ paging) Orderlies

9:30am–6pm = 1 Orderly

10am–6:30pm = 2 Orderlies

11:30am–8pm = 1 Orderly

1pm–9:30pm = 2 Orderlies

9:30pm–7am = 1 Orderly

Subsequent to this conversation, the team decided to speak with the head of SSD.

4.3.5 Scene-4: Workflow Analysis and mapping at Sterilising Services Department (SSD)

The external team finds that the closest ally and network partner for CSU is SSD, which handles sterilisation of equipment before it is sent out to relevant areas via orderlies. They decide to approach the head of the team, for mapping the workflows.

External Team: Could you explain to us the working of your department?

Head-SSD: The SSD received 10 orders per day. It has 10 technicians in the team, five who are in morning shift and five in the afternoon shift. The rosters are:

7am–3.15pm = 4–5 Technicians

11am–7:15pm = 2–3 Technicians

1pm–9.15pm = 2 Technicians

All devices owned and maintained by SSD are barcode-labelled and linked to the asset registry at MaQS, the SSD's equipment-tracking system.

External Team: Can you explain the workflows in the department?

Head-SSD: The workflow is divided in two stages 1) initial equipment recovery and 2) equipment collection and delivery. SSD doesn't search for devices outside the Private hospital building. In Stage 1: initial equipment recovery, the workflows are as follows.

1. *the workflow is initiated by the daily morning route executed by the technician on duty to collect all the devices storage behind the lift area on each of the floor*
2. *all the equipment collected is then returned to the sterilising room at level 3*

External team: So it can be mapped as follows.

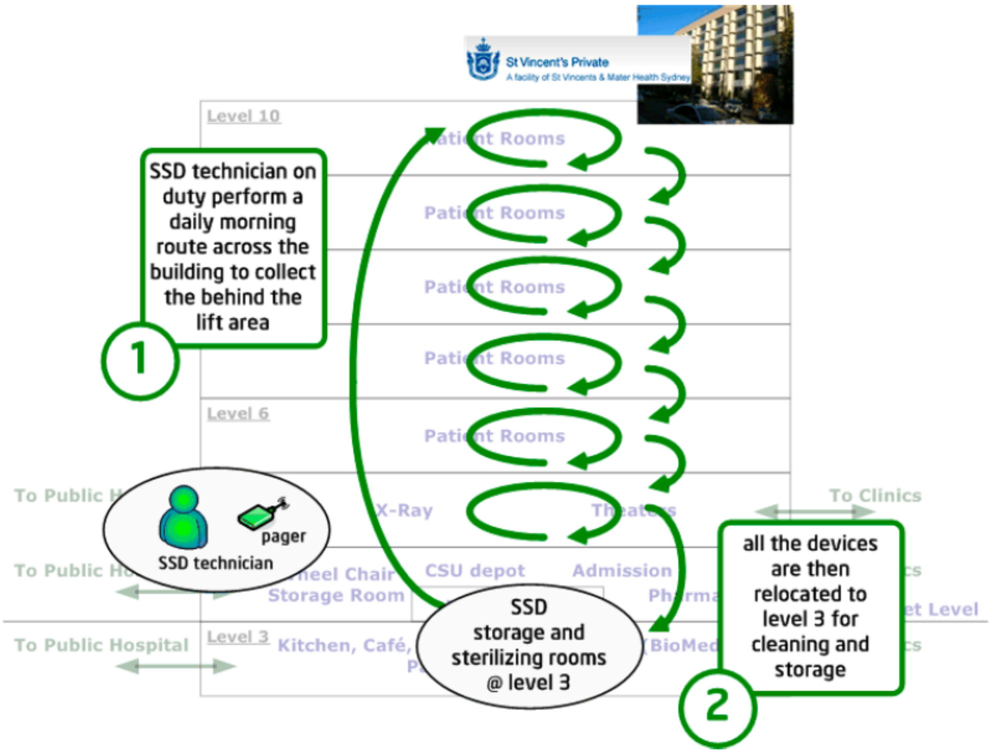


Figure 4.6: SSD Workflow Mapping: Stage1 (source: RTLS Report)

Head-SSD: Yes, correct. In Stage 2, equipment collection and delivery is made, as follows.

1. *the second stage of the workflow is initiated by the requesting nurse when they enter the requisition online using deLacy web*
2. *the request is then automatically printed on the printer located outside the storage room at level 3*
3. *the technician on duty collects the printed docket from the printer and proceeds to assemble the order*

4. *the technician scans all the items of the kit and enters the assignment information into the MaQS Instruments Tracking System*
5. *once all the part has been entered into the system, the technician delivers the order to the requesting nurse within the in-patient floor. The equipment is then left on the front desk; it is not delivered to directly to the patient.*

Also note that rarely, requests are actually received directly from the nurse over the phone. In such occasions, no tracking information is recorded within the MaQS.

External team: So we can map stage 2 for SSD as follows.

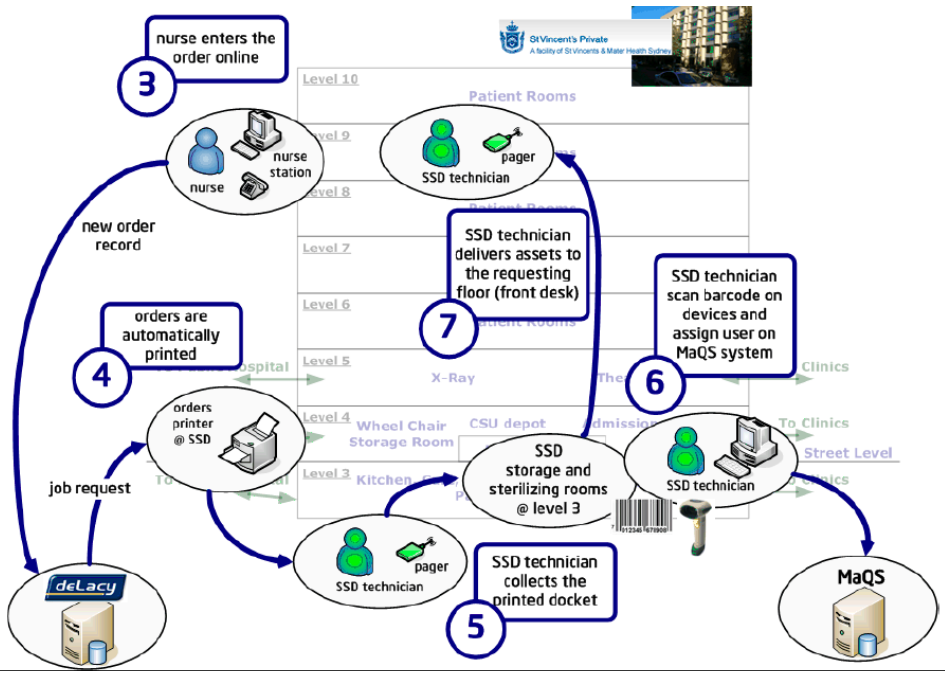


Figure 4.7: SSD Workflow Mapping: Stage2 (source: RTLS report)

Head-SSD: *That is correct.*

External team: Can you elaborate on the business problems relating to tracking in SSD.

Head-SSD: We spend AUD27,000 per year on rentals for equipment but have no visibility of its utilisation rate. On average, SSD replaces four syringe drivers per year, which costs AUD7,200. Typical lapsed time between an order and equipment delivery is 90 minutes. This can potentially delay the procedure and compromise patient safety. Therefore, for critical cases, nurses will not wait for the delivery but look for other alternatives such as to take it from a non-critical patient or borrow it from other department.

The equipment delivery location (level basis) is specified in MaQS but the technician does not cross-check with it during collection. They only collect equipment that is left behind the lift (a space that is behind the lifts that is allocated for this purpose). Thus, they are not sure if all equipment is recovered and collected. As equipment recollection is required during the day if there is a shortage of supply—to theatres. The requestor or nurse will first check at the lift area and inform the technician if there is one. The technician will then collect the equipment from that particular level, return it to SSD, clean it and deliver it to the nurse. This will normally take 30 minutes and it happens around two to three times per week. SSD staff only search in the designated areas thus limiting the availability of devices. Not every item is scanned on return. The staff at the Theatres do not use deLacy - they use the telephone.

4.3.6 Scene-5: Meeting with the nurses

After mapping the workflows, the external team decided to interview some of the nurses, who initiate orders for equipment to be delivered. The nurses in this conversation are five in number, but they are voicing the comments from all the nurses within the hospital. I had noted that nurses speak with one voice, and refer to themselves as ‘we’ and ‘us’ rather than me.

External Team: As we understand, you place the orders using deLacy, call CSU or SSD to follow up on the delivery every 30 minutes for non-urgent cases. If *the devices are not delivery on time, you go to search for them at levels four and five, particularly in emergencies. Is this correct?*

Nurse: *Yes. For example, Infusion Pumps are in high demand, on average ten orders per day. The orders are entered via deLacy when needed. For emergencies, we keep pumps in our offices as normally the waiting is two hours. Two pumps are usually dedicated for chemotherapy. If the equipment does not come, we go and get it…got to sort out our issues ourselves.*

Nurse: *If there is no wheelchair, we go grab one. There is constant chasing of orders, usually it takes between 30–60 minutes per order. We spend a lot of time chasing orders that would be best spend with patients! We place orders on deLacy and then have to call CSU to chase up, as there is a patient waiting all the time. We really work at high stress levels.*

Nurse: *Hate to look for bladder scanners, at least 30 minutes each time. I spent a whole shift looking for patient belongings…we spend hours looking for stuff.*

Nurse: *If urgent, we go and get it, Availability of devices means increase in safety and better care, we have secret spots to hide devices Things such as ECG equipment should be traceable. The average orders are as follows:*

- *20x WC orders per day*
- *2–3x PCA orders per week*
- *5–10x infusion pump orders per day*
- *~10x patient transport trolleys orders per day*
- *~2x oxygen regulators orders per day*
- *~1x syringe driver order per day*
- *~1x bladder scanner order per day*

External team: *So in summary, you spend an average of 30 minutes per day in chasing orders for medical devices; the average waiting time for delivery is on* *average two hours per order; and patients are always waiting. The time spent in following up with CSU and SSD can be better used with patient, correct?*

Nurse: *Yes, that is correct.*

Subsequent to this meeting, RFID deployment was made by the external technology team. During the pilot project the back end systems were not integrated. The following diagram illustrates the architecture deployed at the private hospital. The nurses place the orders using: the health information system (HIS) from the nurses workstation computer, the mobile phone nurses could use to place orders and chase asset locations using mobile computing devices like MCA. Orderlies close the order using computer workstations, the paging officers read and update the orders via deLacy and find asset locations via *MobileView*, while CSU and SSD supervisors find asset locations using *MobileView*.

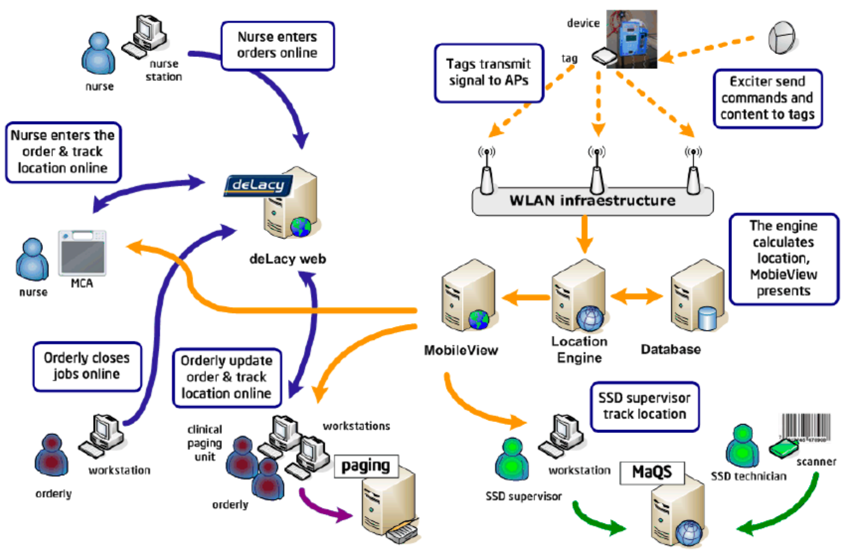


Figure 4.8: Architecture by External Team for the Private hospital for RFID deployment (source: RTLS report)

The above diagram shows the architecture provided for the RTLS system by the vendor. The Web deLacy is internal to the hospital HIS.

For a production deployment integration, the back end could be archived by using the *MobileView* gateway to interface directly with the HIS web platform (a server farm).

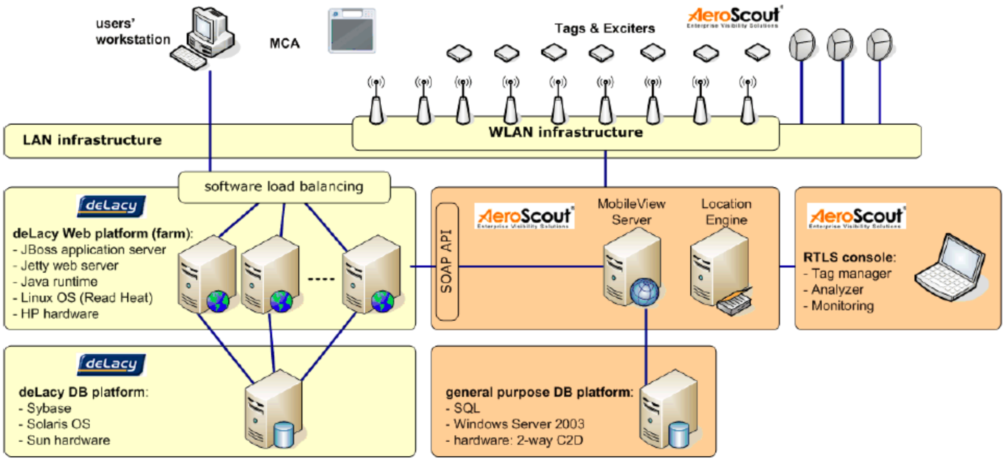


Figure 4.9: MobileView Gateway (Source: RTLS report)

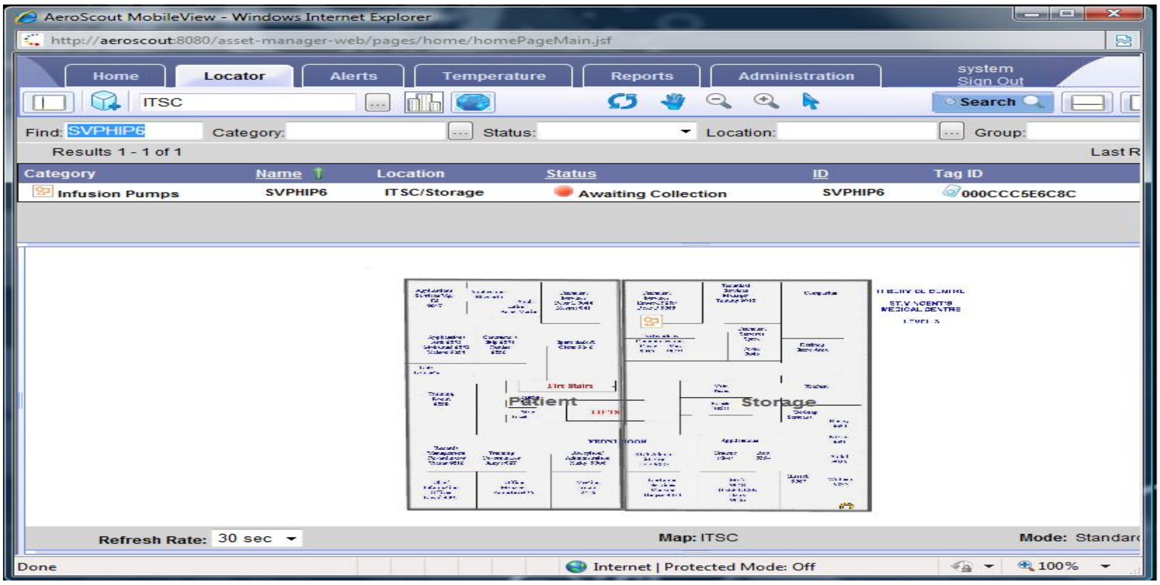


Figure 4.10: MobileView Interface for the Private hospital (source: screen shots from the HIS).

An inventory of selected assets was tagged using RFID. During deployment, the main actors were RFID-related equipment (debut actors) and the orderlies from SSD/CSU (supporting cast). After tagging, the users tested the tracking process by walking the tagged equipment through the gateways, and tested if they were being captured correctly in the *MobileView* interface. Subsequent to these tests, the pilot was launched.

The heads of SSD and CSU informed the orderlies that the equipment was now tagged, and there was an interface to track the equipment. They were required to use the interface to track the equipment instead of trying to do this manually. The pilot then took place. At this stage, other than a common briefing, the users of the RFID tracking system, (i.e., the orderlies) were not consulted nor given any specified training for the new system. One orderly was given a briefing by the head of the department, and he had to inform others and also briefly show them the system.

4.3.7 Scene-6: Post-implementation Review

After the pilot was deployed and tracking was done sufficiently to collect data on the system, the ICT department, along with the external team, interviewed users (orderlies) in SSD/CSU and nurses. The users/nurses are multiple in this scene; however, they all voiced the same opinion through a survey synthesised by the external vendor organisation.

External/ICT team: Do you think that the current workflow solution with RFID tags, improves your productivity (reduces/eliminates the time you spent on searching and tracking the equipment)?

Users/Nurses (in one voice): Yes (60 per cent), No (40 per cent).

External/ICT Team: Please share your observation/experience on the area of improvement.

Users/Nurses: The location is often lost in MobileView, so often 'can't find equipment' easy to find trolleys which are tagged, instead of looking floor to floor we need a list of devices name/serial numbers as unable to find devices without this needs to be named more accurate on the system. This coding makes it difficult in an emergency

External/ICT team: In your opinion, what aspect of current workflow solution leads to most wasted time?

Users/Nurses:

- *searching for equipment*
- *trying to find what a particular piece of equipment is named in the system*
- *equipment not entered in the correct areas where they are located*
- *finding equipment & unorganised parts*

External/ICT team: Do you think that the current workflow solution enables and effectively assists you to handle more orders?

Users/Nurses: Yes (60 per cent), no (40 per cent)

External/ICT team: Do you think that our workflow solution improves the equipment availability?

Users/Nurses: No (80 per cent), Yes (20 per cent)

External/ICT team: What do you think needs improvement.

Users/Nurses: It takes too long to look up–easier just to go look for them. We are able to locate equipment more quicker…system need to be more user friendly. It is good to tag trolleys with equipment, but trolleys are not easy to trace via this system. It is quicker to get parts separately and not search for trolleys.

External/ICT team: Do you feel that patient throughput has improved, due to reduction in waiting time and therefore, this system helps improve quality of care.

Users/Nurses: Yes (100 per cent).

External/ICT team: Could you suggest other improvements?

Users/Nurses: The accessibility could be extended to nurses (says the orderlies), so they can also track equipment in emergencies. The system should be integrated, so we can also view Public hospital and other areas for tracking. Small equipment should also be tagged. The system should be in clinical workstations with no password to access it, so as it becomes easier. The accuracy of location also need to improve, it would assist the pager in letting orderlies on the floor know where the equipment is…integration with pagers.

User from SSD: I used the system four times and I found the device each time. The map actually showed the device about five metres away from actual location, but I managed to identify the device that left the building at Level Five. One occasion the device appeared to be on Level Eight, but it was really in the Public hospital. The interface is bit confusing, I would use it more if it was integrated and easier. A snapshot of the selected items would make it easer to locate. It is recommended to configure events to alert technicians of device presence at the lift areas for proactive collection. It has improved overall equipment availability by 60 per cent, reduced rental costs and search time reduced 15–20 minutes.

SSD Head)/user: It would be good to tag all assets, including small items. Small tags would be great. It is definitely a good solution–if the decision was mine, I would implement it in all the hospitals.

CSU users (orderlies): It did help with finding small items quickly, saved time when searching by about an hour. However, it takes 10 minutes to use the *system to locate the assets, slows down the workflow. It saved me 15 minutes to find a trolley though.*

CSU users (orderlies): Need to create a better application. Need more location accuracy, maps are out of sync. It needs to integrate with our pagers. A couple of times, I have been misled about location.

CSU Head: The system not used…orderlies look at the storage area and they have a mental picture of the locations; however, the system could help for the night collection. It needs to be integrated fully, and orderlies need to be trained very well. A better interface integrated with deLacy would help. If it was my decision, I would only use it if it is taken up by SSD first, or perhaps other areas.

After these interviews, the external team left the private hospital on the premise that the hospital will inform them when they are ready to undertake a full deployment of RFID tracking in the two hospitals, and the board approves funding for the same.

In summary*,* the hospital had begun a pilot implementation of RFID integration with the existing hospital information system, with the support of a major vendor, Intel. One of the pilot deployment's main objectives was to demonstrate the usefulness of this technology, when translated into the context, for improving collaborative care. More importantly, it was an aim that if usefulness was demonstrated, the ED in their public hospital, would take up this technology. The ED was definitely in need of tracking support, but they were unconvinced about the usefulness or adaptation of any innovation in their context.

The pilot was deployed in two major areas, SSCV and CSU, both of which support emergency and theatres in the private hospital. The main stakeholders involved were the patient care orderlies, who moved equipment and patients. While the sterilising support had to ensure the apt supply of sterilised equipment, the orderlies (who were reporting to the CSU) had to ensure that the equipment and patients were available in time, for treatment, whether surgery, wards or clinics (to consult with a doctor). When the pilot was deployed, not all equipment (even high-value or frequent use) could be tagged due to cost constraints. The vendor gave a limited supply of tags and related technologies to the hospital for tracking. Equally, the placement of tracking equipment also meant it was not possible to trace certain locations due to a lack of coverage.

More importantly, the vendor recruits, who redesigned the processes as per their perception without consulting the end users, conducted the deployment. In addition, the RFID integration to hospital information systems did not take place, and the pilot became a stand-alone project. In short, although 90 per cent of the equipment, such as wheelchairs, were tagged in order to track them, the orderlies had to log into a new system that they were unfamiliar with and locate the item using codes. The process thus took more time, making the tasks inefficient. This resulted in users ignoring the RFID system completely and going about their tasks as usual (e.g., finding a wheelchair manually). There was non-alignment of strategic needs, user requirements and perceived benefits from the technology. Therefore, users abandoned RFID after some time.

4.3.8 Act-1 through the ANT Lens

In this section, the summary of Act-One is presented in the ANT framework, identifying relationships formed with RFID as a debut actor.

In this Act, the main blackbox of the hospitals, containing the private and public arms, was opened by an external team, through establishing a relationship with the CIO of the hospital, along with the ICT department and his team. It was then jointly decided that the technology implementation team members would assist them in exploring the business case for deploying RFID-based tracking in the private hospital, focusing on the key areas supporting emergency and theatres. The key areas were SSD and CSU: these departments ran the operations mainly within the hospital. The ICT department, along with the external technology organisation team, met with SSD/CSU departments of the Private hospital, to analyse workflows and tag critical assets for the pilot implementation of RFID in 2007.

The public hospital remained invisible as a location in Scene-1, although it figured in the communication flows between the Intel team and CIO. Specifically, it was indicated that if the pilot were successful in the Private hospital, the main beneficiary would be the ED in the public hospital.

Table 4.3: Act-1: Actors Who Entered and Exited

Human Actors	**Existed**	**Entered**	**Exited**	**Sustained**
CIO (The Champion)	X			X
PM (Technology Company)		X		X
External Company teams		X	X	
Head (SSD)	X			X
Nursing Unit Manager-Private	X			X
Orderlies (Private)	X			X
Nurses (Private)	X			X
SysAnalyst (Implementation Projects)	X			X
Business Analyst				
Cameo				
Wards-in-Charge (Public)				
Head (ED)				
Non-human actors				
RFID Tags and Equipment The Debut Actor		X		X
RTLS Report		X		X
Web Based Clinical System (deLacy)	X			X
Bo-Beep Interface	X			X
Touch Screens				

As pointed out in this table, some human actors existed in the blackboxes, interacting with the human/non-human actors who entered and networked; relationships were formed. At the end of the Act, some of these relationships sustained while others exited, as illustrated in Figure 4.9.

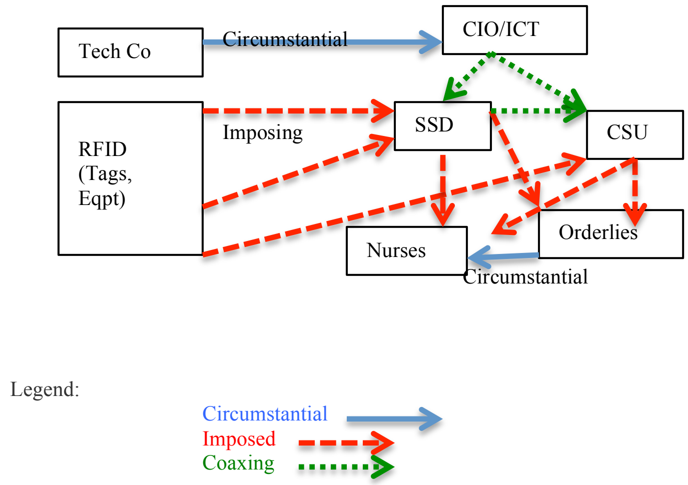


Figure 4.11: Summary of Act-1: Actors, Networks and Relationships

As illustrated in the figure above, I classified the relationships between actors into imposed, circumstantial, coaxing types. There are established links based on these relationships, some of which were broken at the end of the Act. This figure represents only the private hospital, with the two main departments SSD and CSU and the users, namely nurses and orderlies, who were mainly influenced by RFID implementation.

At the beginning, the technology vendor established a 'circumstantial' relationship with the CIO, offering funding. Together with the technology vendor and CIO/ICT department, which also had discretionary funding, they 'imposed' RFID as a debut actor into the private hospital. The CIO then 'coaxed' the SSD department to take on the debut actor (or deploy RFID), and subsequently imposed the debut actor. Therefore, both coaxing and imposing relationships were made at this level. Subsequently, the CIO along with SSD, who accepted RFID as a debut, also coaxed the CSU department to take on the debut actor, RFID. In addition, CIO and his department also imposed the debut on the department. In summary, RFID as a debut actor was imposed into the Private hospital by CIO, influenced by a circumstantial relationship with the technical company. The CIO also formed a coaxing relationship with the departmental heads to take on the pilot deployment with the debut actor RFID. In terms of ANT, the CIO was essentially the 'champion' who spearheaded the debut of RFID in the hospital.

While the department heads established an ‘imposing’ relationship with the users, it can also be perceived that due to the nature of the work involved, the orderlies had a ‘circumstantial’ relationship with the nurses. That is, coaxed by the CIO, the SSD head had RFID imposed on him. He then imposed RFID on the department, particularly the orderlies who moved the equipment and assisted patients. The SSD head then established a coaxing relationship with the head of CSU (who was also coaxed by the CIO) and had RFID imposed in his department, which was then imposed on the orderlies and nurses as the human actors. The nurses’ duties involved requesting the orderlies to find equipment, which were tagged with RFID. Earlier, the orderlies had to find the equipment ordered by nurses, while RFID enabled tracking and tracing. At the end of the RFID pilot, the orderlies suggested that as the nurses had visibility regarding RFID-tagged equipment, they could also send the location of the given equipment through pager messages in terms of need. This would enable the orderlies to find the equipment faster, making their work more efficient, nonetheless changing the process slightly. Therefore, RFID, which was imposed on the users, also enabled a circumstantial relationship with orderlies and nurses to potentially improve the processes.

The relationship between the two departments (i.e., SSD/CSU) and external teams remained throughout the Act-One; however, this was broken at the end this Act when they exited the hospital after the deployment of RFID. The relationship or link was broken. RFID as an actor remained in the scene, although invisible. In the background, the conversations between SSD/CSU heads of department and CIO/ICT department continued on exploring how RFID could be deployed for the full benefit of the hospital. The *circumstantial* relationship formed between the External Vendor and the CIO also remained, although invisible to the hospital blackbox. The communication between the department heads (actors), CIO (actor) and orderlies/nurses relating to the deployment of RFID as an actor continued to develop.

According to all concerned human actors, no other technology deployment was talked about for this long and over such a sustained period. Credit must be given to the influence of RFID as an actor that had built confidence in the mindsets of all actors regarding its potential ability to improve their processes. As a result of these recommendations, it was proposed that a business analyst (BA) be introduced to handle the project, initiating a new relationship link from ICT to these two departments, enabled by RFID, the debuting actor. The proof-of-concept was positive, and RFID as a debut made an indelible impact and remained in the minds of all concerned within the blackbox of the hospital.

4.4 Act-2: Tracking the Disappearing Debut Actor (RFID)

In relation to RFID deployment, the top of the blackbox was closed after this scene for some time before the entry of the Cameo. Scene-Two begins with the entry of the Cameo (myself as 'I') to explore this situation, resulting in opening the blackbox again. The visit resulted in new relationships/linkages being established in/between the private and Public hospitals, renewed relationships between existing/fading actors.

In this scene, I had entered the site (as Cameo actor) with a view to explore the current innovation translation into the context with RFID as the debut actor. All actors concerned in the context were interviewed and presented in the following acts, which draws some conclusions.

4.4.1 Scene-1: Meeting with ICT/Strategists at the Hospital

Cameo: *Could you explain the RFID deployment and where you are at this time?*

CIO: *As you have seen in the report, the pilot was deployed, and some data was collected after the implementation. These were essentially to draw improvements needed before final deployment. But we have some time to decide on a full deployment because we need further funding and a clear view of what changes need to be made to include the two hospitals.*

Cameo: *So currently, you have halted RFID full deployment at the private hospital?*

CIO: *Yes, we have. There is no clear picture as to what were the issues with the new technology…you see, the departments no longer use the interface to track the equipment. The equipments are still tagged, but the users are tracking the assets manually. We don't know why they don't use the system. Perhaps our new business analyst can throw some light on this…*

BA: *Well, I joined after the deployment of the pilot. David felt that there is no communication with the users in the departments or hospitals, or rather their views are not reaching him. Perhaps it is due to the fact that only heads of departments speak with the CIO. A strong need was felt for a 'go-between' person, who is also a technologist, at the same time a business/strategy analyst, who can gather requirements/feedback of users of the system and revise it in terms of today…*

Cameo: *So, it will not be out of place to say that it was RFID that brought you into this hospital?*

BA: *Yes, very true. I have spent 15 years in the profession, in hospitals and the CIO wanted someone who knows such contexts for revising the radical technology being deployed. At the beginning, when I was given this project, I noted a key problem. When a technology is introduced in hospitals, usually it is not by pilot/business case, which is then approved by the board. Yes, it is necessary at some later stage. However, at the beginning, department champions (mainly heads or users) need to speak to each other and promote it. For this to happen, they need to have played with the technology for some time. If one department takes it up, promotes it to the other, it can spread. However, if there are no champions, it is unlikely to succeed, even if a pilot built the case for it. This is what has happened here.*

Yes, there was a pilot, it built the case for RFID. However, the users ignored the system—mainly due to the infrastructure issues and their own non-involvement. And the result was that it was abandoned after a *year. RFID tags are still there, equipment is still there; however, no one is tracking equipment using it. Perhaps we can get further insights from the department heads…they have been promoting the use of RFID, without too much success.*

At the end of this conversation, the BA took me to meet the head of SSD.

4.4.2 Scene-2: Meeting SSD

Cameo: *I hear that you are the person who has been promoting RFID in this hospital. Can you elaborate?*

Head-SSD: *Yes, when the pilot project was launched, I was really pleased because tracking equipment is one of the key issues in the hospital. And I also felt that the technology had much potential. SSD experienced major time savings as a result of the RFID pilot. The time taken to search the equipment in particular has been reduced. Most of the equipment are of high-utilisation nature, and need to be sterilised and reused continuously…these equipments would need to be loaned or purchased and stocked in excess to optimise staff time spent in tracing them. With the RFID deployment, the process of day-to-day work became more efficient…much time was being saved through better equipment recycling.*

Cameo: *So, your department is still leveraging on it?*

Head-SSD: *Well, unfortunately, no. Our technicians and the common orderlies (shared in the hospital) found that the location was inaccurate, so after a few times they decided to revert to the manual process again.*

There were a few problems with continued use. The tracking system cannot detect small devices, which have high utilisation…they tend to get lost under patient beds.

...Most of our staff tend to be part time, casual on shifts. Very few are permanently employed and full time. So their interest in learning new things are minimal.

The MobileView Interface was cumbersome and because it is not integrated with Web deLacy, the users felt that they needed to learn yet another interface, which delayed them further by 10–15 minutes in actual time as well. There is a new interface, passwords and then the item needs to be located on the system. By the time it was already 20 minutes, and the orderlies found it much easier to go physically find them. Also, being casual/non-permanent staff, they don't really get trained or apprised about the technology. They just come in shifts, follow pager messages—and really don't want to do anything else. Training means they need to spend time, and the hospital needs to spend time on them, and money.

Cameo: *So what is your opinion with the future of RFID here?*

Head-SSD: *Accuracy of location needs to improve. We have to tag all equipment available, including small devices, meaning we need small tags. And then integration with Web deLacy need to happen. You see, this enables pagers to be integrated too—which might then help orderlies.*

Cameo: *So what do the orderlies think at present? Why are they not using it?*

Head-SSD: *I think you need to have a chat to the orderlies themselves. They are on the move always, and most of them have shared duties with CSU. Perhaps, talking to 1–2 key orderlies may help voice their opinion. They have been there since the pilot, and are actually full time. Best is to meet with the CSU Head and take it from there.*

Cameo: *Ok, I will do that. Do you have any further inputs on the situation, as I understand you are one of the promoters of this technology in this hospital?*

Head-SSD: *Potentially, RFID tracking system could be integrated into other areas such as bedside applications/monitoring and extending into remote monitoring our multi-hospital environment, where patients do tend to 'wander away'.*

The extension into patient monitoring and after-care support is another area, which could bring in better efficiencies for the hospital.

…Patient and staff tagging—Maybe…

The potential of RFID is much more…for example, there are RFID implants in prostheses that is now possible, and if this is done with the support of vendors, the specific prostheses to a patient may be possibly done without bringing the patient into the hospital each time…makes the process more efficient, saves time and additional costs.

4.4.3 Scene-3: Meeting CSU Head, Orderlies and Nurses

On the advice of the SSD Head, the Cameo approached the CSU Head, who was also in charge of all the orderlies.

Cameo: *I hear from the head of SSD that the RFID tracking is almost abandoned now. Can you throw some light on this?*

CSU Head: *I had advised the orderlies to trial the system with a view to switch eventually. However, most orderlies don't seem to bother with it. They seem to think it is a waste of time and effort. Perhaps you can speak with some of them to know the real issues. And also, speak with some of the nurses—so we have another viewpoint.*

Orderlies: *I can't be bothered…by the time I look up the computer, find a wheelchair on level 10, reach there, someone has taken it…what is the point?*

This RFID tracking system is not incorporated with the Clinical Support System…so we have to understand/cope with a new interface…we work on shifts, part time and most of us are casual…learning a new interface is not our priority. We rather use the tried and tested system, which is easier.

We receive orders for equipment, with patient details on a pager. For using the RFID tracking system, we have to then look up a computer at the workstation. However, we are always on the move, often not near a workstation. To use this system, we have to find a closest workstation first, then spend time looking up the system for the equipment (such as a bariatric wheel chair, considered high-value/scarce equipment). Frankly, it is a lot easier to manually look for the equipment, which may be available on a corridor, and then transport the patient to the destination…more efficient!

We are used to taking orders from a nurse on the phone at times…and find the equipment down the corridor where it usually is…by the time we track a wheelchair that may be on level 10 and get there, someone may be have already taken it…then we have to go hunting again for another one on another floor…it makes us waste a lot of time!

We work here part time, learning a new thing during this time is rather difficult…it disrupts our work and time…I rather continue with what I do know…unless it is a norm…why learn a new thing, which may not even be implemented in future or rather replaced or integrated into the old system—which then means there will anyway be another interface to learn!

We work on pager messages, sent through by nurses. If the message also contained the 'location of the equipment', it would be better. The messages usually contain the equipment that is required to be transported along with the patient. We take the patient and collect all *the equipment on the way. If this message really also came with the 'location of the equipment'—I feel it is much more optimal—saves us the time looking up the computer. Anyway, all the information comes in the pager message—why not just add this information? It is much easier for the nurse who is already looking up the rest of the information and sends us a message to do this.*

Nurses: *We have to still look for equipment, hide some important ones, so we can find them in need. Orderlies still seem to take the same time, except in few occasions.*

Cameo: *What is your opinion about integrating the orders along with location, when it is sent out to the pager of orderlies? They seem to think it is more efficient as you already have access to the system when you are sending the order, it is only another additional step. If they know the location as well, it is then a matter of picking it up. Saves time and the orderlies really do not then need to be trained. You already have all the information.*

Nurses: *Finding things like wheelchairs is not my job—it is their job. We already have sufficient work and rather spend the time with patients instead of spoon-feeding the orderlies. If they cannot find the equipment in time via the interface, let them go hunt for it. They know all the hiding places anyway.*

4.4.4 Scene-4: Meeting Technologists/Strategists (including CIO)

Subsequent to the conversations with the SSD and CSU heads, orderlies and nurses, the Cameo approached the ICT department, where the technologists and strategists were located. It was felt that their opinion on this implementation was valuable.

Cameo: *Let us go back into history a bit. Why was the pilot deployed (objectives/rationale)?*

CIO: *The need for RFID and its potential benefits for the hospital was recognised by me mainly through vendor information. The hospital itself had 14 years of experience with developing the Web DeLacy, a clinical information system and using the same within the hospitals. A key module in this is the clinical resources support module, which supports the Patient Care Orderlies to track patients and move them point-to-point along with necessary equipment. This is the module where RFID was proposed, mainly to tag movable equipment that is highly used for patient transport.*

Subsequently, a business justification team was formed with representatives from the selected vendor (external team), us (the hospital) and the Australian Centre of Health Innovation (ACHI). However, the effort of performing the preliminary assessment, deriving metrics and associated KPIs, collecting base line data, conducting in-depth interviews with key stake holders—were performed by the external team. I was in the role of ensuring that the technology benefits of this pilot were aligned with the business objectives of the hospital.

The external team used its Health care IT (HIT) Economic Model, which is a patent-pending tool based on a method it had originally developed to measure the value of its own IT investments for deployment of this pilot. Clinical and financial analysts in their company Digital Health Group have adapted it for use in hospitals, which want to make the business case for proposed investments and/or measure post-deployment benefits. The model is based on the belief that IT investments must support strategic goals. Benefits are measured as improvements compared to a current baseline.

Cameo: *How many items were tagged and which were the key items for analysis?*

CIO: *Fifty-one of 318 assets that were considered as part of the movable, high-value items in the two departments were tagged. The detailed* *analysis for benefit realisation was carried out on three most requested CSU items, namely oxygen regulators, portable weight scale and patient transport trolleys. Active RFID tags were attached to high-value and high-utilisation assets, including a group of critical equipment and patient transport equipment (such as wheelchairs) and selected patients within the premises, including the operating theatre and radiology departments. The tags were also attached to selected loan assets such as infusion pumps and ECH machines.*

Cameo: *Which areas were covered and what was monitored?*

CIO: *The tracking of the RFID tags took place through the five in-patient floors of the private hospital, theatre complex and Radiology Department, storage area in level 4 and the Sterilisation Department. The impact on workflow was monitored in two areas: Clinical Support, that is involved with patient movements/transport; and Sterilising Services, that is involved with sterilisation and supply of critical/high-utilisation equipment on a regular basis to relevant areas.*

The pilot was a proof-of-concept aimed at benefit realisation and hence had some constraints. The RFID tracking system was not integrated directly with the clinical support resource management system during this pilot. Rather, the RTLS was deployed with its own web-based interface, which was then used by the orderlies/SSU unit members to locate resources within the hospital. The rationale were that: (1) this typical implementation would cause minimal disruption, (2) users could manually locate resources if necessary, and (3) the system could be tested for effectiveness, user-friendliness and with refinements deployed fully in the hospital, covering all areas. Furthermore, since all the areas were not covered in the pilot, the location accuracy was not 100 per cent, and this was already noted before implementation.

The success of this pilot was evaluated on a set of criteria such as:

- *demonstrating the real benefits to hospital staff (users) and processes*
- *increase in process efficiency and asset utilisation*
- *reduce staff frustration in finding equipment*
- *demonstrate the capability to assist with patient risk management (i.e., real-time confused patient location)*
- *ability to track patient/assets on each floor of the hospital, then each wing and each room; (6) demonstrate the reliability and discrimination of the system*
- *assist in specifying number and location of access points to minimise infrastructure investment trade-off with location accuracy and*
- *successful level 1 integration with the hospital infrastructure.*

There were two key service areas, which had contained users/user managers—key to the pilot—known as Clinical Support and Sterilising Services Unit. The key process involved the users (patient care orderlies), who transported equipment with and without patients.

Really, it was an attempt to study if the technology can be exploited for better efficiencies, cost and time savings…and it was easy to deploy the pilot with the support of Intel, as they had the implementation plan, phases, baseline planned…and the technology was being tested…without much constraints to our budget.

Cameo: *Were there issues already known before implementation, from a strategic or technical viewpoint?*

CIO: *The pilot did not cover all the areas completely, so if the orderlies had to trace the equipment, they would find it in the vicinity, but a few metres away maybe…that much less accuracy was expected in a pilot.*

The external vendor as a trainer was not exactly the best fit…he was not a people person…and really did not empathise with the users…but we still decide to go with him.

A full-scale implementation was only possible after the potential was demonstrated at a basic level…this objective was achieved.

Cameo: *What were the key issues that were noted after the pilot?*

CIO: *Learning a new interface, particularly if that was going to be changed again…is rather an ask from the users…we noted this so that we can come up with a user-friendly interface, integrated to the clinical resources support system.*

Technologist: *The accuracy of location is being considered carefully…however, 100 per cent accuracy is still not expected…relative accuracy is what we think is achievable…the orderlies may still find the piece of equipment in the room, it may be behind a bed, or few metres out of sight…perhaps we can improve this through the antenna placements and other ways.*

CIO: *Involvement of users are required…we are very aware of this issue…however, the initial pilot had to demonstrate the potential—only then we would have thought of involving users in preparation of a full-scale implementation—particularly in emergency department—there was no experimentation possible there.*

Overall, the technology has demonstrated potential…time saving, which translates into reshaping the processes and cost savings…it is just the case of optimising it.

Cameo: *Can you comment on the orderlies' view about chasing equipment across floors—which may never be found or gone before they find it?*

CIO: *On every level, there are sufficient number of wheelchairs present…so if the nurse needs a wheelchair on level 10, an orderly can easily locate it on level 10…he does not need to go from level 3 to level 10 just because a nurse from level 10 has ordered a wheelchair to take a patient…it is just that the orderly wants to chat up the nurse…that is the real reason!*

Technologist: *The take-up of the tracking system effectively would mean that the user-friendliness of the system needed improvement. This can only be achieved on deployment of a full implementation covering all the hospitals, rather than some areas…which is the limitation of the pilot.*

Technically, it is possible to address the location accuracy problem—antenna placement is one of them. RFID is a dynamic technology; it is evolving…we need to be aware of the infrastructure needs, revising tags into smaller ones—specific for hospitals and so on.

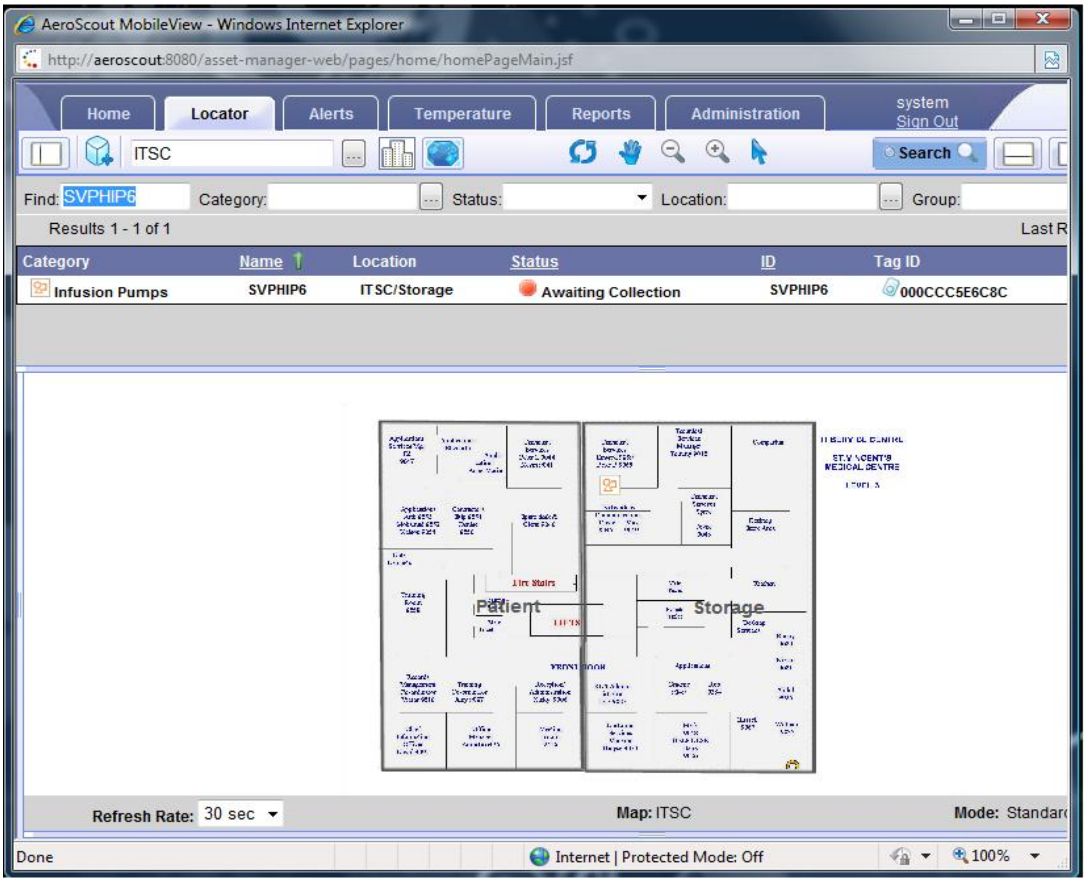
Integration with the clinical resource support system, which eliminated the need for users to learn another interface (particularly that the users are mainly part time and casual staff) is imperative for the continued use of RFID tracking system…then we can achieve time and cost savings…reshape the processes more efficiently.

Cameo: *Is there any further potential to exploit this technology?*

Technologist: *Potentially, RFID tracking system could be integrated into other areas such as bedside applications/monitoring and extending into remote monitoring our multi-hospital environment, where patients do tend to 'wander away'. The extension into patient monitoring and after-care support is also another area, which could bring in better efficiencies for the hospital. We could easily consider this for further implementation.*

Cameo: *As a BA, could you please explain something? It seems that the interface for location tracking, namely MobileView, was not favoured at* *all. Have you found an alternative to this for better integration since you are now in charge of further deployment?*

BA: *Yes, instead of MobileView, we have developed Bo-Beep, which is also something the nurses use already in both hospitals and integrated with deLacy. We are trying to integrate RFID tracking to eliminate MobileView altogether. The location tracking module has been tested with [a] few orderlies, who found it an improvement of course, but the location mapping is still with codes on items…we need to have some sort of an improvement so that they don't need to memorise codes now. Here is a comparative image.*



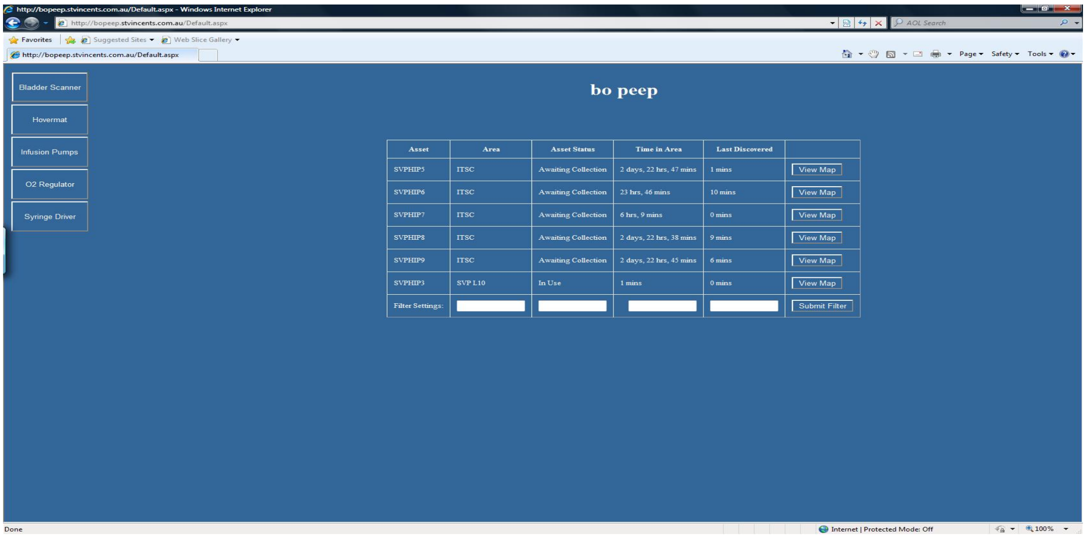


Figure 4.12: Mobile View *v*. Bo-Beep (source: Internal Screen Shot from the Hospital).

Cameo: *What are your general views on this situation with RFID deployment?*

BA: *I have come in almost after the first phase of the pilot, and has been asked to take on the case…so had a third-person view of the situation…what I feel, from primary observation, is that the pilot was driven by technologists…external and internal…the users were not involved in it. Any deployment has to be business and user-driven…only then the full potential can be realised.*

In my view, using an external company (Intel) for the user training and pilot implementation has caused some strife…the users did not feel comfortable with the idea of new technology being imposed on them without really involving them…and this could be the reason why it is not taken up by users as much. Unless they were specifically asked to use it, they rather not…technology-driven approach is not conducive to this environment…it is the users who need to embrace the technology to exploit its potential.

At this time, the PM (Tech Co) made a guest appearance to meet with Cameo at the request of the CIO.

Cameo:	*What are your experiences with RFID implementation of the pilot?*
PM:	*The pilot was successful; I think everything worked well. Orderlies were happy; so were the nurses.* *There were only technology integration issues…the orderlies do not really understand new technologies…so there need to be some training…we can provide that too…just waiting for full deployment and cue from CIO.*

In summary, it was evident until the end of Act 4 that if RFID needed continuum, the technology integration, or rather training using the new interface, which was then incorporated into the hospital system, had to be in place. The technology integration issue had to be addressed to reap the benefits from RFID. As key users, the orderlies were reluctant to change their method of working due to the technology-induced change. Unless there was some incentive, they could not be bothered learning a new skill, particularly when it disrupted their routine. The heads of departments felt that if RFID was integrated with the hospital IS and that training was provided to staff, the technology could enhance their workflow, resulting in time and cost savings. Technology implementers concurred with the users' view; they indicated that the implementation of the pilot was driven by technologists and not the end users. In such environments, users are the major catalyst of success to effectively reshape processes, so they needed to be involved in shaping the deployment.

The efficiency of accurately tracking equipment and small devices from a location was not possible until a full deployment was completed. However, was this aspect the only requirement for completing the technology integration? The technologists expressed that there was a need for user involvement in reshaping the process flow, integrating the user interface and making it user-friendly, and there was potential for further technology exploitation at the next level.

The strategic managers expressed that the technology could be deployed to track resources and patients in the future, and this would reshape the processes within the hospital and make them more efficient. The staff time would be recorded more efficiently and their work processes would be enhanced, resulting in time and cost savings. However, users felt that they were not involved in conceptualisation, while the internal technology integrators felt that there was more potential for RFID and that accuracy could be better handled if user involvement was higher than that of the external vendor. The senior managers of the units also felt that more could be achieved through user involvement if the technology and needs of the hospital were better aligned.

From the brief conversation with the Intel representative, the Cameo felt that he was perhaps oblivious of the issues involved. There was also no recognition of the real issues; rather, there was disdain, which resulted in the department heads and users breaking their relationships with Intel. Most of the staff did not want to acknowledge or talk to the person when he visited the hospital, as arranged by the CIO, to meet with the Cameo.

The Cameo observed that the orderlies had a communication channel with the nurses, who they interacted with most of the time; this added to the work culture. RFID may act as a rein in this implicit work culture, making the process flow efficiently. How important is it to the hospital—in relative terms to cost/time saving and process efficiencies? Perhaps users could be involved in the future implementation and exploitation of technology.

Subsequently, the Cameo revisited the SSD head, who had championed RFID. He had suggested a revisit to improve the understanding of the processes within the department. The visit was to consider the department structural redesign to suit full-scale RFID deployment.

4.4.5 Scene-5: Revisiting SSD and meeting with Head-SSD

Cameo: *You mentioned interest in being the pioneer for a structural redesign of processes involved in the department for implementing RFID. I would like to begin this by understanding the processes. Before that I would like to understand the department bit better.*

Head-SSD: *This department is critical to the hospital. For example, if there is a broken instrument, damaged item, unclean item, it wastes time, and if overlooked, it can be at the cost of a life. If the instrument or equipment is not available on time, it becomes a serious issue, costing life and death situations. Therefore, patient life is compromised without the due processes working efficiently in SSD.*

Cameo: *How about the equipment? Does SSD own it?*

Head-SSD: *SSD does not own all the equipment, but some are owned by it. These are kept in the storage room. The central area for storage holds all equipment and instrument inventory, which is then shared by all the hospital departments.*

Cameo: *So what does it do mainly?*

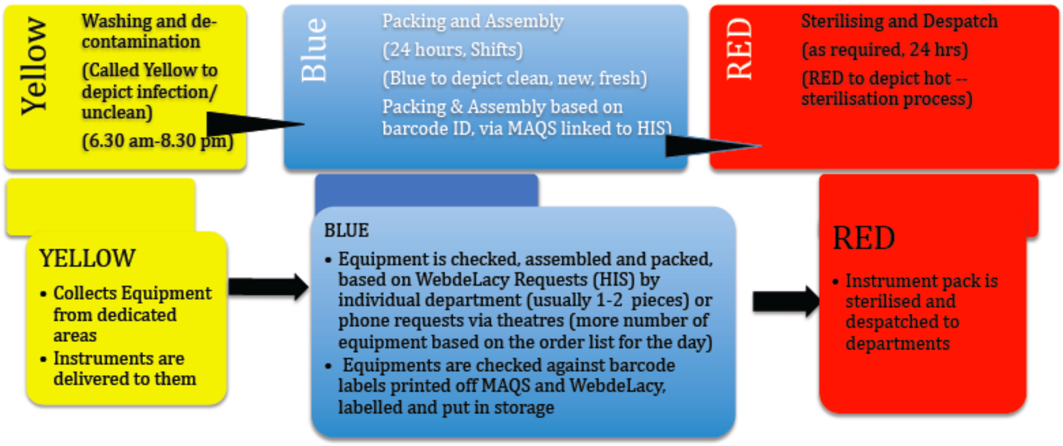
Head-SSD: *the orderlies collect equipment from a specific area…but often staff need to look for critical equipment required in theatres when it is not available, which takes away their time in conducting the process of sterilisation regularly.*

RFID enablement would help locate high-value equipment, as well as equipment that needed to be sterilised and maintained on a regular basis. The department can be divided into three zones, and mapped as follows.

SSD (Sterilising Services Department)

(Divided into three zones)

(1) FIRST LEVEL DIAGRAM – SHOWING LINKS BETWEEN ALL ZONES & MAIN PROCESSES INVOLVED



2. THE YELLOW ZONE PROCESSES (Level 2)

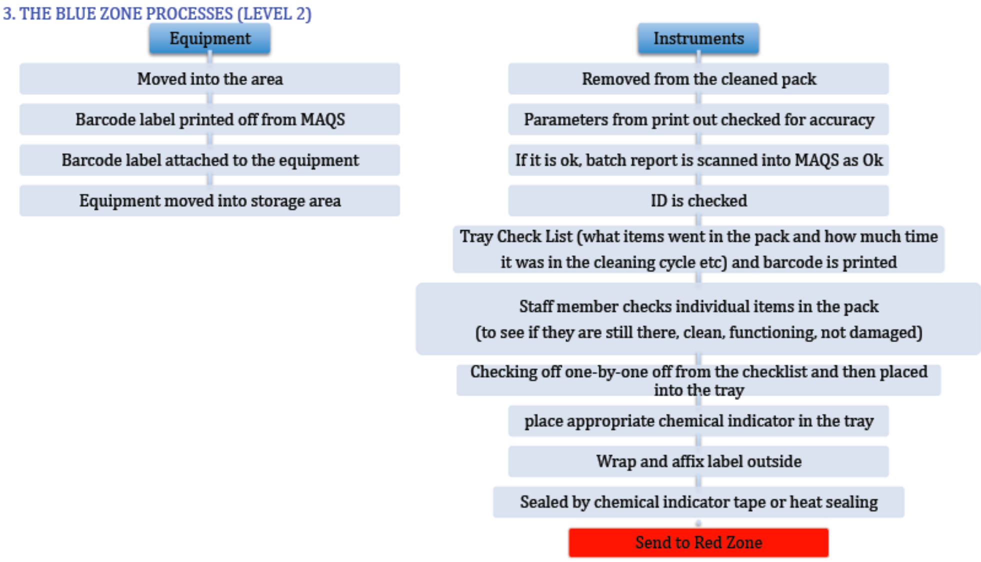


Figure 4.13: Mapping Process Flows at SSD with RFID

Cameo: *I have a few clarifications. Where does the batch report come from?*

Head-SSD: *From MAQs—the tracking system at SSD.*

Cameo: *Is the batch report generated for a batch of items that came in?*

Head-SSD: *Yes.*

Cameo: *Is the batch report generated for different categories of instruments?*

Head-SSD: *No.*

Cameo: *Is the batch report generated for sterilisation process?*

Head-SSD: *Maybe.*

Cameo: *If one item in the batch report is damaged, missing, not clean—how is it reported?*

Head-SSD: *Via MaQs.*

Cameo: *Before getting to validation, does a damaged item get reported? Does batch list alter? What is the process of reporting? Does check list then get altered?*

Head-SSD: *Only manually.*

Cameo: *How does the items get out of the pack and back in?*

Head-SSD: *The day surgery nurses open them. Let us now look at the red zone.*

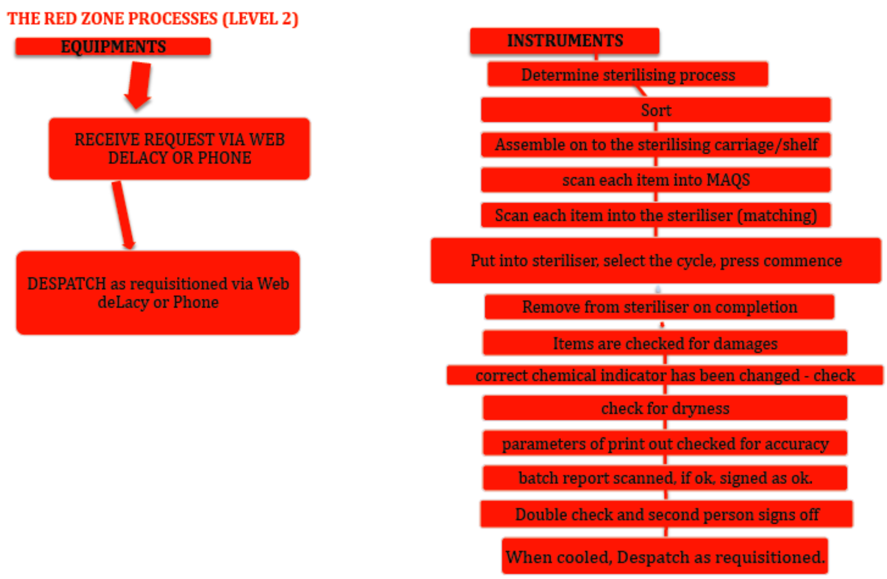


Figure 4.14: Mapping Process Flows in SSD Red Zone with RFID

Cameo: *I have a few more clarifications. How do you handle exceptions? If two items are not in order, does the whole batch get changed?*

Head-SSD: *No, depends on the situation. If there is a tear in wrapper or item is wet 1 item, reject items, not whole load. If steriliser failed then whole cycle rejected.*

Cameo: *So, really, RFID may not be useful for all areas in this department?*

Head-SSD: *Yes, true. For example, the high-value equipment for sterilisation could be tracked and brought into the department, which was valuable.*

However, surgical equipment could only be tagged by a box with a number of instruments, and not specifically by single instruments. Therefore, the RFID enablement for making clinical processes efficient is limited in this department. Nonetheless, the department was expecting to reach the next level of technology (i.e., embedded instruments) such that each single instrument could be tracked for sterilisation. This would mean an investment in new equipment of course, but in the long term, better efficiencies in a private hospital.

Cameo: *I have organised a preliminary redesign for you to comment.*

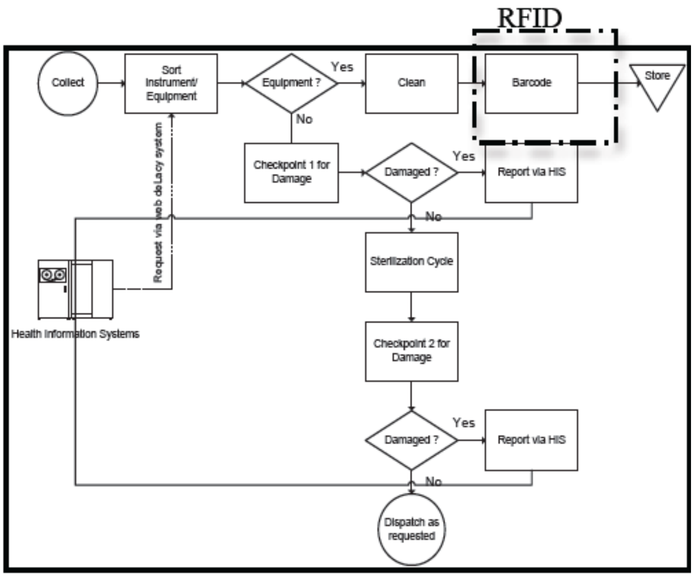


Figure 4.15: Redesigned Process Flows with RFID

Cameo: *I found couple of process areas that need to be redesigned. As depicted in [the] figure, there is a collection point where equipments and instruments are to be taken into the SSD for undergoing the relevant processes of cleaning. The equipment and instruments are sorted separately and they go through different processes. For instruments, the cleaning process is simple: they are sorted, cleaned and then barcode-labelled. I am suggesting RFID tagging instead, so that these cleaned equipment, when then moves into their store (owned by the unit), can be traced quickly when the equipment is requisitioned. The figure indicates the RFID intervention point.*

Equally, if the sorting indicates these are instruments, they are sorted, arranged and placed in trays before sending into the next cycles of cleaning. All the sub-processes of cleaning are not depicted in this diagram.

Nonetheless, RFID becomes relevant is the last cycle, when instruments are found to be damaged and therefore cannot be despatched as required for the relevant surgeries posted (which may be next day).

Head-SSD: *The process works as follows. The requisitions for equipment and instruments come into the unit via Web deLacy, which is one of the sub-systems that are integrated into the Hospital's Information System (depicted as HIS in Figure 2). And the requisitions are addressed the same day. A printout is taken for the required equipment, and these are gathered together, kept in an area for sending next day via an orderly or they are sent out immediately via the person (orderly), who will collect them and take them to wherever required. However, if the requisitions come in towards end of the day for a surgery posted next day, a set of instruments may go into a cleaning and sterilising cycle. When it finishes, they will be available at the end of the day. However, there is possibly no one at the time to check for damages. Therefore, when the orderly comes in to collect the instruments next day morning, it may be found that the instruments may be damaged. Therefore, another set has to be sterilised and given. This causes a delay of anything between half-hour to two hours, which can be very critical if the patient is already under anaesthesia and on the operating table. Orderlies then search for alternatives, resulting in delays.*

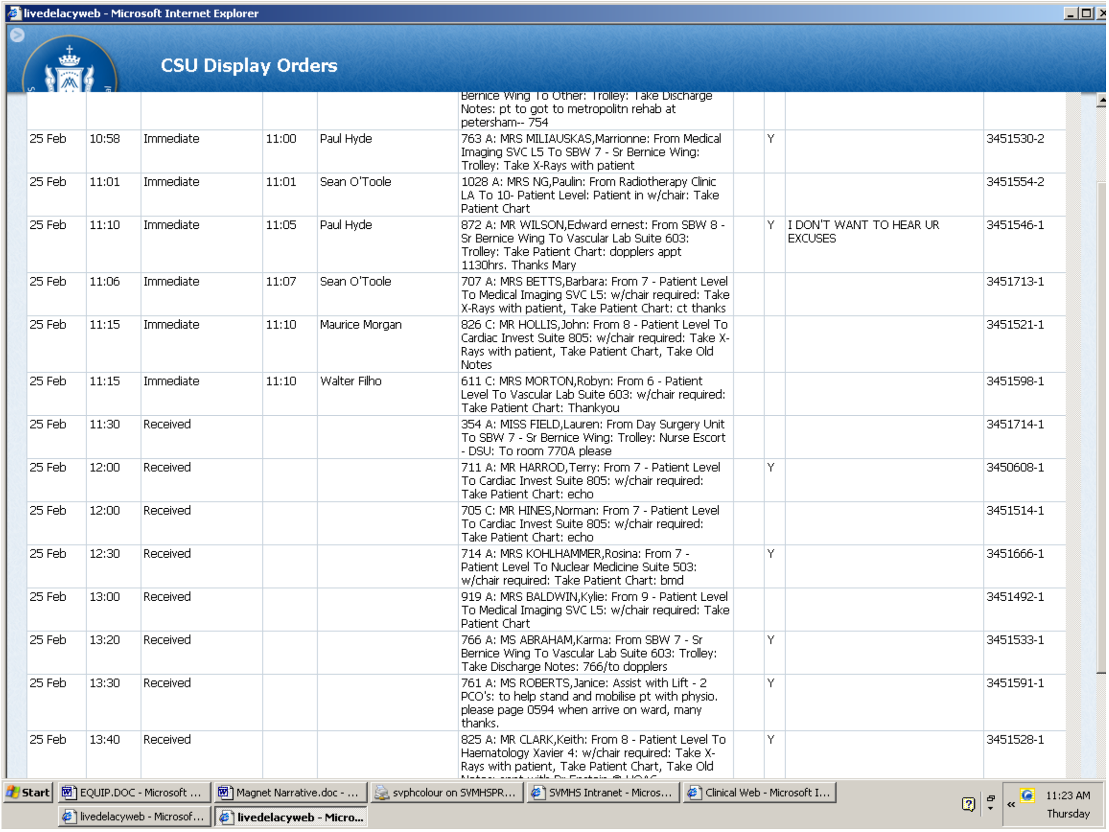
Cameo: *Please note average incidents on delays in finding equipment pre- and post-RFID integration to study the efficiencies. I suggest to redesign the process, where the damage of equipment or instrument is reported via the deLacy the previous night rather than waiting for the next day only to discover that there are critical instruments damaged, causing delays. When MaQs and deLacy is integrated with RFID tracking systems, it* *will reduce the delays in finding alternatives and enable rescheduling surgeries in advance.*

Head-SSD: *Sounds like a good plan.*

Cameo: *However, RFID systems are not 'big brothers' in that they cannot monitor what is being done always. Nonetheless, RFID tracking within the cleaning cycles of the department will also caution the staff to report any damage immediately rather than leaving it for the next day.*

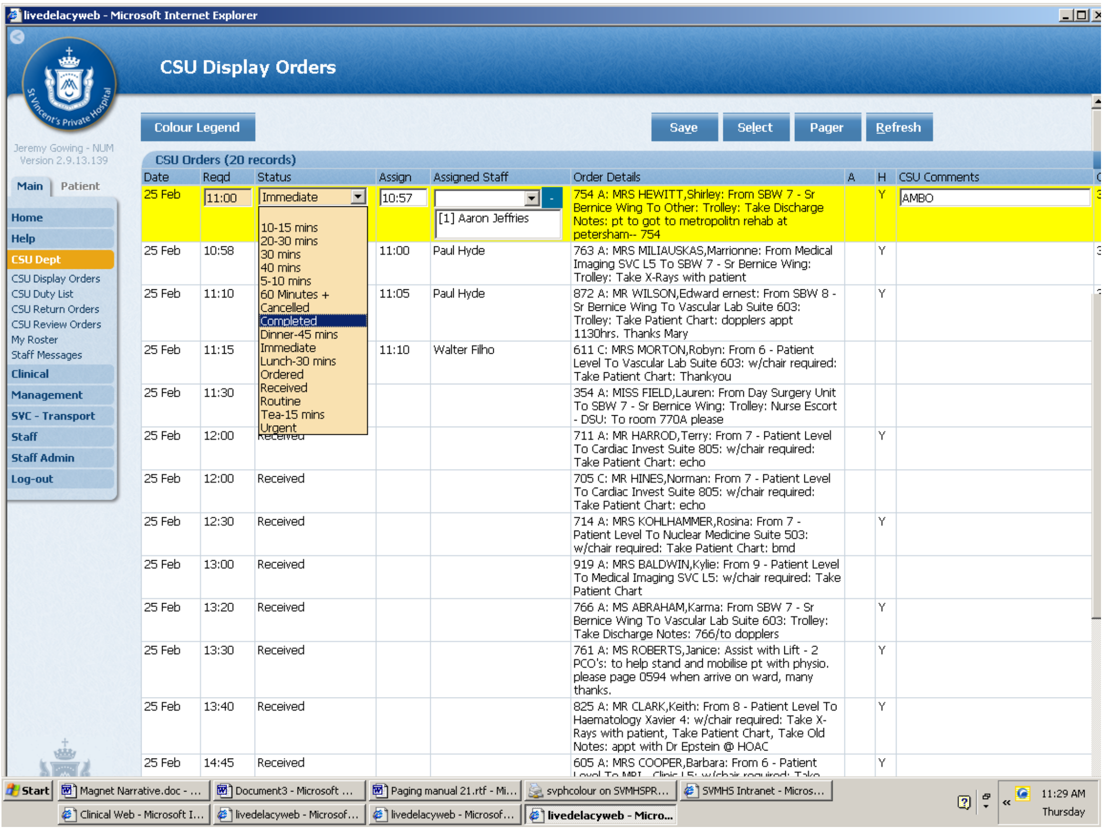
At the end of this Act, I found that the department was well aligned in its expectations with RFID enablement to improve clinical process efficiencies. However, the budget limitations held back any further implementation. The redesign was going through further iterations, but the process had slowed down because the Head of SSD had other priorities. In the meantime, the Cameo also met with the Head of CSU to begin redesigning the processes to enable RFID there.

As a preliminary gesture, the following screen shots were provided to provide an understanding of the processes. The Head-CSU also informed the Cameo that if SSD was happy, CSU was also happy with the redesign. It may be noted that the Patient IDs and relevant information on the screens that follow are 'dummy data' and not real. Hence there is no privacy violation involved in this process.



					Bernice Wing To Other: Trolley: Take Discharge Notes: pt to got to metropolitn rehab at petersham-- 754				
25 Feb	10:58	Immediate	11:00	Paul Hyde	763 A: MRS MILIAUSKAS,Marrionne: From Medical Imaging SVC L5 To SBW 7 - Sr Bernice Wing: Trolley: Take X-Rays with patient		Y		3451530-2
25 Feb	11:01	Immediate	11:01	Sean O'Toole	1028 A: MRS NG,Paulin: From Radiotherapy Clinic LA To 10- Patient Level: Patient in w/chair: Take Patient Chart				3451554-2
25 Feb	11:10	Immediate	11:05	Paul Hyde	872 A: MR WILSON,Edward ernest: From SBW 8 - Sr Bernice Wing To Vascular Lab Suite 603: Trolley: Take Patient Chart: dopplers appt 1130hrs. Thanks Mary		Y	I DON'T WANT TO HEAR UR EXCUSES	3451546-1
25 Feb	11:06	Immediate	11:07	Sean O'Toole	707 A: MRS BETTS,Barbara: From 7 - Patient Level To Medical Imaging SVC L5: w/chair required: Take X-Rays with patient, Take Patient Chart: ct thanks				3451713-1
25 Feb	11:15	Immediate	11:10	Maurice Morgan	826 C: MR HOLLIS,John: From 8 - Patient Level To Cardiac Invest Suite 805: w/chair required: Take X-Rays with patient, Take Patient Chart, Take Old Notes				3451521-1
25 Feb	11:15	Immediate	11:10	Walter Filho	611 C: MRS MORTON,Robyn: From 6 - Patient Level To Vascular Lab Suite 603: w/chair required: Take Patient Chart: Thankyou				3451598-1
25 Feb	11:30	Received			354 A: MISS FIELD,Lauren: From Day Surgery Unit To SBW 7 - Sr Bernice Wing: Trolley: Nurse Escort - DSU: To room 770A please				3451714-1
25 Feb	12:00	Received			711 A: MR HARROD,Terry: From 7 - Patient Level To Cardiac Invest Suite 805: w/chair required: Take Patient Chart: echo		Y		3450608-1
25 Feb	12:00	Received			705 C: MR HINES,Norman: From 7 - Patient Level To Cardiac Invest Suite 805: w/chair required: Take Patient Chart: echo				3451514-1
25 Feb	12:30	Received			714 A: MRS KOHLHAMMER,Rosina: From 7 - Patient Level To Nuclear Medicine Suite 503: w/chair required: Take Patient Chart: bmd		Y		3451666-1
25 Feb	13:00	Received			919 A: MRS BALDWIN,Kylie: From 9 - Patient Level To Medical Imaging SVC L5: w/chair required: Take Patient Chart				3451492-1
25 Feb	13:20	Received			766 A: MS ABRAHAM,Karma: From SBW 7 - Sr Bernice Wing To Vascular Lab Suite 603: Trolley: Take Discharge Notes: 766/to dopplers		Y		3451533-1
25 Feb	13:30	Received			761 A: MS ROBERTS,Janice: Assist with Lift - 2 PCO's: to help stand and mobilise pt with physio. please page 0594 when arrive on ward, many thanks.		Y		3451591-1
25 Feb	13:40	Received			825 A: MR CLARK,Keith: From 8 - Patient Level To Haematology Xavier 4: w/chair required: Take X-Rays with patient, Take Patient Chart, Take Old		Y		3451528-1

Figure 4.16a: CSU Process Flows Part A (Source:Internal)



Date	Reqd	Status	Assign	Assigned Staff	Order Details	A	H	CSU Comments
25 Feb	11:00	Immediate	10:57		754 A: MRS HEWITT,Shirley: From SBW 7 - Sr Bernice Wing To Other: Trolley: Take Discharge Notes: pt to got to metropolitn rehab at petersham-- 754		Y	AMBO
25 Feb	10:58		11:00	Paul Hyde	763 A: MRS MILIAUSKAS,Marrionne: From Medical Imaging SVC L5 To SBW 7 - Sr Bernice Wing: Trolley: Take X-Rays with patient		Y	
25 Feb	11:10		11:05	Paul Hyde	872 A: MR WILSON,Edward ernest: From SBW 8 - Sr Bernice Wing To Vascular Lab Suite 603: Trolley: Take Patient Chart: dopplers appt 1130hrs. Thanks Mary		Y	
25 Feb	11:15		11:10	Walter Filho	611 C: MRS MORTON,Robyn: From 6 - Patient Level To Vascular Lab Suite 603: w/chair required: Take Patient Chart: Thankyou			
25 Feb	11:30				354 A: MISS FIELD,Lauren: From Day Surgery Unit To SBW 7 - Sr Bernice Wing: Trolley: Nurse Escort - DSU: To room 770A please			
25 Feb	12:00	Received			711 A: MR HARROD,Terry: From 7 - Patient Level To Cardiac Invest Suite 805: w/chair required: Take Patient Chart: echo		Y	
25 Feb	12:00	Received			705 C: MR HINES,Norman: From 7 - Patient Level To Cardiac Invest Suite 805: w/chair required: Take Patient Chart: echo			
25 Feb	12:30	Received			714 A: MRS KOHLHAMMER,Rosina: From 7 - Patient Level To Nuclear Medicine Suite 503: w/chair required: Take Patient Chart: bmd		Y	
25 Feb	13:00	Received			919 A: MRS BALDWIN,Kylie: From 9 - Patient Level To Medical Imaging SVC L5: w/chair required: Take Patient Chart			
25 Feb	13:20	Received			766 A: MS ABRAHAM,Karma: From SBW 7 - Sr Bernice Wing To Vascular Lab Suite 603: Trolley: Take Discharge Notes: 766/to dopplers		Y	
25 Feb	13:30	Received			761 A: MS ROBERTS,Janice: Assist with Lift - 2 PCO's: to help stand and mobilise pt with physio. please page 0594 when arrive on ward, many thanks.		Y	
25 Feb	13:40	Received			825 A: MR CLARK,Keith: From 8 - Patient Level To Haematology Xavier 4: w/chair required: Take X-Rays with patient, Take Patient Chart, Take Old Notes: appt with Dr Epstein @ HOAC		Y	
25 Feb	14:45	Received			605 A: MRS COOPER,Barbara: From 6 - Patient		Y	

Figure 4.16b: CSU Process Flows Part B (Source: Internal)

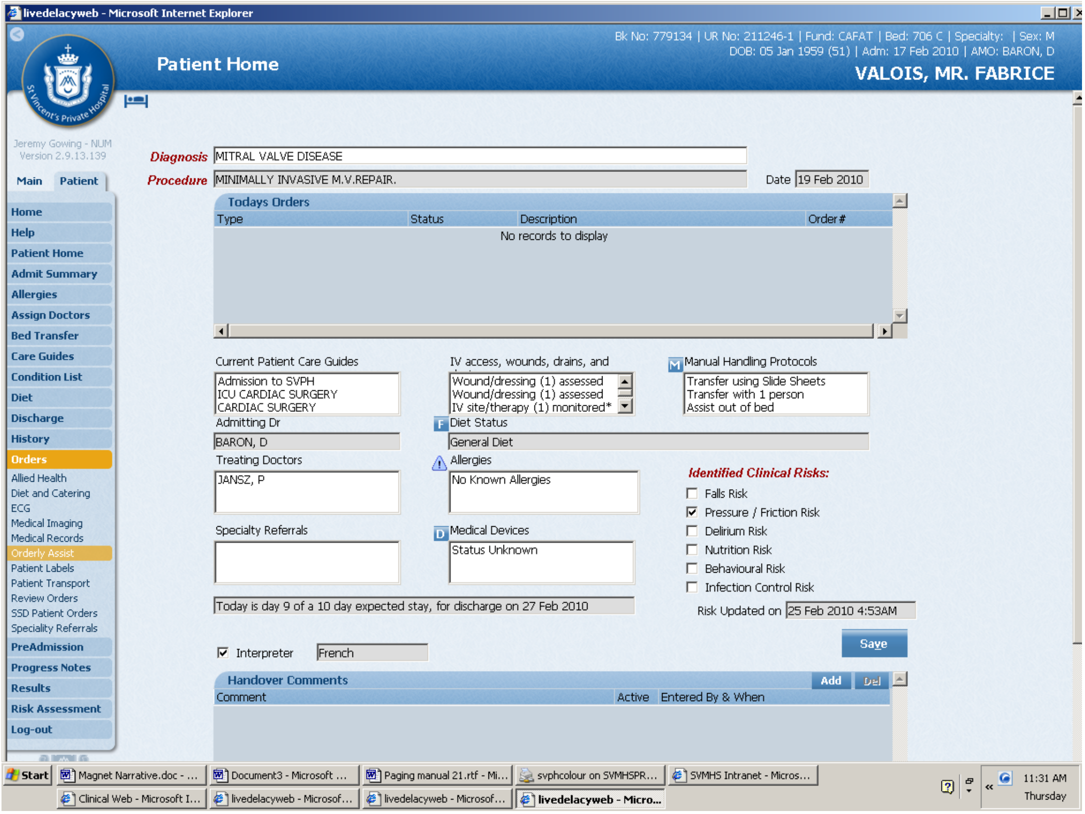


Figure 4.16c: CSU Process Flows Part C (Source: Internal)

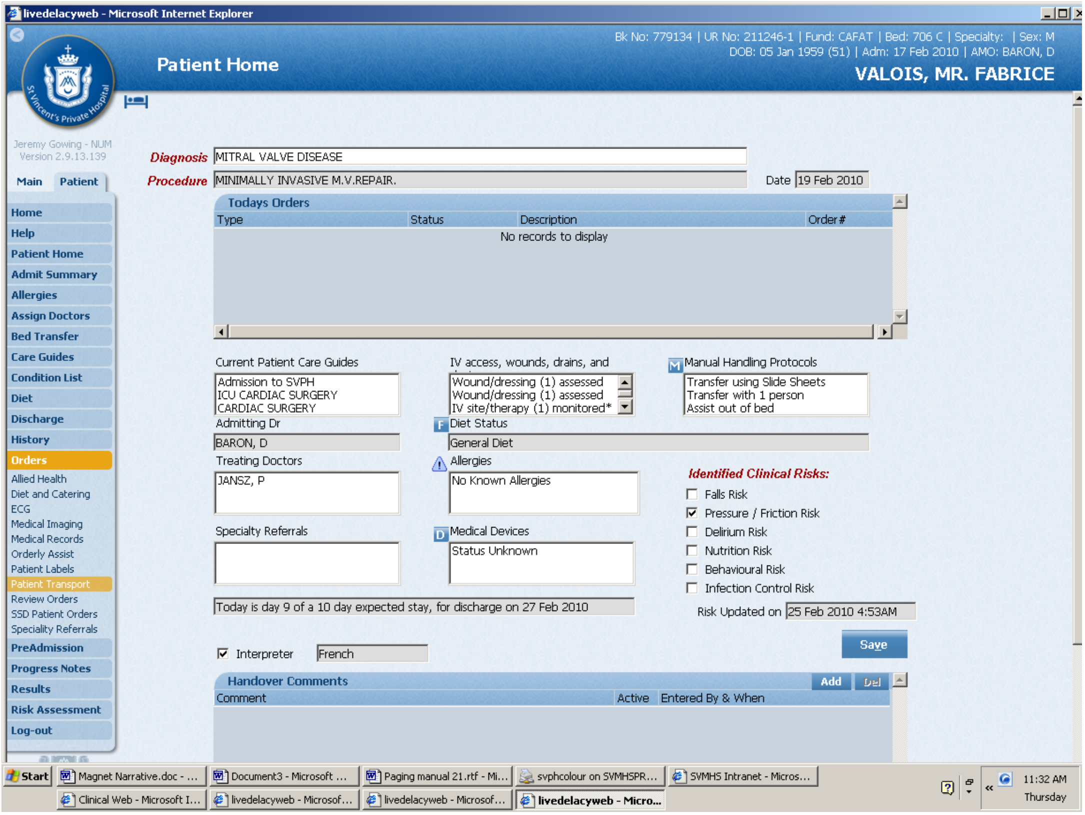


Figure 4.16d: CSU Process Flows Part D (Source: Internal)

Subsequent to these discussions, the Cameo made the following observations.

4.4.6 Planning Paucity

Any standard technology implementation that is aimed at process improvements would begin with recognising the need and then eliciting requirements from the key stakeholders or users involved in this process. Hospitals worldwide have recognised RFID as a technology that can improve their processes. This was undoubtedly known to the CIO and his team. The division has 14 years of experience in developing clinical information systems. Hence, the CIO/IT division would be conversant with the processes involved, the solutions and the alignment with the strategic directions of the hospital. When a pilot is envisaged or initiated, it is usual for the organisation to use a consultative approach to gather the requirements from end users in a process. This is usually done through a simple brainstorming exercise and sometimes via discussion groups or user surveys. During this phase, the users, or the people who may be part of the processes that the technology-induced change are expected to improve, would put forward their expectations and concerns.

In the case of this pilot study, it should be noted that RFID integration was being considered for the 'clinical resources support system', which is a module within the 'Clinical Information System'. The key users of this system are neither managers nor nurses (which is the case with most of the Clinical Information System), but rather the Patient Care Orderlies. Ideally, their inputs and concerns should have been elicited at the conceptual stage. Instead, the report from the technology company (as well as my in-depth interviews as discussed) revealed that the Heads of SSU and CSU, as well as the technology implementers and nurses, were consulted for base lining the pilot. There were only two end users involved, while the ideal scenario would have been a survey or discussion group at the beginning, which should have involved more orderlies.

The key users of the system, orderlies, were pivotal to maximising the benefits of RFID. While the CSU/SSU managers may have been consulted, they were not day-to-day operators of the process. The managers prepared the rosters, while the orderlies actually performed the tasks. Equally, some consultation with the nurses had occurred, as they operated the Clinical Information System. The orderlies took orders from the nurses via a pager and undertook said tasks, for which they needed to use the interface of the 'clinical resources support module'. Therefore, instead of the managers/nurses, more of the users' involvement would have been a better methodology to plan. Being given a 'top-down' approach, there is sufficient reason for the orderlies to feel 'disempowered'. Specifically, their 'reporting authorities' were consulted instead of them. Administratively, the orderlies reported to their managers and followed orders from nurses in the process of their work.

In addition, the technology was given to the users as a top-down approach. The orderlies were given a 'new interface' to work with without fully considering the process involved and the potential disruption that could result. It was evident that the orderlies found it difficult to coordinate their work and learn a new interface in order to modify their process of working and make it more efficient. In addition to the 'top-down approaches', the training provided by an external vendor, which was aimed at realising the potential of the technology, was not well received by the users. An external vendor who was not part of the hospital system was not perceived by the users as a supporter of their well-being, but rather another 'reporting authority' with some 'directives'. The orderlies felt pressured because they were already under significant pressure in their chaotic work environment.

The final result was that the actual users of the process felt 'disempowered' and therefore became disengaged and indifferent to the technology. Although the RFID pilot has demonstrated benefits, it is not currently being used for clinical resources support at SVPH. As the in-depth interviews revealed, it has not been used for almost a year since the pilot, although the equipment/tags are still in existence. The planning paucity that has resulted in a lack of user engagement has to be addressed before the next deployment if the technology is to be used effectively in order to realise its demonstrated benefits. It is also evident from the view of technologists that the potential of RFID can only be driven by the users involved in the processes.

Some orderlies suggested integration and nurse-driven approaches as the solution. However, nurses did not wish to make it part of their role to do the tracking, even though it is on their desktop. Equally, the orderlies expressed that they waste time by tracking equipment that seems to be available on a particular level but is not there. The

CIO feels that it is an attempt by the orderly to 'chat up' nurses. Communication networks between nurses and orderlies are the key to the smooth running of this operation. For RFID translation, the CIO does not recognise the need as part of the work culture; rather, he sees it as a waste of time. The orderlies perceived RFID to be a threat to their relationship network with the nurses on every level.

Similarly, the potential to exploit the technology further, as well as addressing existing flaws in location with the accurate use of technology, has been put forward by users and internal technology implementers. Their views would have been beneficial for the pilot implementation. They recommended that:

- the involvement of users be improved through discussion groups, brainstorming, email discussions or surveys (web-based or otherwise)
- they address requirements such as: (1) interface integration with HIS, and (2) location accuracy
- they consider the views of users and technology integrators from Scene-1 to effectively deploy the technology to enhance existing processes
- they identify a representative team with users, technologists and managers internally to work with the external vendors and train the users effectively.

The Cameo made specific suggestions for either a link to the current hospital IS and a connected interface for the users, and user education. To improve the accuracy of tracking, it was recommended that a full wireless infrastructure, tagging of all equipment and an improved, user-friendly interface be made. It was also suggested that the hospital use its in-house facilities for the development/translation of the technology, restricting only RFID tags and tracking equipment from the vendor.

The Cameo also found that a tracking screen for RFID was built, which indicated the movement of equipment, based on codes, on a new interface—Bo-Beep—which was linked with the hospital IS. However, the users still found it difficult to use passwords and codes (each equipment had a code); therefore, a new solution was needed. The Cameo suggested implementing touchscreens on all floors with clear graphics so that equipment could be tracked easily. Strategically, there was also a recommendation to employ permanent part-time staff as orderlies so they could be trained on RFID tracking in the long term.

Due to a lack of funding, the implementation at the private hospital was put on hold. The ICT staff continued to look for funding options such that RFID with its full infrastructure, which enabled the tagging of all equipment and location tracking across campuses, was enabled. As some funding was released for buying equipment, touchscreens were installed as recommended by the Cameo. The Head of SSD continued conversations with the ICT department and initiated talks with the Head of Wards in the Public hospital to promote RFID.

4.4.7 Act-2 through the ANT Lens

Table 4.4 denotes the movement of the actors after Act-2. I entered this Act as the Cameo with a view to investigating the networks and interacting with all actors.

Table 4.4: Act-2: Actors Who Entered and Exited

Human Actors	Existed	Entered	Exited	Sustained
CIO (The Champion)	X			X
PM (Technology Company)		X	X	
External Company teams				
Head (SSD)	X			X
Nursing Unit Manager(private)	X			X
Orderlies (private)	X			X
Nurses (private)	X			X
SysAnalyst (Implementation Projects)	X			X
Business Analyst		X		X
Cameo		X	X	X
Wards-in-Charge (Public)				
Head (ED)				
NON-HUMAN ACTORS				
RFID Tags and Equipment The Debut Actor		X		X
RTLS Report		X		X
Web Based Clinical System	X			X
Bo-Beep Interface	X			X
Touch Screens		X		X

In Scene-2, the Cameo (researcher) entered the blackbox and formed an ‘investigative’ relationship with all actors in the blackbox, as well as a circumstantial link with the external team. Specifically, due to the nature of the investigation, the Cameo had to meet the technical vendor, who introduced RFID. The findings from Act-1 were confirmed by this investigative relationship.

The process of the Cameo forming an investigative relationship with all actors also refreshed the existing relationships between the departments, which had been lying dormant since RFID had been abandoned. It was found that RFID had enabled a new actor—the BA (Business Analyst)—to enter the blackbox, with whom the Cameo also established an investigative relationship. The BA had initially established a relationship with the Head of SSD and continued the discussion of full-scale RFID implementation.

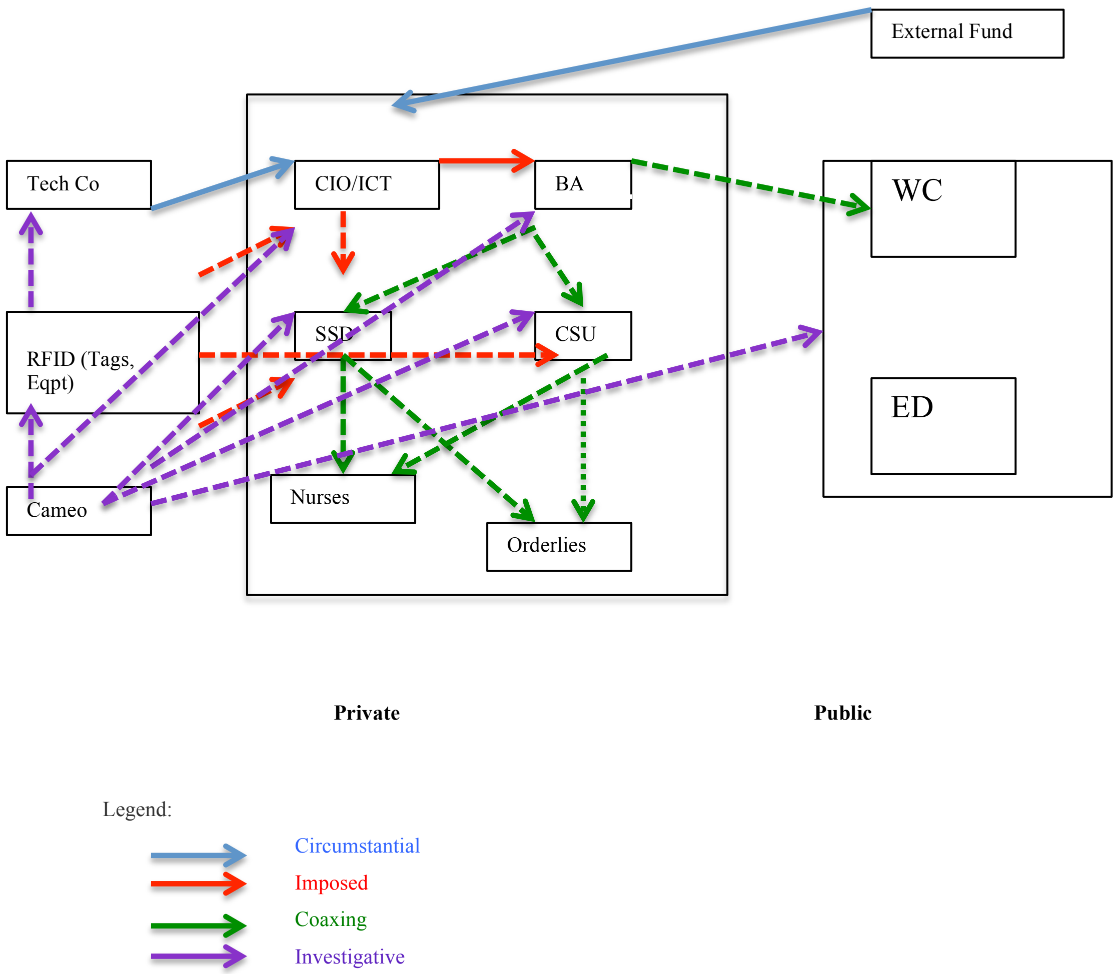


Figure 4.17: Summary of Act-2: Actors, Networks and Relationships.

My role as Cameo was to investigate the disappearance of 'RFID'—the debut actor. It was found that RFID still existed in the blackbox, albeit lying dormant or invisible, waiting for the script to be written in the next scene. The Head of SSD and Wound-Care Wards in the Public hospital had a conversation, establishing a relationship via the ICT department. CSU continued to talk to the ICT department, continuing the relationship and awaiting the next performance of RFID. However, the links with external entities (companies/team) had become defunct and broken.

The existing relationships were refreshed, extended and realigned. One 'circumstantial and imposed' link was broken (i.e., with the technical vendor and all other actors within the blackbox), although the Cameo had made a short connection, inviting them to visit the blackbox. However, the relationship was fading already, and no one was interested in a re-alignment with the external team.

The 'coaxing and imposed' relationship between SSD and ICT was extended to the Public hospital 'Wound Care Ward' and thereafter as an 'investigative' relationship with the Cameo. The ICT department's 'imposed' relationship was extended and realigned as a 'coaxing' by the presence of the newly appointed BA, which was enabled only for RFID deployment. As the BA was not only coaxing, but also involving the actors in decision-making by giving RFID a screen-test in the 'Wound Care Ward' (test run), RFID made its debut into the Ward as an empowering agent. The Head of the Wound Care Ward felt empowered by the way it was presented.

The BA also changed the 'coaxing' relationship between the ICT and SSD/CSU, as well as nurses/orderlies in the private hospital, into an 'empowering' one by involving them in the future deployment discussions of RFID. The BA was able to make this change, triggered by the investigative relationship established by the Cameo. Specifically, the Cameo opened the blackbox and formed an investigative relationship with all actors, which in turn enabled the BA to refresh existing or fading relationship between ICT and them. Together with the Cameo, the BA was able to change the image of the debut actor, RFID, from a debut actor who was 'imposed' to an influential actor who empowered all other actors. RFID had become an influential actor who continued to motivate building relationships, enable the extension of relationships and sustain itself in the process within the blackbox. The imposing image had changed to an empowering image, which was slowly transforming RFID from a debut actor to an all-pervasive star.

During this time, a lack of funding and the introduction of e-medical records had mired the thought of the full-scale implementation of RFID at the private hospital. The Cameo also realised that many technologies and systems were being introduced into the blackbox, including the electronic medical records, which took primacy over the idea of implementing RFID on a full scale. That is, the launch of RFID as an actor was shelved due to other priorities and other actors' (orderlies/nurses) reluctance to trial it again while other systems 'had to be implemented'. At this stage, even the BA who was pivotal in re-aligning all relationships, was more involved in other implementations and hence decided to shelve the project for some time. The Cameo closed the blackbox and exited the scene.

4.5 Act-3: RFID in the Public hospital

Almost one year had passed when the hospital informed the Cameo that special funding had been obtained and had triggered RFID implementation in the Public hospital. The Cameo decided to revisit the site and meet with the ICT people to further investigate the matter.

4.5.1 Scene-1: Meeting with CIO and ICT department

Cameo: *So, you have received funding to deploy RFID in the Public hospital and ED only?*

CIO: *The Public hospital has received A$60,000 as a grant for RFID-related expenditure linking wards, emergency and medical imaging departments at this stage. A fundraising group known as Sirens got the money for Emergency department in hospitals and approached us in the ICT department with it. I suggested that they pull out the infrastructure from private hospital such as servers, information systems etc. and use the funding only to obtain new tags, exciters and licenses.*

Sirens thought that this was a good idea, as the base was already there, the money would be utilised optimally and this way, ED and linked *departments in private hospital could trial RFID for their benefit. According to Sirens, RFID tracking would be an innovation for a Public hospital in NSW.*

I had also felt that this would then justify a budget for RFID in the private for a full-scale implementation.

Technologist: *The infrastructure (wireless) had to be completed on 10 levels of the building. We are beginning this…technology has now moved on, Wi-Fi infrastructure at Public need to be refreshed for location-based services. A standard network designed for data is not sufficient for the Public.*

BA: *We have plans for moving the touch screens to the Public as well if the funding is not sufficient to buy new touchscreens.*

4.5.2 Scene-2: Meeting Wound-Care Wards in Charge

The Cameo met with the Head of Wards in the Public hospital when the infrastructure building for RFID was in progress from Levels 7 to 10. The BA (ICT department) accompanied the Cameo in this discussion to gather inputs.

Cameo: *What is your current experience with RFID?*

Head-Wards: *The wards in Public hospital already have some RFID-tagged equipment and exciters from an older pilot which happened some time ago. However, these were not providing an accurate picture. An equipment which was near the window or in the building next door, with an open window, could be seen as located close by on the same level. Due to this issue, the first trial was abandoned.*

The wards have WLan already and wherever the RFID is being provided, a new system that clinical nurses use, known as BO-BEEP, is the interface where they locate the tagged equipment. This is in-built by *the ICT department of the hospital. The Bo-Beep takes care of all user inputs and comments from the failed trialled implementation. However, the system is still separately monitored, not linked yet to HIS (could be in future).*

Cameo: *What are the processes in the Wards?*

Head-Wards: *Patients come into the ward from the following ways:*

Out patient department:

- *patient is admitted after check until surgery or other*
- *patient is admitted so that next day or in some time lab, tests can be taken (radiology).*

Emergency department (including Medical Imaging (MI)):

- *patient comes into ED, goes into surgery direct, then taken to wards*
- *patient comes into ED, is stabilised in the ED for any condition, then taken to the wards*
- *patient comes into MI from wards, taken back to wards*
- *patient comes in with a fracture into ED, taken to MI after stabilisation, then taken to wards.*

Cameo: *So what is being done now?*

Head-Wards: *Well, the implementation is expected finish soon. When done, we will monitor the time taken for finding equipment and the accuracy of location. And this will then be reported to ICT.*

BA: *Sixteen exciters to cover main entry and exit points are being installed. The relevant equipment has been tagged already (the wards also use separate equipment such as wound pumps, which are not part of ED). Equipment is owned by wards here.*

At this stage, the wards have equipment such as 'Wound Pumps' (which are 6–7 nos only in the wards), and other equipment, such as IV tubes, tagged. Exciters have been placed next to main entry and exit points of the ward. The signal strength has been corrected such that the equipment is now located on the correct level only.

Cameo: *What do you do currently to track equipment?*

Head-Wards: *I keep equipment information in two ways to track them currently. Until six months back, I used to keep information in a paper diary and personally track the equipment. In January this year, the IT Department said that there is some equipment possibilities with RFID, which can track some equipment currently available from the previous pilot, which they can trial. So we trialled this; however, lack of accuracy in location caused severe conflicts between ward nurses. However, I was still able to use it for getting information instead of a diary.*

If I can see that there are 6–7 wound pumps in the hospitals, and if they are attached to a patient or in surgery (ED) or elsewhere, and which one of these are where, using a system, then it is only a point of finding them. If one of them is attached to a patient, for example in a bed no. four, then I know it cannot be taken off until a particular day. So I can look for another, so on…The time taken for tracing has now gone from two hours to less than an hour at times, with this half a system. If it was fully accurate, it could reduce to 10 minutes, which is time I could spend with patients in need in a 300-bed hospital. It is time and efficiency improvement.

There is only 6–7 pumps available for whole hospital. If they cannot be found, we end up renting them for 75 dollars a day, which increases the costs considerably. If we could avoid this, costs could go down—we will monitor this after implementation.

Another equipment such as bladder pumps is used only in one ward, which specialises in renal area. They tend to remain in that ward. But if it is taken to surgery or ICU (ED), then currently what we do is that there is a whiteboard. When an equipment is taken by ward boys, they write on the board. However, these are supposed to be returned to this location. However, they might go from ICU to another level of wards for another patients. But the whiteboard entry remains that the equipment has gone down a black hole into ICU. This is very inefficient that we cannot track the equipment for next emergency as well…This happens often enough in a month, so staff spend an average of an hour/two hours in a week at times…in an emergency-related ward—this time is rather too much. So we would like to fix this with RFID tracking.

There is an area where people go out smoking. This area, equipment such as wound pumps can disappear with a patient (they tend to be attached to patients) or other equipment, which ward boys take with them when they go out for a break. Occasionally, once a month or so, it so happens that the equipment is in this 'blind smoking area' which is not covered in the current tracking area.

BA: *Well, this is a good input from our discussions today. We will put another exciter in this area.*

Cameo: *Can you elaborate if there are any issues at this point?*

BA: *There are some limitations. Currently only main entry and exit points have exciters. On each level, there are two more stairwells through which occasionally equipment could go out by authorised personnel to another level. However, this does not happen mostly, and if it does happen, the personnel would already register this into the system. Currently, they do not intend putting exciters covering all the entrances as it is expensive and not budgeted under the grant.*

Head-Wards: *Mostly these pumps go disappearing into ED and surgery, which is why we need to track them there.*

Subsequently, the Cameo visited the Head of ED and then met with the BA in the ICT department.

4.5.3 Scene-3: Meeting ED head and BA (ICT)

Cameo: *What is your opinion on RFID being deployed here in ED?*

Head-ED: *This is an area where there is frequent movement of equipment, people and other resources on a regular basis. In this chaotic environment, it is an expectation that equipment can be tracked immediately, and these are sterilised and the correct equipment.*

For example, often this department loses its wheelchairs while transporting patients, and over the last year, there has been a loss of 11 wheelchairs. Similarly, there is equipment that gets lost in laundry areas of wastebaskets due to the nature of emergency. There are no tracking or information systems in place at present, and collaborative care is therefore dependant on the goodwill of existing orderlies only (not RFID).

Cameo: *Can you explain the location of ED?*

Head-ED: *ED and Medical Imaging are located on Level 3 only. This is a very complex area with multiple entry and exit points.*

BA: *The hospital has grants to cover 18 exciters on this floor, plus installing WLAN, which is not present in the floor. Linked to ED is Surgery on Level 5 and Out-patient on Level 4. The processes from these levels are interconnected. Hence, the grant also partially cover these areas. We are putting in 14 exciters on each floor and WLAN partially, so that the main areas are then covered for locating equipment. For example,* *equipment from ED can travel to the Surgery and wards and is meant to be returned to ED. But they could be lost somewhere in transit. So when the ED does want this, they cannot find it in an emergency. The RFID-enabled locating can assist in reducing the time taken to find this equipment.*

Cameo: *So the wards and ED will get RFID soon now?*

BA: *We have hit another glitch. The infrastructure need to be refreshed fully, some reprogramming need to be done. In the meantime, we have been asked to implement e-health records in the Public hospital, which has taken priority now.*

In the Public hospital, the Level 1 has doctors, cleaners; Level 2 has medical records and nuclear medicine; and level 6 has pathology. At this stage, the implementation is skipping these locations, as there is no movement of equipment in these areas nor expected.

In summary, RFID was being deployed in the Public hospital, albeit slowly, because e-health records took priority. However, RFID could also help with e-health records systems and tracking. RFID was definitely going to remain in use at the hospital.

This Act concluded the Cameo's relationship with the blackbox and all actors. While the deployment of RFID was underway, the progress was slow; hence, the Cameo decided to close the investigative relationship at this stage and exit the blackbox.

4.5.4 Act-3 through the ANT Lens

Table 4.5 illustrates the movement of the actors in the last Act in the case study. I re-entered the scene as the Cameo and interacted again with some of the actors.

Table 4.5: Actors in Act-3

Human Actors	Existed	Entered	Exited	Sustained
CIO (The Champion)	X			X
PM (Technology				

Company)				
External Company teams				
Head (SSD)	X			X
Nursing Unit Manager-Private	X			X
Orderlies (Private)	X			X
Nurses (Private)	X			X
SysAnalyst (Implementation Projects)	X			X
Business Analyst	X			X
Cameo		X	X	
Wards-in-Charge (Public)		X		X
Head (ED)		X		X
NON HUMAN ACTORS				
RFID Tags and Equipment The Debut Actor		X		X
RTLS Report		X		X
Web Based Clinical System	X			X
Bo-Beep Interface	X			X
Touch Screens	X			X
New Funding Group (Sirens)		X		X

In this scene, the relationship between the Cameo and the blackboxes with its actors remained, and it resulted in them extending an invitation to reassess/design the processes within the Public hospital because they received funding to deploy RFID in the Emergency Department. A group that brought in the funding had indirectly formed a new relationship with the ICT department; hence, it is denoted as a 'non-human actor'.

The Cameo entered and revisited the private and public hospitals, extending the networks while sustaining the existing ones. In the meantime, the SSD and CSU departments in the private hospital extended their support to the Public hospital by foregoing some of their existing RFID-related equipment to enable fast deployment in the Public hospital. This resulted in extended relationships between the two hospitals, as well as the ICT department, which now had re-aligned itself as a strategic partner for them, thereby forming strong linkages.

The link with the previous technology vendor was now broken completely. With the exception of the equipment and tags that were brought in initially, there was no presence of the organisation or human actors within the blackbox. However, RFID remained an influential actor in the Private hospital, while the two departments and the hospital as a whole were slowly progressing with the redeployment of RFID. The strategic alignment established between the Private and Public hospitals, extended with the help of the ICT department and the Cameo, was enabled by RFID as it translated into this context. While RFID was once again being imposed on the blackbox (this time in the Public hospital), it was regarded as an empowering relationship by all actors concerned. While the Wound-Care Wards and ED awaited its implementation, the SSD and CSU departments continued to await its re-appearance in another avatar.

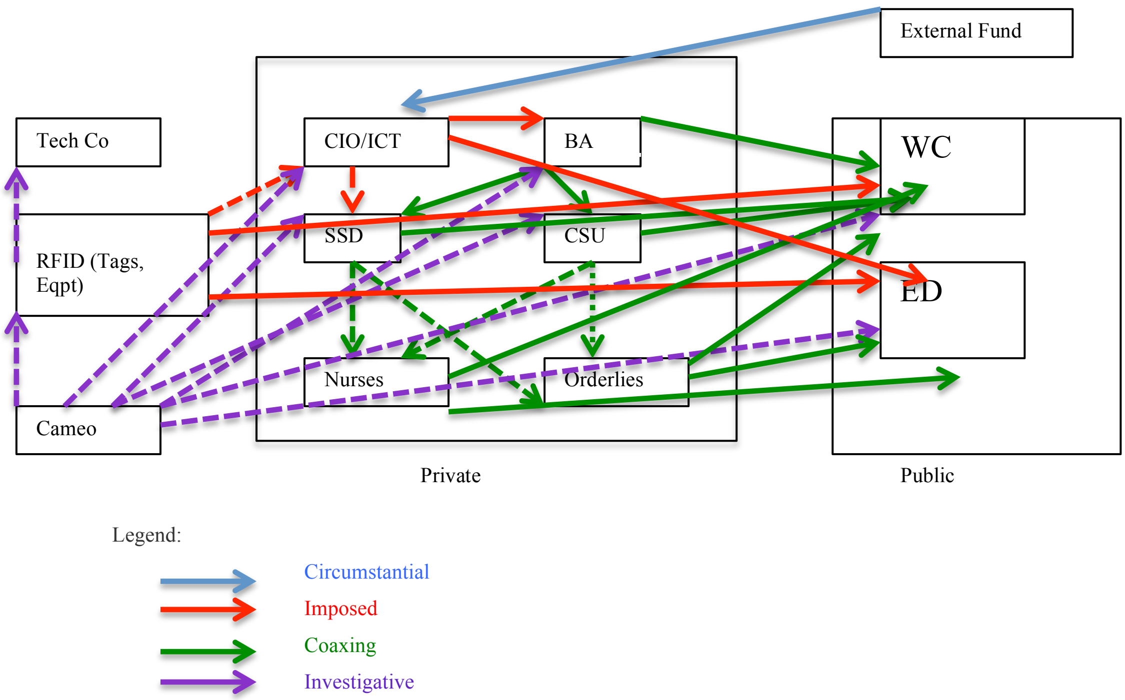


Figure 4.18: Summary of Act-3: Actors, Networks and Relationships

The most important observations made are outlined below. Although RFID deployment was initially abandoned after the pilot, and then revisited by the champions in the Private hospital (two department heads), the RFID tags on the equipment stayed on. Therefore, there was an invisible presence of RFID that was never completely abandoned; rather, it was just ignored. Why did this happen? Even the BA, who was under the advice of the CIO, did not feel that the 'top–down' approach from the IT department would work in the hospital. Users were not consulted, and the main orderlies felt disempowered and disconnected from the communication. They did not want to promote a technology that enabled this lack of communication in the hospital, which also helped them in the quality of services rendered.

Therefore, it had to be a nurse or, in this case, the ‘wound-care-wards in charge’ (also a nurse), who then communicated with the IT department and the head of the ED (also a nurse) in the Public hospital to re-initiate RFID in the hospital. Subsequently, RFID became the buzz word again, as they communicated in a different language to the operations people—namely orderlies—in the hospital. This triggered the redeployment.

It is interesting to note that the hospital management, the CIO and ICT department, other department heads, clinicians and orderlies heeded the nurses’ communication. While the CIO and BA had tried for three years and even pumped discretionary budget into the RFID cause, these were rendered futile. It only took the wound-care-ward in charge a few months before the ‘stage was reset’ to deploy RFID again.

RFID was undoubtedly the enabler of relationships, linkages and re-alignments in the hospital. The technology was accepted not only as useful for tracking and thereby improving the quality of processes, but also for enabling the hospital to uncover inefficiencies in its day-to-day work due to a lack of alignment between the business strategy, technology and clinical process that involved most of the staff. This misalignment was caused by the failure to recognise the need for users to be involved or consulted in the process of deploying technology that helps them improve efficiencies. Introducing new technology to help almost every process in the hospital enables efficiencies that result in higher-quality care. It is critical to note that RFID could affect every area within the hospital, as assets (e.g., surgical equipment, wheelchairs, infusion pumps, defibrillators) and tracking was becoming a necessity.

However, as this story suggests, RFID not only became useful as a tool for tracking; it also provided an opportunity for the hospital to analyse its processes from a people perspective and address the gaps, thus enabling better alignment of strategy and technology. While other technologies are useful, none had the effect of RFID as it translated into this context. Five years after its debut, RFID had evolved in the blackbox, enabling the formation of linkages, realignment of relationships and sustaining itself to emerge as the ultimate star.

4.6 Chapter Summary

This chapter discussed the first case study in which RFID was piloted and is now in the process of full-scale implementation. A long, periodical data collection process, which involved myself as a researcher, traced the potential of RFID as it translated into the context. With an Actor–Network Theory lens, it was found that the technology was not only perceived/accepted for the reasons that it was deployed for, but also for improving the social network quality within the hospital. It had the potential to empower its users, thus improving relationships within the hospital, and it was also dynamic to evolve, transform and sustain itself.

The next chapter presents a case study in which RFID has been successfully implemented to improve efficiencies in a particular area and has incidentally helped to improve other departments, resulting in full-fledged acceptance within the hospital.

Chapter 5: Case-2: The Victory Group: Findings and Analytical Discussion

This chapter explores the innovation–translation of RFID technology in a second Australian hospital via a case study investigation. Similar to Case-1 (Chapter 4), I have sought to understand how the technology has translated into this context, as well as its impediments in terms of socio-technical issues.

The use of Actor–Network Theoretical concepts has again been used as a framework in narrating this case study. Similar to Case-1, RFID is considered the key actor (non-human) in this site. It enters the scene as a 'Debut', or 'innovation', at the time of entry, and it translates or 'integrates' itself into the context. It re-negotiates the existing network of relationships within the hospital and establishes/sustains its presence, while evolving and emerging as a 'Star' that holds much promise in the future. RFID technology entered the hospital (blackbox) as a key non-human actor and retained a position while enabling varied networks. In the continuum, it translated or integrated into this blackbox (hospital), transitioning into a more influential actor who has now become the 'Superstar', as it has been accepted as the 'key technology' for the new regional site. Table 5.1 notes the key actors and blackboxes in this study.

This is a *post hoc* case study that acts as a validating case for Case-1 (presented in Chapter 4), as I have entered the site as the Cameo after the implementation of RFID. The initial contact with the Cameo was via a symposium, where the CIO of the hospital had presented the case of RFID adoption. Similar to Case-1, the acts presented in this case are re-constructed from the data collected in semi-structured interviews and a focus group. The actors involved have validated all data collected and presented through further telephonic interviews.

It may be noted that unlike Case-1, the process redesign diagrams using RFID and other details are not presented in this case study. I was not involved in the process design stages or the implementation of RFID at this hospital. Rather, I was a non-participative observer. The focus group with key people and interviews that formed the basis of the data collection were conducted after the successful implementation of the technology. For confidentiality reasons, these documents were not made available. However, the existing diagrams that are presented in this case narration reveal instances of workflows that were successfully affected by the use of the technology in terms of time, cost and workflow efficiencies. The successful implementation of RFID is evident and has been indirectly substantiated with pieces of the evidence.

5.1 The Milieu

The hospital is situated in regional Victoria, Australia, with more than 3,400 staff and 653 beds. More than 37,000 in-patients are treated annually. It deals with more than 45,000 emergency cases and approximately 1,200 births annually. These services are complemented by a 60-bed rehabilitation unit, eight-bed intensive care unit and five operating theatres, where almost 10,000 surgical procedures are performed annually. The organisation provides services in emergency, maternity, women's health, medical imaging, pathology, rehabilitation, community services, residential aged-care, psychiatric care, community dental, hospice, palliative care, cardiology, cancer services and renal dialysis.

The hospital began to roll out a Wi-Fi-based solution in July 2010 to manage the flow of patients through its surgical wards (Friedlos 2010). In 2011, it expanded the use of the system to include the temperature monitoring of pharmaceuticals and blood supplies, and a staff safety system for doctors and nurses.

The system operates on a standard Wi-Fi network and utilises RFID tags and RTLS software, as the hospital received funding to install Wi-Fi in its surgical theatre. Initially, the hospital wanted to obtain better real-time data regarding theatre and staff utilisation in its perioperative suite, which handles up to 10,000 surgical procedures annually. Upon arrival in the surgical theatre, orthopaedic patients are given a tag that provides information on the patients' location and movements, thereby enabling staff members to ensure that scheduled procedures start on time and that patients receive proper care.

The system collects data as it follows a patient's journey through theatre, from the admissions area to the waiting area to the theatre complex and the anaesthetic bay. This allows for business decisions to be merged into the complex flow of staff and resources to the perioperative suite. It was expected that the hospital would be able to process patients through the surgery more efficiently and use resources better. The system operates on the hospital's existing unified wireless network with access points throughout the hospital that act as RFID interrogators. This aspect resulted in a lower total cost of ownership for the hospital. The system utilises active tags, which are 802.11-compliant and operate at 2.4 GHz. Information is transmitted from the tags across the Wi-Fi network to MobileView software from AeroScout, which can be accessed by all employees on any computer monitor.

It should be noted that this hospital effectively gathered market information from the learning of the hospital in Case Study-1 in relation to the technology evolution of RFID, medical-grade tags and the strength of the technology company that supplied the RFID tags/equipment. It was also aware of the implementation hiccups and was relatively better prepared for the outcomes. Compared to the previous hospital, which debuted RFID in 2007, this hospital implemented the technology in 2010. By this time, RFID had evolved in terms of acceptance within the Australian health sector.

To validate Case-1, at this site, I sought answers to the following: Who were the champions of RFID in this context? Who was able to influence the adoption? Were all actors involved in the progression? Were participants forced or coaxed to accept RFID? Who were the external players, and were they influential or imposing? As a validating case study, the data collected were expected to help understand and better interpret the findings from Case-1.

In this case, I had first-hand information from the CIO after RFID had been implemented initially, and the hospital intended to continue with full implementation. The data collection involved unstructured interviews with two CIOs, who succeeded each other (and worked together), and the department representatives in a focus group. Nonetheless, the second CIO, who was also the champion of RFID, acted as the systems implementer and business analyst in a combined role and had influenced the departments. Some department heads also made him their ‘spokesperson’ or the ‘voice’. The actors and blackboxes are presented in Table 5.1.

Table 5.1: ANT Depiction of Actors (Human and Non-Human) and Case Site

Actors/ Blackboxes	**Name**	**Details (Non-Human Actors have been given a voice by a Human Actor)**
Blackboxes	Regional hospital	The site where RFID entered into the context and has propagated successfully
	New Site	The new site of the regional hospital under construction
Non-Human Actors	DHS (Department of Health Services)	The external entity, which funded RFID implementation via a grant
	Symposium article	Voiced by CIO (Past)
	RFID tags/equipment, external entity (includes temperature tags)	Voiced by CIO (past and present)
	RFID results	Voiced by CIO (Current)
	RFID maps	Voiced by CIO (Current)
Considered Non-Human Actors	Nursing staff/orderlies	Voiced/represented by CIO in the focus group
	Pathology Food Services Engineering ICU OHS Infection Control	Voiced and represented by CIO (1) and CIO (2), Deputy Pharmacist
Human Actors	CIO (1) (The Champion)	The CIO is overall in-charge of all technology-based strategic decisions and drove the cause of RFID; the Godfather of RFID, who launched its career
	CIO (2) (reigning champion or current CIO—named as CIO)	This CIO was earlier the deputy head of ICT, second in command to the CIO; he is currently the CIO and also the champion of RFID who coaxed all the departments into trialling RFID and was successful
	Deputy Pharmacist	Deputy Head of Pharmacy Operation who drove RFID pioneering and propagation in the focus group
	Simpkin House Head	Voiced by the CIO in the focus group—followed up for confirmation by the Cameo
	Cameo (I/self)	Cameo did the first direct interview with the old CIO; focus group was run by a moderator who then became the voice of the Cameo.

5.1.1 The Storyline

The Victory Group is a fictitious name given to the hospital in this case study. It is situated in regional Victoria, Australia. It has autonomous authority, strong support of the Department of Health Services in the state and a large budget. The hospital pioneered RFID in 2009, when national discussions about technology refreshments towards building e-health records were underway. It should be noted that Wi-Fi technology had evolved and touched the nation in almost every corner, including hospitals. In 2007–2009, both Wi-Fi and RFID were in the nascent stages of evolution, while in 2009 both had evolved, which helped the hospital to initiate RFID.

Victoria was experimenting with technologies and the Department of Health was supporting many such initiatives with grants. The RFID pilot was initiated by a set of orthopaedic nurses in the hospital using a successful grant application. RFID was deployed as a pilot to track the patient journey to theatres and back to the wards in the elective hip/knee surgery area. The pilot was extremely successful. However, as the Patient Management System (PAS) had not been incorporated in the hospital at the time, nurses had to enter RFID tracked results manually into a system that was acceptable for reporting to the Department of Health Services. Therefore, after a six-month successful trial period, the nurses decided to trial the technology in another area that might be useful. Through a conversation with the ICT department and other nurses and clinicians in the hospital, the nurses moved the RFID tags to the ICU area to track beds and patients in the waiting bay. It should be noted that this deployment worked successfully and improved efficiencies in the hospital, including waiting times and the number of patients cared for by clinicians and nurses. They also used it successfully to track some equipment.

Parallel to this deployment, a set of RFID tags for monitoring temperatures was given to the ICT department on a trial basis by the technical vendor. These temperature RFID tags were then trialled in the Pharmacy area and found extremely useful for monitoring refrigerator temperatures (fridges that kept emergency medication in particular). Thereafter, the pharmacists decided to deploy RFID because it saved the costs that were incurred by throwing out medicines. Subsequently, the ICT department showed the positive results to the Pathology department, which used it to monitor blood fridges. The success of this department led to Food Services taking on the deployment to monitor refrigerators. Concurrently, as a result of an Occupational Health and Safety (OHS) audit, Engineering Services used the RFID temperature tags to monitor air-conditioning in staff areas.

Parallel to these developments, there was an incident in the mental health facility within the hospital, where the cleaner had a heart attack while working, and it was some time before he was taken to emergency. This triggered an idea that RFID could be used as wearable devices by staff. Subsequently, an RFID tag that could be worn around the neck was developed so that by pushing a button, a person could be tracked until the alarm was attended to. The silent working of the RFID tag helped inside areas of the hospital where the noise of an alarm could be harmful. A person wearing the device could be tracked and the incident attended to without attracting attention.

The varied successes within the Theatre, ICU, Pharmacy, Pathology, Food Services and Engineering Services, and the use of RFID as an alarm device for staff, helped the hospital improve its efficiencies and boost the quality of care. Thereafter, full-scale implementation was initiated for tracking assets and people using RFID.

The key point to note in this case is that the orthopaedic nurses had propagated the deployment of this technology through word-of-mouth among nurses, clinicians, orderlies and various department heads. Subsequently, when the hospital had acquired the PAS required by the Department of Health in 2011, the pilot implementation gave way to a full-scale implementation of RFID. The journey of RFID into the hospital, which began with the same nurses, had found its way through varied departments and returned to this department to be fully implemented for theatres. A nurse initiated the deployment of this technology. Although it was not used initially for the reason it was piloted for, it became pervasive and was eventually also deployed where originally planned. In this successful case, the nurse or triage had the pivotal role of initiating RFID into the hospital. Without the nurse propagating the cause of RFID and the support of the ICT department, RFID would perhaps be abandoned in this context.

When I completed the study, the hospital was in the process of building infrastructure for a new building with Wi-Fi and RFID to become a large regional hospital with world-class service. The narration is presented similar to Case-1, in three acts and scenes. The initial deployment is presented in the first Act. The temperature RFID tags deployment is presented in the second Act. The third Act presents the technology as an innovation and how it translates well into the context with a new proposition as people tags.

Table 5.2: Outline of Acts and Scenes

Section	Act	Scene
5.3	Prelude	RFID in conversation with Cameo
	Act-1: Reconnoitring RFID Debut in the blackbox	
		Scene-1: RFID Debut into the hospital
		Scene-2: Re-casting of RFID in a new role
5.3.1	Summary	
5.3.2 (2010)	Act-1 through the ANT lens	
5.4	Act-2: Exploring RFID permeation in a new Avatar	
5.4.1		Scene-1: Temperature Rises from Pharmacy, Pathology, Food Services and Engineering
5.4.2	Act-2 through the ANT Lens	
5.5 (2011)	Act-3: Managing Duress with RFID in High and Aged Care Facilities	
5.5.1		Scene-1: Tagging Staff for monitoring Duress
5.5.2		Scene-2: Exploring the translation of RFID Duress Alarms
5.5.3	Act-3 through the ANT Lens	
5.6 (2012)	Act-4: Consolidating RFID role in the Hospital	
5.6.1		Scene-1: Establishing the position of RFID in the hospital
5.6.2	Act-4 through the ANT Lens	
5.6.3	Summary	

5.2 Prelude: RFID in Conversation with Cameo

Cameo: *You are a debut actor in this place. Could you tell me about yourself?*

RFID: *I am debuting into this hospital. I am commonly known as the hospital grade RFID tag here. I came as a debut actor brought in by the orthopedic nurses initially. I have two main skills. I can monitor temperatures and track equipment/people. And I am still evolving and wish to adapt into this background. I do like everyone here, they seem very supportive.*

And now the Act begins where I am trying to reconstitute the conversations (interviews/focus groups) had between 2010-2012 period into acts and scenes.

5.3 Act-1: Reconnoitring RFID Debut in the Blackbox

5.3.1 Scene-1: RFID debut into the hospital

The hospital receives A$70,000 grant from the Department of Health Services in Victoria for installing wireless equipment in operating theatres. Subsequently, the CIO, in consultation with his department (ICT) decided to deploy RFID to track a patient's journey. This scene contains relevant excerpts from the conversation with the Cameo (myself), who entered the milieu in an investigative mode. The CIO (1) has now retired and CIO (2) is currently in the role. However, both are in the focus group.

Cameo: *How was RFID technology considered for the hospital?*

CIO (1): *The hospital received A$70,000 grant from Department of Health Services in Victoria for wireless equipment in theatres. We then partnered with an RFID tag/equipment provider who was well known in the sector (having trialled RFID) and deployed Cisco network designed for location-based services 18 months prior as part of network rebuild.*

CIO (2): *Basically…when we did the network upgrade three years ago, as part of that we decided to put in a hospital grade wireless network…Since then…few other things come up but Department of Health Services put out bids for money for various trials, and the orthopaedics department decided they want some money.*

Cameo: *In terms of where these things started…who first started talking about this? Was it an ICT department initiative or was it medical staff or the management strategists saying 'we must get into this'?*

CIO (1): *ICT had this medical-grade wireless network that we weren't actually doing anything with, so let's get some benefit out of the wireless network that was put in.*

Cameo: *Was the nursing staff or the clinical staff or the orderlies or anyone else been involved in the discussion underpinning it, or were they treated as just an amorphous user group?*

CIO (1): *The nurses just treated it—the patient tracking was just another process. Infection control people got involved because it's going to be on the patient's skin so you've got to clean it between patients and things like that.*

The orderlies were supposed to remove the tags when the patient either went to the ward or went home…and the first time they didn't do that we could bring up and say, you know, patient so-and-so, their tag is in their room, it's either on the foot of their bed or it's in their document file, or something like that. That scared them a bit when they realised we could track the patients to that level.

Cameo: *Was there a training process—you mentioned for the orderlies?*

CIO (2): *For the orderlies, we keep re-training and re-training and I don't think we ever achieved 100 per cent tag removal, but we tried hard. But certainly the patient team, the tags going on was 100 per cent; the nurses had no problem with that. So we got everyone involved and the trial went really well.*

Cameo: *What was the purpose for using RFID?*

CIO (2): *Orthopaedics wanted to track patients through the theatre process to see if there was any particular point where the patient's journey was delayed or where there were undue problems and that's where it began.*

CIO (1): *The original idea was to track a patient journey through the operation theatre suite and record dates and times for use in the patient management system (iSoft). Until HL7 messaging was enabled, data was recorded in databases and transcribed to iSoft iPM.*

At this time, the Cameo's interest was to find out who initiated the technology as a solution into this context, and the purpose for which it was deployed. The following conversation ensued, which detailed that the theatre manager (nurse) was the initiator of RFID through the orthopaedics department. It was triggered by a US hospital-based white paper, where this had worked out well. This was the supporting rationale for the grant and pilot deployment in this hospital.

Cameo: *Who was driving the RFID deployment?*

CIO: *Well the theatre manager (nurse)…was the driving force behind it because she had been elsewhere and there was also a white paper, that came out from USA where they knew it was the surgeons causing the delay. Here, (in Australia) you can't tell surgeons they're the delay, so they ended up putting a big display board up which tracked the patients through and after…so the surgeons could sit there and say, 'Hmm, there's a patient there waiting, and they're waiting for me—maybe I should be doing something, yes'.*

Cameo: *So in the Australian hospitals, we cannot tell surgeons directly that they are causing delays, correct?*

CIO: *No, surgeons have to be made aware subtly—that is the way it works…Anyway, for the period of trial, they had exact information on every patient and we could…*

The Cameo noted that it was evident that in the Australian context, for smooth workflow to occur within the hospital, communication must be subtle but clear. Referring back to Case-1, the communication between orderlies and nurses was also subtle and often regarded by technologists as unnecessary; however, it was necessary for smooth functioning of day-to-day operations and the adoption of RFID in this context. Subsequently, the Cameo investigated what was actually trialled.

Cameo: *What was done in this pilot? How was it done?*

CIO (1): *Tags were attached to ankles and wrists (wristbands) of patients as well as equipment. The hospital was able to accurately record patient flows, including entry into the theatre, various stations along the journey, could view tags moving on floor plan in real time and get information on which patient was in which theatre or at various stations in real time.*

The pilot involved only hip/knee surgeries…the system logged the exact time and with that they could see exactly how long it took the patient to go through the entire process. As part of the patient check-in they got the wristband, their details were recorded in the system and the system then tracked that wristband as them for the rest of their journey.

At this time, Cameo is given the theatre arrangements map as well as an explanation with a sample (see figures), on results that are anonymised—reflecting the effect of RFID in improving the existing process. The theatre diagrams reveal the exit points where RFID systems track the equipment and people in motion.

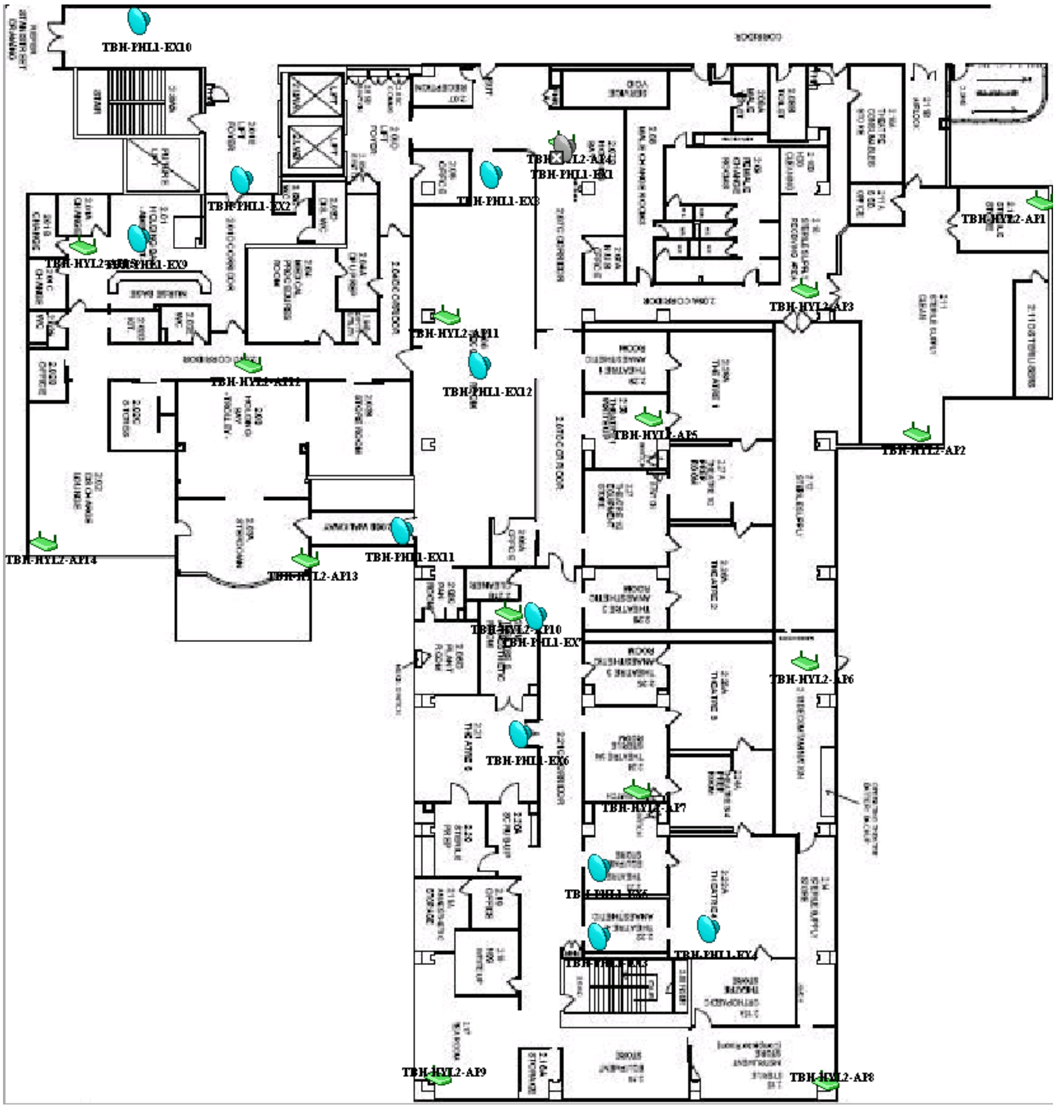


Figure 5.1: Theatre Arrangements (Source: Internal documents).

Table 5.3: Details of the Patient Journey

Asset Name	Date	Event Name
john smith 123456	25 Nov 10 12:54:33	DSU Entrance
john smith 123456	25 Nov 10 12:54:39	DSU Holding Bay
john smith 123456	25 Nov 10 13:34:42	Holding bay
john smith 123456	25 Nov 10 13:44:37	OT5 Anaesthetic Room Entrance
john smith 123456	25 Nov 10 14:05:45	Entry into Theatre 5
john smith 123456	25 Nov 10 16:02:18	From Theatre 5 to Recovery Room
john smith 123456	25 Nov 10 17:36:24	Recovery room to wards exit
jill smith 234561	25 Nov 10 12:32:07	DSU Holding Bay
jill smith 234561	25 Nov 10 14:08:52	Holding bay
jill smith 234561	25 Nov 10 14:51:22	Outside Theatre 4
jill smith 234561	25 Nov 10 15:19:21	Entry into Theatre 4
jill smith 234561	25 Nov 10 17:32:13	From Theatre 4 to Recovery
spot dog 345612	25 Nov 10 11:33:42	DSU Entrance
spot dog 345612	25 Nov 10 11:34:25	DSU Holding Bay
spot dog 345612	25 Nov 10 12:07:04	Outside Theatre 4
spot dog 345612	25 Nov 10 12:32:35	Entry into Theatre 4
spot dog 345612	25 Nov 10 14:48:59	From Theatre 4 to Recovery
spot dog 345612	25 Nov 10 15:40:13	Recovery room to wards exit

CIO (2): *John Smith is wheeled through to waiting—the day surgery holding bay. So he goes through the entrance and then six seconds later he was sitting in the holding bay…Then almost three-quarters of an hour later he went 'round the holding bay and got put on a trolley. He then went to anaesthesia outside theatre…10 minutes later he was at the anaesthesia room entrance, and then it took 20 minutes to get him under, and then they moved him into theatre five. And he was in there for almost two hours! Then, from theatre five to the recovery room, sat in there 1.5 hours and then they sent him up to the ward.*

Jill went the other way—she went straight to the holding bay; she might have been on a bed in day surgery rather than in the waiting area…she probably sat or lay on a bed for a couple of hours, then into outside theatre four for anaesthesia, into theatre four, back to theatre four recovery, and looking at the time…So basically 29 minutes later she went into theatre four. And because she came out at five-thirty, they took the tag off her then, rather than take it…That was just their policy—after five o'clock they didn't worry, they would just recover the *tags as soon as possible, which is why there is no recovery room to ward or recovery room to home because they took the tag off before she went anywhere.*

Spot Dog—Much the same—he came in, sat around for half an hour…didn't sit in the holding bay, he went straight to outside theatre four, so they were either running behind or they had a slot and put him in real quick…two hours in theatre, and then he left at almost three o'clock. An hour in recovery…then they took him back to the ward.

Cameo: *Was there response from the surgical staff…for example, feeling that they were being closely monitored and that it was looking at their productivity, in principle—and one could have actually analysed and said, 'look you're taking two hours to carry out that procedure; it should be no more than 45 minutes, what the hell are you doing?' But there was none of that kick back or response?*

CIO (2): *I think that was going to be the next part of it.*

Cameo: *It potentially is a problem isn't it, because it can be actually used to monitor surgical efficiency?*

CIO: *As I say, the white paper…from in the states,, they had just a TV display and you could see where the patient was at each step of the way, and the surgeons themselves picked up the fact that the patients were waiting at particular spots.*

Cameo: *So there were efficiency issues and presumably that could be dynamite in the hands of a politician who had an axe to grind, or if it ended up in the courts,*

CIO: *Yes, There are limits. In each of these, you don't see that there are alarms set. So, if someone is sat in the holding bay for a period of* *time…or say 10 patients are in holding bay, alarms could be set up…we are looking into it.*

It was evident that patient tracking was successful, but a full implementation needed to have consent also from medical staff at some stage. In Australian hospitals, monitoring staff directly or indirectly poses an issue if it is done without consent. From the documentation available, the Cameo was aware that the pilot was successful, but subsequently, a full implementation was not undertaken.
To seek clarification, I continued the probe.

Cameo: *The pilot was successful but it did not develop into a full-scale implementation in theatres…what happened?*

CIO: *HealthSmart in Victoria did not approve to send HL7 messages to iPM to enter data into the PAS in real time, and therefore, the project was abandoned, as efficiency was minimal. A nurse had to still physically enter details and be present throughout the patient journey. The nurses accepted it at the beginning but after six months they said, 'you've had a good trial, we don't need to do this manually any more, use the tags for something else', which is what we did—we just repurposed them and used them for something else. They weren't lost or anything.*

All the equipment in the theatre has been turned off at this point but I would suspect that it will probably come back on again some time this year or over the next few years. We put in another bid for more equipment and if we're successful there will be about another 1,000 tags put out in the field.

In summary, the pilot was successful, but it was due to operational difficulties with compliance that the technology was rendered inefficient. The theatre nurse who had initiated the technology use in the operating theatres had asked the ICT department to repurpose them for another area, as they were unable to utilise it. The Cameo also noted that the recommendation was to re-deploy RFID in another suitable area rather than abandoning it.

It was also notable that the nurses had ‘one’ voice, which was given via the theatre nurse as the spokesperson. It was interesting that the voice of the nurse was considered powerful enough for the ICT department to consider RFID as useful for another area.

5.3.2 Scene-2: Re-casting of RFID in a new role

In this scene, the Cameo, in an investigative mode, explores the re-positioning of RFID in the hospital. As understood from documentation, the nurses had recommended moving the RFID tags and equipment to the ICU and related wards for asset-tracking purposes.

Cameo: *As I understand, RFID tags/equipment were re-purposed and re-located?*

CIO: *Asset management and some of them have actually gone up to the ICU for the bed tracking…believe it or not, they are using it to track their beds because their beds wander off over the weekend and they want to know where they are on Monday morning. Something as simple as that, it’s a start. Some of their critical resuscitation equipment is taken as well so they lose the area.*

The beds go down to the catheter lab or the beds go down to the theatres, and they put them straight in the beds. Sometimes the beds come back to ICU and sometimes they go somewhere else. Someone else grabs them and they end up in another ward or they end up sitting in an alcove off a corridor somewhere.

Cameo: *And what sort of devices are they putting them on?*

CIO: *…high-value assets…Computers on wheels, ICU beds, emergency resuscitation equipment—it all came back from the fact that after ED had their little rework last year, there was a $30,000 piece of equipment* *that no one could find anywhere—it had been submerged somewhere during the refit.*

Cameo: *Was there a process before RFID tracking equipment, or was it reliant on orderlies presumably returning it?*

CIO: *Well, it may be orderlies or the manager of the department saying 'that's pretty great, I'm going to stick that away over there'. Then the manager goes away or gets changed…then where is the equipment—no one knows. They've got no recollection of where that was left.*

Cameo: *Was there a notion that there was already built with this pilot about RFID tracking capabilities?*

CIO: *Well, the biomedical people, we'd given them a little taste…tracked a few of their fusion pumps. When they go to do a service on the fusion pumps, it can take them three and a half to four weeks to locate them all—they loved the fact that they can press a button and at least find four of them in a minute and a half. So they're quite happy to go down the 'yes let's tag everything' path because it saves them a lot of time.*

And we use the simplest interface—just have a webpage that shows you a picture of where they are.

Cameo: *So that overcame this problem that was the stopper for the patient-tracking using RFID?*

CIO: *Yes, because that doesn't need to go back anywhere—it's all internal basically, it's all within the hospital. Clinical staff also thought it was a good idea.*

In summary, I made a few clarifications. First, as the nursing theatre staff initiated the recommendation, medical staff and others regarded it as worthwhile. Specifically, they did not feel that the technology was being imposed on them. Equally, the ICT department was supportive in that they made the simplest interface possible at the beginning—that is, a web page that could track where the equipment was left—to enable a smooth transition.

The move from the theatre area of tracking the patient journey to the ICU area for asset-tracking was an internal decision driven by the actual caregivers (i.e., frontline staff who support the clinical area, namely nurses), and this trait made the RFID adoption easier. RFID was re-purposed and re-located.

5.3.3 Summary

In this hospital, RFID was debuted into the operating theatres by the orthopaedic department and nurses, enabled by a grant from the Department of Health Services. Full implementation was possible after the success of the pilot, but was abandoned because 'Healthsmart'[23] would not allow for the results to be entered directly into the iPM (or patient management) system, which was a legal requirement at the time in Victoria, Australia. Subsequently, influential nurses suggested that these tags/equipment might be used for asset-tracking in ICU or critical wards. On this recommendation, RFID then debuted into the ICU and wards.

The original RFID tags that were obtained by the orthopaedic department moved on to the ICU and wards to track assets on the recommendation of nursing staff, who found the tracking capability supportive of their work. Clinical staff were comfortable with the idea already and posed no objection. Orderlies were already aware of what needed to be done with patients, and they felt that it was just a move from one place to another.

More important was that medical staff did not feel imposed upon by the RFID tagging, which indirectly tracked their productivity. In fact, they felt that it was useful for them to be able to track and reduce the waiting time of patients, thus rendering a better quality of service. It is notable that having the introduction done by medical staff (nurses) helped the communication flow and acceptance of RFID into the context.

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[23] The HealthSMART Program was announced in 2003 as a total revamp of Health IT in Victoria's public health system. In May 2012, the Victorian Government made the decision to scrap the HealthSMART system, which was years overdue and had run hundreds of millions of dollars over budget.

5.3.4 Act-1 through the ANT Lens

Table 5.4 identifies the actors who were initially involved in Act-1. The 'existed' column represents actors who existed and are relevant to this Act. They either exited, sustained or transformed towards the end of this Act. For example, RFID tags entered into a department and moved to another department and transformed from the role of tracking the patient journey to tracking assets in the ICU.

Table 5.4: Actors and Roles in Act-1

Actors	Existed (in the blackbox)	Entered	Exited	Sustained/ Transformed
DHS		X	X	
Symposium Article		X		X
RFID (tags, eqpt) (External Company)		X		X
RFID Pilot Results		X		X
RFID Maps		X		X
CIO (Old)	X	X	X	
Cameo		X	X	
Nursing Staff	X			X
Orderlies	X			X
CIO (new)	X	X		X
OHS	X			X
Infection Control	X	X		X
ICU	X	X		X

RFID had initially debuted to track the patient journey in the operation theatre suites (or OT). The actors who were involved then included nurses and theatre staff (patient care orderlies). Nurses saw RFID tracking as another process they had to get used to and did not see it as an imposition. Orderlies who moved patients had to ensure that tags were in place. However, they were not involved with tagging at the time; rather, they were indirectly involved. Nurses felt that RFID was really successful in its role and empowered them to see the results quickly. At the end of this Act, nurses and orderlies had transformed into the role of influencers for RFID. Hence, their roles are shown as sustained, rather than exited.

All human and non-human actors in the blackbox existed before the entry of RFID. The DHS and RFID (tags, eqpt, external entity) entered the milieu as actors. The new CIO was then the Deputy Head of ICT Operations. I entered into the scene as the Cameo in an investigative relationship. The DHS had entered into a circumstantial relationship with the CIO in the blackbox and exited at the end of the Act. RFID entered the milieu in a circumstantial relationship with the ICT department via the CIO, as the grant was given for it to be implemented in the OTs to track the patient journey.

The Cameo entered this scene to investigate the situation having imbibed the published information in technical journals, combined with the symposium results on RFID. At the end of the scene, DHS had exited (after the grant was given) and the Cameo also exited. However, the relationship was sustained for further investigation. The CIO (1), who was also the champion of RFID, also exited the scene, taking retirement and passing on his role to the current CIO (2) (who was then Deputy Head of ICT). The 'Infection Control' staff and 'OHS' were involved in the RFID implementation and had interacted with the actor in relation to tagging equipment and training staff to attach/detach tags. Therefore, these departments were involved and had an influential relationship with the actor.

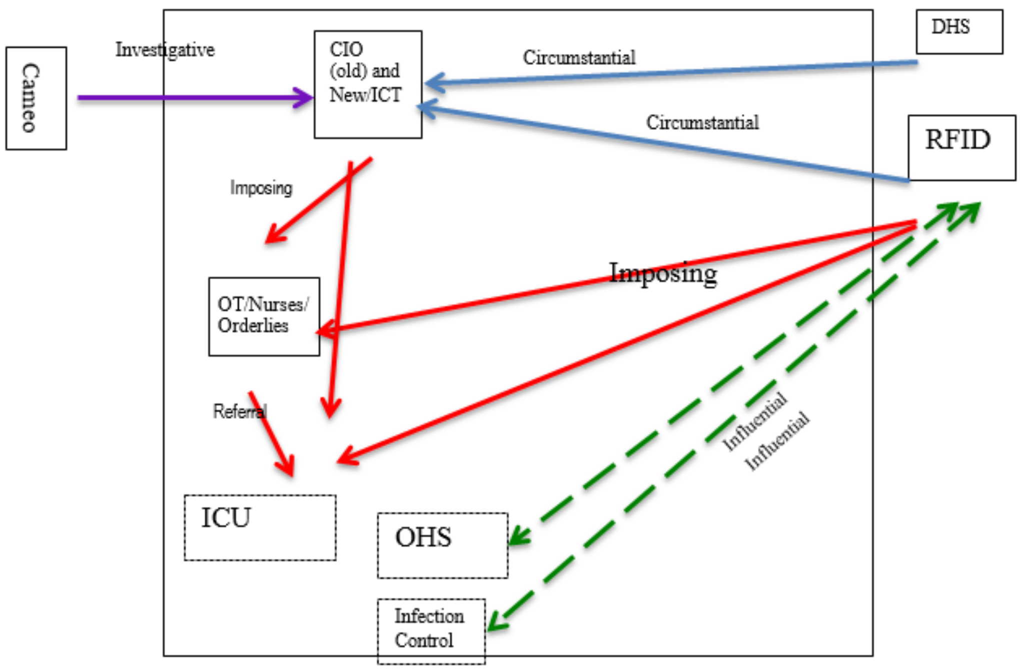

Figure 5.2: Actor-Networks after Act-1

Towards the end of Act-1, the OT/nurses subsequently entered into a referral relationship with the ICU, thus imposing RFID on them via the ICT department.

5.4 Act-2: Exploring RFID permeation in a new Avatar

From the existing information and documents, it became clear to the Cameo that RFID had been introduced in another format known as ‘temperature tags’ by the ICT department. These were not planned for deployment, but rather accidental; however, these tags introduced RFID in a new avatar, which effectively permeated RFID into the milieu. In this Act, the Cameo explores how the new version of temperature tags was accepted into Pharmacy, Pathology, Food Services and Engineering Services. The CIO (2) and representative heads from the departments were involved in the conversations/endorsement.

5.4.1 Scene-1: Temperature rises from Pharmacy, Pathology, Food Services and Engineering

Cameo: *In our last conversation, you mentioned RFID temperature tags. What are these and how did they come into this hospital? Was it a separate initiative?*

CIO (2): *The supplier gave it to us…threw a box of temperature tags…said ‘here, have a temperature tag to play with as well’, so we put it in the fridge and the results were brilliant. We then went to Pharmacy and said ‘would you like to be able to give a five-minute result on all your fridges?’ and they said, ‘yes, thank you’…the exact figures —Pharmacy head will confirm—but approx. 30,000 per month spent, every six months in medicines that have been exposed outside of their temperature range.*

Cameo: *So the temperature tags were actually an accidental by-product of the original one and then you realised the opportunity to do something?*

CIO (2): *Well, once we got it and put it in the first fridge and found the fridge was faulty…Once it's in and you put alerts on it so they know at two o'clock in the morning when the system sends them an email or SMS saying the fridge is out of temperature, they can look at it and go 'they've left the door open', so they ring up and say 'you've left the door open'. And someone can shut the door rather than lose an entire fridge, and usually the information they get is much faster than the existing alert system. They get it so much faster.*

Cameo: *Okay…did these bring about any cost savings, time efficiency gains?*

CIO (2): *Well, the Pharmacy for example…would get the manual reports once a week and have to spend a morning going through the manual reports. Now they just flicks on one sheet and if it's correct—goes onto the next one. Basically, the report is an exception report—if something has gone wrong, the system will flag exceptions.*

In its new avatar, the success of temperature tags being accepted with a relatively low turnaround time for testing was indeed a success of RFID. The concept of temperature tags had been accepted with no problems. The Cameo then probed into the acceptance and diffusion of RFID temperature tags in different areas of the hospital.

Cameo: *So how did the Pharmacy take this idea initially?*

CIO (2): *I sold the idea of temperature monitoring to Pharmacy for refrigerators. T5a RFID tags (including a lithium battery, motion sensor, temperature sensor) to all pharmacy fridges were deployed. Data was logged in real time at five-minute intervals, which then set alarms to notify the pharmacy when temperature varied outside a pre-set range. This data was then used to identify fault fridges. This project was successful.*

Cameo: *Ok, then how did this go to Pathology?*

CIO (1)/(2): *We mentioned the success of Pharmacy to Pathology. They decided to install tags for fridges including sub-zero freezers. Alarms are set to notify Pathology when temperature falls outside the pre-set range. Data is used for accreditation purposes and to identify faulty refrigerators. Pathology uses the refrigerators for blood samples and also for keeping dead bodies in a certain temperature…Subsequently, Food Services began using temperature tags for monitoring cabinet temperatures…it worked too.*

Pathology liked what we were doing with pharmacy and said, 'We'll be in on that'. They did their manual tracking for about two hours and said, 'This is much better than what we can do manually, so we're not interested in doing it manually any more'.

Cameo: *So basically it was as quick as that—a two-hour acceptance? And is this ongoing?*

CIO (1)/(2): *Yes, it's continuing and they love it. Let us look at [a] few examples.*

At this time, a few examples were presented to demonstrate the effectiveness of the temperature tags and how they are used, as follows.

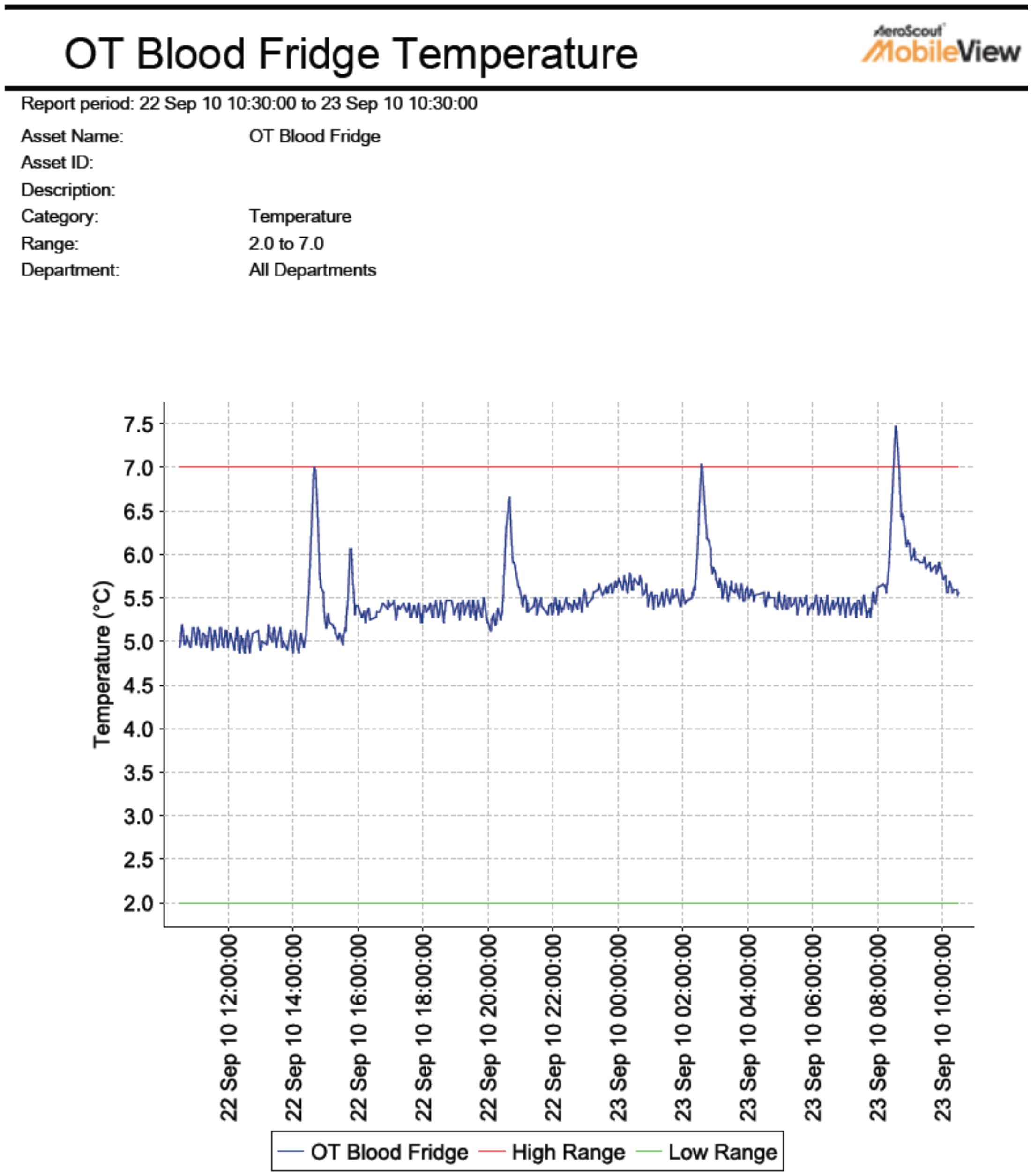

Figure 5.3: Monitoring Blood Fridge Temperatures with RFID

CIO (2): *Yes, for example—this is a pathology one—they're its parameters, 38–45, has to be triggered for 10 minutes…it reminds you every 15 minutes until it's resolved…it sends an email to—paging messenger group 1240.*

If it is at the ED trauma fridge—it sends to the pharmacy alert staff that this alert has been triggered, as well as sending to the ED shift manager, so not only the pharmacy manager knows about it but the shift manager knows about it and can do something about it, probably before the pharmacy guy can ring the phone and say, 'what's wrong'?

It was clear that both the Pathology and Pharmacy departments had accepted the temperature tags with low turnaround times. There was not much convincing required for testing and acceptance.

Cameo: *How about Food Services?*

CIO (2): *Food Services were the next one—we gave them—they thought 'this is a good idea', and we gave them their tags and we sat and monitored for a couple of days and asked when they wanted to go live. They said 'let's go alive now', so we switched it alive and within half an hour the system had discovered one of the fridges had gone faulty and the operator had merrily logged the fact that the temperature was rising and hadn't done anything about it.*

Cameo: *So it was almost an immediate payback, within an hour or so in fact there was a significant problem?*

CIO (2): *Well, the payback was that it was prior to a weekend, so if we hadn't caught it they would have lost the entire weekend patients' food and they would have had to resupply it from somewhere else.*

Cameo: *So basically that one was already break even on the first couple of days?*

CIO (2): *That's it—they paid for themselves after the first hour basically.*

Food Services took on the temperature tags very quickly. At this stage, a Deputy Pharmacist (P) joined the conversation as the representative for Pharmacy. The Cameo focused on the Pharmacist to obtain his views, as it was evident that Pharmacy was the most successful and influential in further diffusing the new avatar of RFID.

Cameo: *From your viewpoint, how did RFID temperature tags come about in your area?*

P: *…it was IT came to us and said, 'hey this is possible—we've got the Wi-Fi'. Before we had Wi-Fi, we had manual tags, which recorded everything, we manually pick them up—each week—I would download everything and then see…Wi-Fi gave us ability to set alarms, ability to have real-time monitoring...saved us at least a couple of hours a work week. Now we get reports once a week and look at them, but if we get any alarms, basically we follow them up. Alarms come in an email and to my phone. But now with Wi-Fi phones take-up, whoever in charge in the wards can get it too. So they can just go shut the fridge door (almost 90 per cent of the time). Otherwise, if it is Engineering problem, then we can move stuff to another ward fridge and get the technicians in next day.*

Cameo: *Who are all involved in it really?*

P: *We kept it just to myself and the director…if we pass on to an on-call pharmacist etc.—people wouldn't be familiar enough with the fridges and what was happening. If every time they alarm they rang up a call or call back or whatever…*

Cameo: *How about cost savings?*

P: *Well there's time savings for staff each week, and also not having to throw drugs out as well because with the old manual downloads every week, we'd download them and if we did find the fridge had gone out, it would always be at the very least a day or so, up to a week, and then we'd just have to throw the drugs out. That would be a cost.*

Cameo: *And what typically would be the value of a fridge full of drugs? It would depend on what's in it I suppose. Are we talking tens of thousands, hundreds of thousands, hundreds of dollars?*

P: *The ones on the wards, hundreds to low thousands, so anywhere between a couple of hundred dollars to say 2,500 it might be. A&E there's a bit more because they've got some anti-venoms and things in there. The pharmacy fridges, there's hundreds of thousands of dollars in a couple of them.*

The Cameo realised that there was significant cost savings, a tight control by a few senior staff at this stage in the Pharmacy area with temperature tags. It seems to work well for them. If a fridge dies, it could cost a significant amount to replace the drugs, including anti-venoms. Therefore, the role of RFID in temperature tagging was significant. The Cameo then probed into the permeation of RFID into Food Services.

Cameo: *Did you actually talk to any other person, say for example food services?*

P: *I didn't no—the CIO may have.*

CIO (2): *Pathology followed on from Pharmacy and then in Food Services, we just sort of gave them to them and they said, 'Yes we'll have that'…I had shown them some of the results coming out of Pharmacy.*

Engineering…were the hardest but once they saw it in place and saw the results, they thought. 'this is a good idea, we'll buy some of them ourselves'…Engineering really did not want to do anything about it when it first came out have jumped on board and they used them everywhere. They use them when people complain about air-conditioning because you can put a tag there and within 24 hours they have a complete history of the temperature within that location and they can say, 'it's actually not the temperature but it's the fan that kicks on at three o'clock in the morning that causes the problem'.

Cameo: *How about efficiency improvement over the manual or old systems?*

CIO (2) *…they were all manual-based systems where the staff member would have to go and check…they would have to actually go to the fridge (daily or monthly) and log whatever was on the thing and log it again on a manual system…visually inspect the recording. For example, pathology is monthly—they get all the alerts in between, but they get a physical file once a month—an electronic file once a month with all the results from that particular tag, so it's quite easy to see whether it's been in and out—it can reach the alert temperature but not be there for long enough to actually generate the alert, so we had to work out a few parameters. So the temperature was all manual and was converted to fully automatic.*

Cameo: *So apart from the benefits of performance that you couldn't get before, in terms of cost savings, they're largely the tasks that someone would have had to do in the past? Are the real savings time savings to a person in his position?*

CIO (2): *The pharmacist used to take half a day…he's got 30-odd fridges, so he's got to go through 30 emails or something like that, but that's about all. A task that would have taken him several hours going through manually compiled reports, he can basically just look at the exception report, which has already done all of the scanning and screening for him, and cut a job which could have been several hours down to 15–20 minutes.*

Cameo: *So that's significant cost savings.*

CIO (2): *Under the old system, they couldn't guarantee that the temperature hadn't been outside the range they were looking for between sampling periods because when they checked the samples it could be fine, whereas with this they know if it's been outside the range for the entire period.*

It was clear that there was time, cost and efficiency savings using the temperature tags or the new avatar of RFID.

5.4.2 Act-2 through the ANT Lens

Representatives of Pathology, Food Services and Engineering endorsed the conversations that included the CIO and the pharmacist. Subsequently, I identified the actors involved in this Act, as presented in Table 5.5.

Table 5.5: Actors and Roles in Act-2

Actors	Existed (in the blackbox)	Entered	Exited	Sustained/ Transformed
Symposium Article		X		X
RFID (tags, eqpt) (External Company)		X		X
RFID Results		X		X
RFID Maps		X		X
CIO (Old)	X	X	X	
Cameo		X	X	
Nursing Staff	X			
Orderlies	X			
Pharmacy (Dpty Pharmacist)	X	X	X	
Pathology	X	X	X	
Food Services	X	X	X	
Engineering	X	X	X	
CIO (new)	X	X		X
OHS	**X**			**X**

Some of the actors/actants from Act-1 remained in the blackbox. In this Act, Pharmacy, Pathology, Food Services and Engineering, along with RFID temperature tags, entered the milieu and interplayed with each other along with the CIO (2), who is now the reigning champion of RFID. I re-entered the scene as the Cameo in an investigative relationship to study the permeation of RFID temperature tags or RFID in the new avatar in the three departments.

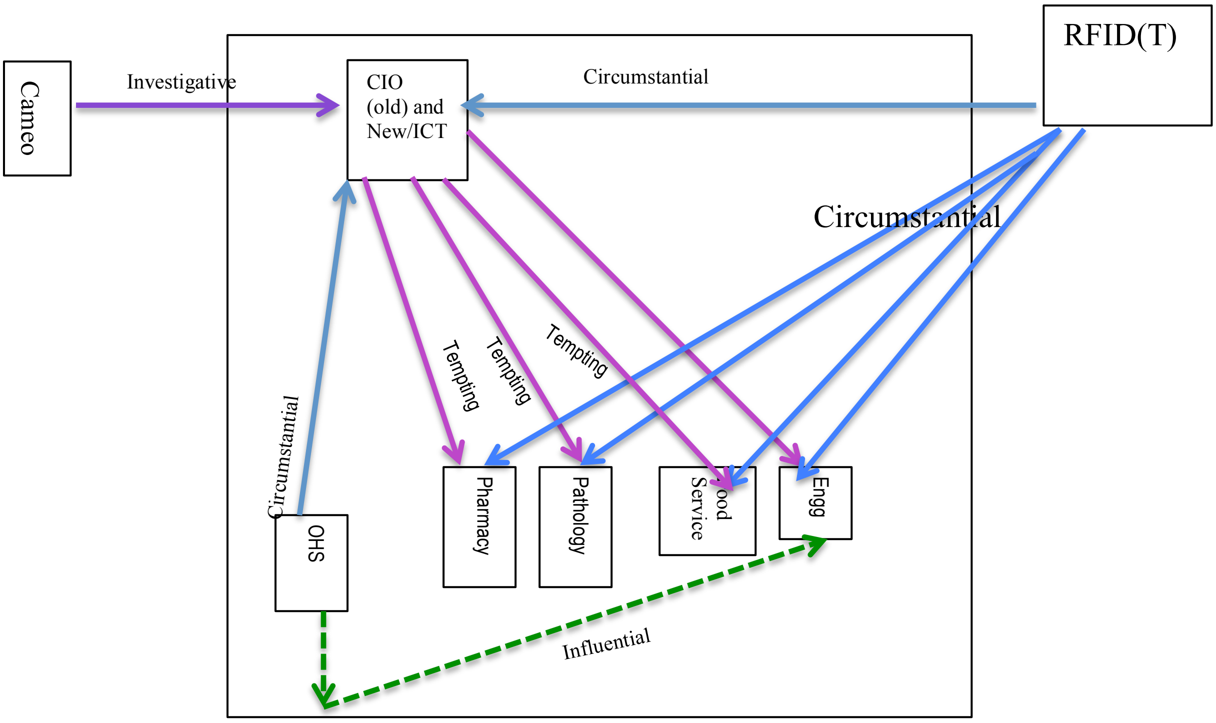

Figure 5.4: Actor-Networks after Act-2

In this Act, RFID is in a new role (i.e., temperature tags), which is circumstantial (or incidental). The CIO/ICT with the ICU enters into a 'tempting' relationship (armed with temperature tags) with Pharmacy, Pathology and Food Services. It should be noted that this temptation was initially given to Pharmacy, which had exhibited positive results. The CIO/ICT department showed the results to Pathology, which then took RFID on board. Similarly, the results of Pathology and Pharmacy were shown to Food Services by the ICT department.

In all cases, RFID had a circumstantial relationship via the ICT department, which had 'tempted' the departments via RFID tags that were incidental (not the same tags as OT) with the original planned implementation in the ICU. The other departments had come on board, seeing the results from each other through the eyes of the CIO/ICT department. The last to enter the milieu was Engineering, which was influenced by the OHS audit, which required hot and cold temperatures to be monitored in staff recess areas. Here again, a circumstantial relationship was established between OHS and the

ICT department, which enabled the ICT department to show the results from the three departments to Engineering, thereby getting into another tempting relationship.

In this Act, several roles do not have relevance. For example, nurses and orderlies were not involved in the permeation of RFID temperature tags into these departments. Hence, they are not shown in the diagram. Further, the DHS had exited Act-1. Infection control was not involved in the permeation of the temperature tags.

It should be noted that this research project originally began investigating the role of RFID in improving efficiency in 'asset-tracking' within the Australian hospital context. However, the RFID temperature tags were not meant for asset-tracking. Nonetheless, the incidental tags improved the efficiency within the hospitals and improved the environment. Hence, the new avatar, or role, of RFID was significant.

5.5 Act-3: Managing Duress with RFID in High- and Aged-Care Facilities

Towards the end of Act-2, the Cameo chanced upon the fact that the hospital was experimenting and had deployed RFID for managing staff duress, or 'staff tags'. It was not clear where this began; hence, the Cameo decided to investigate the concept. The following conversation ensued between the CIO (2), OHS and the head of a high-care facility within the hospital.

5.5.1 Scene-1: Tagging Staff for monitoring Duress

Cameo: *There has also been an initiative in duress alarms. How does RFID figure into this?*

CIO (2): *Staff duress alarms are for staff safety—they press the button and the system alerts other people that they're in duress…it's just a little tag with a button on it—you press it a couple of times inside of 20 seconds.*

Cameo: *So it was triggered by an audit? How did OH&S play a role in this?*

CIO (2)	*The OHS department had an audit…they needed a solution for managing staff duress. And there was also an incident. A theatre cleaner had a heart attack in the middle of the night and no one came running. So before he came back to work as part of his OH&S plan, they needed a process to be able to prevent further recurrence of being isolated.*
Cameo:	*Okay, so basically there had to be OH&S assurances that that situation could not arise again? And I guess there are all sorts of legal implications and so on for that.*
CIO (2):	*Yes, OH&S came looking, there were a few options and…I said why don't I just give you a roaming tag, and he presses that? The earlier CIO and the residential manager of nursing facilities was also pushing the concept of duress alarms at some stage…and here was an option, it works better…Originally, the tags went to high-care residential facility area with mental disorder and violent patients…there were instances where staff was assaulted. Then, aged-care communal areas were then covered for 'staff duress' using ultrasonic tags and ultrasound exciters across 40-room facility, which received commendation from aged-care audit…originally it went to high-care residential facility with mental disorder or violent patients…there had been a couple of instances where staff had been assaulted.*
Cameo:	*And how did RFID get picked up as another use? Was this initiated from the IT people or someone directly in nursing?*
CIO (2):	*There was a question raised from the nursing staff and we went out and said 'well, hang on, we've got an RFID back end, why don't we use it'? So at the high-care, there's three levels of tracking…Wi-Fi tracking, ward tracking as they move in and out of the wards, and actually room tracking so we can get them almost to the exact location, and that seems to work really well. Because we had the tags and Wi-Fi, we've now*

gone to a roaming duress situation where overnight there are two or three areas where there is just one staff member. For example, the theatre cleaner and he had a heart attack and was on the job, and it was a couple of hours before anybody found him. He was quite happy, he was fine, but now he has a tag.

So it's expanding—so there's the theatre, there's another facility where there is just one staff member looking after low-care patients that are on their way home basically or going to go into surgery first thing in the morning. There's all of the Food Service people who work after hours, and it's just been expanded again—there's a ward that only has one staff member overnight so that means a tag.

At this stage, it was clear that there were a few triggers that introduced RFID tags for managing staff duress. First, the CIO (1) and theatre nurses who had originally influenced the repurposing of RFID from tracking the patient journey were pushing for the use of RFID in duress alarms for staff. They had tried the RFID tags for tracking the patient journey and knew its benefits in being able to track where people were in stressful situations. This aspect was further strengthened by the case of the theatre cleaner having a heart attack while on duty and no one was watching. OHS needed a good solution to address the audit and legal issues. The ICT department had championed RFID as a solution in the aged-care facility and subsequently received a commendation. At this point, I wanted to investigate the previous way of managing duress in the hospital in order to verify the improvement that RFID had made. I also wanted to check on the uptake of the new tags, as the staff may have felt that they were under surveillance.

5.5.2 Scene-2: Exploring translation of RFID duress Alarms

Cameo: *In these high-care facilities, they did not have any other systems in place to manage staff duress?*

CIO (2) *Their existing duress system…basically a buzzer…makes a horrible noise…that upsets all the patients, so the patients come to see what the* *noise is and the incident increases. Whereas with the RFID version—they get Jamaica (SW) on their phones and it tells them where to go to…basically, it tells everybody that you need to know about it exactly where the staff member is when the button is pushed, and it continues to track the button until that incident has ceased.*

Cameo: *Okay, so if the medical staff were in fact being grabbed or dragged away they would be tracked, so it wouldn't be a matter of running to a particular ward and finding that there is no one here and we've got no idea where this staff member is?*

CIO (2): *The instant view which pops up on all the screens shows the tag map facility and as the tag is moving around.*

Cameo: *Have there been cases where it's had to be used since, that have convinced people that it's…?*

CIO (2): *It gets used regularly. I couldn't tell you how many—it depends on some of the patients—if they have a bad day, it might get three or four alerts a day, or it might get one a week—it just depends on the patients.*

We thought the big problem we would have would be that people wearing staff tags would say 'you're spying on us' or whatever. We tell them it's anonymous—the only thing on the tag is a number, we don't know who picks—the high-care has just a big basket and they can all pick a tag and whatever. We also tell them that unless we're looking at an incident, it's always past history…the only unfortunate occurrence is that if they are in the toilet and being tracked! Here is the arrangement in high-care facilities.

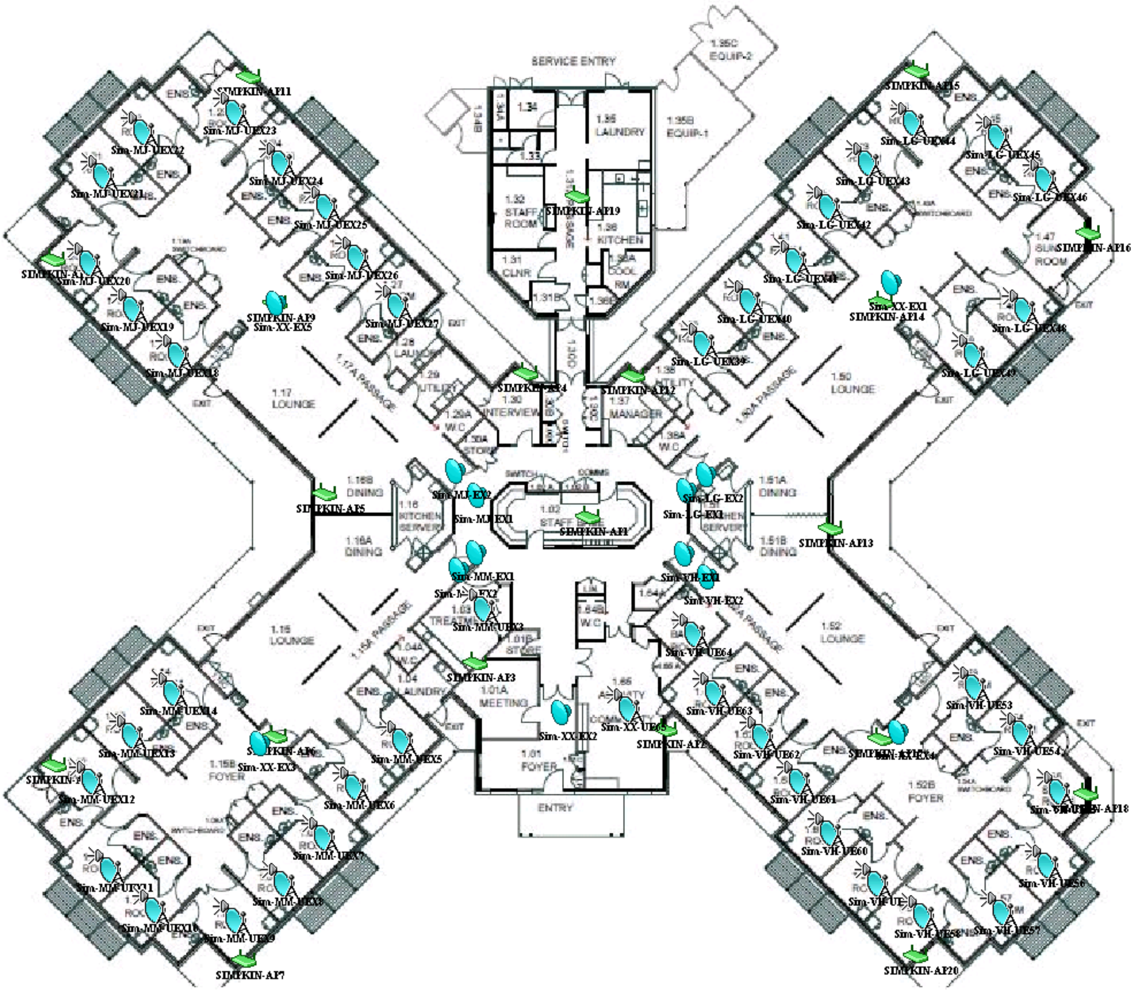

Figure 5.5: High-Care Facility Arrangement (source: Internal hospital documentation).

CIO (2): *Referring to the diagram—In the high-care, common area and the various wards…we have a full-encompassing Wi-Fi environment, so we can three-dimensionally track them. At the same time, we have an exciter in each room and we have a pair of exciters leading into each ward, which is what those alerts are—as they go through each pair, it knows exactly which ward they've moved into. So it gives us three levels of value adding to the duress—we know which ward they're in because they've gone through the exciters, so if the Wi-Fi drops down at least we know which ward they're in. If the Wi-Fi is working and everything doesn't work, 2–3 metres, we're going to get it that way. And then with the room exciters, we know exactly where they are.*

Cameo: *So, the uptake of tags are now very much part of high-care? Or anywhere else?*

CIO: *High care had it the longest. We now also have the roaming duress alarm for staff involved in another facility, under maternity. A lot of young mothers come up here to deliver without telling their husbands in Melbourne for particular reasons that they're delivering up here, and the husband usually if he finds out…storms into the place. The reason is usually that there is an intervention order…so staff have to say 'go away'. For instances such as this, staff may be working out of hours…they use a roaming tag.*

At this stage, it was clear that the concept of using RFID staff tags had been accepted into the hospital due to its various benefits. There was no issue with surveillance, as the use of duress alarms was clearly spelt out and experienced by them. The Cameo then decided to have a final conversation with the ICT department to consolidate the role of RFID, the process of translation and its future, which is presented in Act-4.

5.5.3 Act-3 through the ANT Lens

In this Act, it became apparent that the original RFID tracking tags that were used for tracking the patient journey through to theatres was translated efficiently into staff tagging or duress alarms. The actors and roles in this Act are presented in the table. It may be noted that the temperature tags and related departments do not have a role in this Act.

Table 5.6: Actors and Roles in Act-3

Actors	Existed (in the blackbox)	Entered	Exited	Sustained/ Transformed
RFID (tags, eqpt) (External Company)		X		X
RFID Pilot Results		X		X
RFID Maps		X		X
Cameo		X	X	
Nursing Staff	X			X
Orderlies	X			X
High Care Facility	X	X		X
CIO (new)	X	X		X
OHS	X			X
Infection Control	X	X		X
ICU	X	X		X

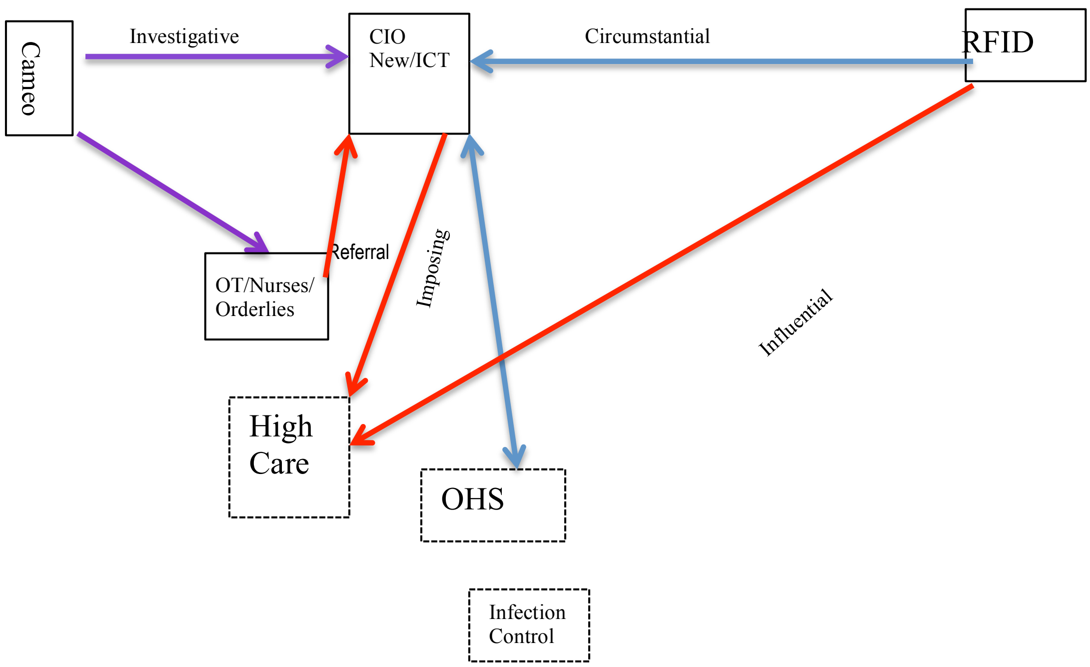

Figure 5.6: Actor-Networks after Act-3

RFID had debuted into the high-care facilities and aged-care facility in the form of staff tagging or duress alarms. The nurses and orderlies from Act-1 had influenced the decision to take up RFID. In this Act, it is evident that they are in a referral relationship with the ICT department. Infection Control and OHS remained in an influential role with RFID as the actor. Infection Control needed to be involved. OHS audit was the trigger for duress alarms. In Figure 5.7, they are shown in a circumstantial relationship with the ICT department (two-way), where the ICT then offers a solution with roaming duress alarms. RFID is in an imposing relationship with the high-care facility. The ICT department imposes RFID on high-care; thus it is in an imposing relationship.
At the end of this Act, the Cameo exits, only to return to the hospital at another time to consolidate the position of RFID in the hospital.

5.6 Act-4: Consolidating the RFID role in the hospital

In this Act, the Cameo had a specific reason to consolidate the position of RFID as an actor in the hospital; that is, to ascertain how the actor had permeated in the context, interplayed and transformed in this hospital. For this purpose, a post-mortem was necessary—or rather a 20:20 vision, looking into the past and future.

5.6.1 Scene-1: Establishing the position of RFID in the hospital

Cameo:	*So what we've talked RFID in place—can we just maybe step through the pre- and post-RFID processes to consolidate the improvement in efficiencies…So patient tracking—was there anything in place at all?*
CIO (2):	*There would have been but it would have been a manual system, and there's no guarantee that the information they put in was exactly…there was some sort of paper-based recording with no guarantee that when it was recorded was the actual time the patient sat in the lounge, or was in the waiting room, or was on the gurney.*
Cameo:	*Was it the manager or departmental head's job to brief the user staff?*
CIO (2):	*Well he basically didn't need to brief after that point because he would get his report whenever he wanted it—either daily, weekly, or monthly—so he has a record to keep everybody else happy. If there's an alert he knows about it, and the person responsible for fixing it knows about it.*
Cameo:	*And for the equipment tracking that is ongoing at the moment, there would have had to be some training on the updates to the software and how to read the software?*
CIO:	*Pretty much you go to the webpage and say what do you want to look at and that's about it.*
Cameo:	*How about training…a half-hour session?*
CIO (2):	*Fifteen minutes is way too long! Usually it is left to department heads and wards…we give them the way to track…beds, equipment, people whatever…when they put in some search parameters…then it is up to each department.*

I do a championing role in that when something is tested to work—then I take the results to the next department…For example, ICU, they're the last ones to cover, which started with their beds, they felt they had a need and heard about this other stuff and said 'tell us about it'.

Cameo: *What about funding?*

CIO (2): *Some internal funds, some budgeted DHS funds, some external agencies—we try from everywhere…and we work along with the department heads—put in bids together.*

Cameo: *Who would you see as being the champions of the technology here?*

CIO (2): *Well on temperature side is the deputy pharmacist who will be here in a little while, but he was certainly the champion of the temperature side and I think everybody else followed after him…they knew they were losing drugs…from the Food Services side, it was me saying how would you like to know what is going on…certainly the senior medical staff are online to do it. The community health are on board and they basically pushed the hospital to deliver programs.*

Cameo: *And going right back to the start, the original patient-tracking initiative, I realise you said there was $70,000—who would you have said was the champion then—going back to the CIO probably?*

CIO (2): *Probably the CIO and ICT manager then—joint champions—one IT champion and the manager. And I sort of got involved after it all started, and now I do it all.*

Cameo: *Just what would have been involved in locating that? We're talking about it could have been half an hour to an hour of a search party compared to almost a couple of minutes to locate where it was?*

CIO: *Well, we know exactly where all the beds are. There's one sitting in recovery so obviously someone has come out of theatre and needs to go into it. And this is the one they were looking for this morning—a medical wing, it's been put there—it's been borrowed over the weekend and nobody knew where it was.*

Cameo: *But it was found essentially just consulting the logs and they knew where it was? And the alternative to that would have been a search party, which could have been an hour or a couple of hours work for a couple of people?*

CIO (2): *We thought wheelchairs were going to be the big thing. There's a couple of specialist wheelchairs for bariatric patients and the non-metallic one for the MRI, so we tried to go around to the people and say 'do you need to know where that is?' and they said 'well yes, but we can live without it for not having for a day or a couple of days' and we said 'well if we put this is on it you can know where it is straight away'. So the bariatric will certainly get done when we get some more tags.*

Cameo: *Has there been any incidents that got these tags mixed up between temperature and tracking?*

CIO (2): *The funniest one I've just thought of just then was we had a temperature tag in the theatre blood fridge and someone had pulled it out and put it back in with the patient tags. So all of a sudden I kept getting an alarm going off in a theatre and I'm going 'what's going on here?' and they'd put a temperature tag instead of a patient tag on a patient, so I was merrily watching the patient's temperature, thinking 'this is very strange'. Then they saw the tag in the fridge and went 'ahah'.*

Cameo: *Where do you see this RFID technology? What's the next big challenge for you? The equipment?*

CIO (2): *The equipment—but making certain it's in place in the new hospital. It's certainly in our specifications, everybody as far as I can tell is on board with having RTLS in the new hospital and tagging, and we talked to the Royal Children's and the mistakes they made when they implemented their new hospital tags and we'll make certain we don't do that in the new hospital. We'll have the Wi-Fi system set up six months before if we can. And the equipment won't leave the loading bay until it is tagged and on the database…basically, the tag will become ubiquitous across the entire hospital, and it's engineered at construction. And with the new electronic patient record, it fits in very—it's one arm of the new patient record—you need to have some form of patient tracking, so the only way to do that is with RFID.*

As such, at the end of this Act, it was very clear that RFID as an actor had permeated and translated well in the role of patient tracking, temperature tags and duress alarms.

5.6.2 Act-4 through the ANT Lens

The actors from Act-1, 2, 3 are merged together, and RFID emerges as a ubiquitous solution that interplays with all actors. The new hospital, DHS and external entities (Private Public Partnerships) enter the milieu at the end of this Act.

Table 5.7: Actors and Roles in Act-4

Actors	Existed (in the blackbox)	Entered	Exited	Sustained/ Transformed
DHS/ PPPs		X		X
Symposium Article		X		X
RFID (tags, eqpt) (External Company)		X		X
RFID Results		X		X
RFID Maps		X		X
Infection Control	X			X
Cameo		X	X	
Nursing Staff	X			
Orderlies	X			
Pharmacy	X	X		X
Pathology	X	X		X
Food Services	X	X		X
Engineering	X	X		X
CIO (new)	X	X		X
OHS	X			X
ICU	X			X
High Care	X			X

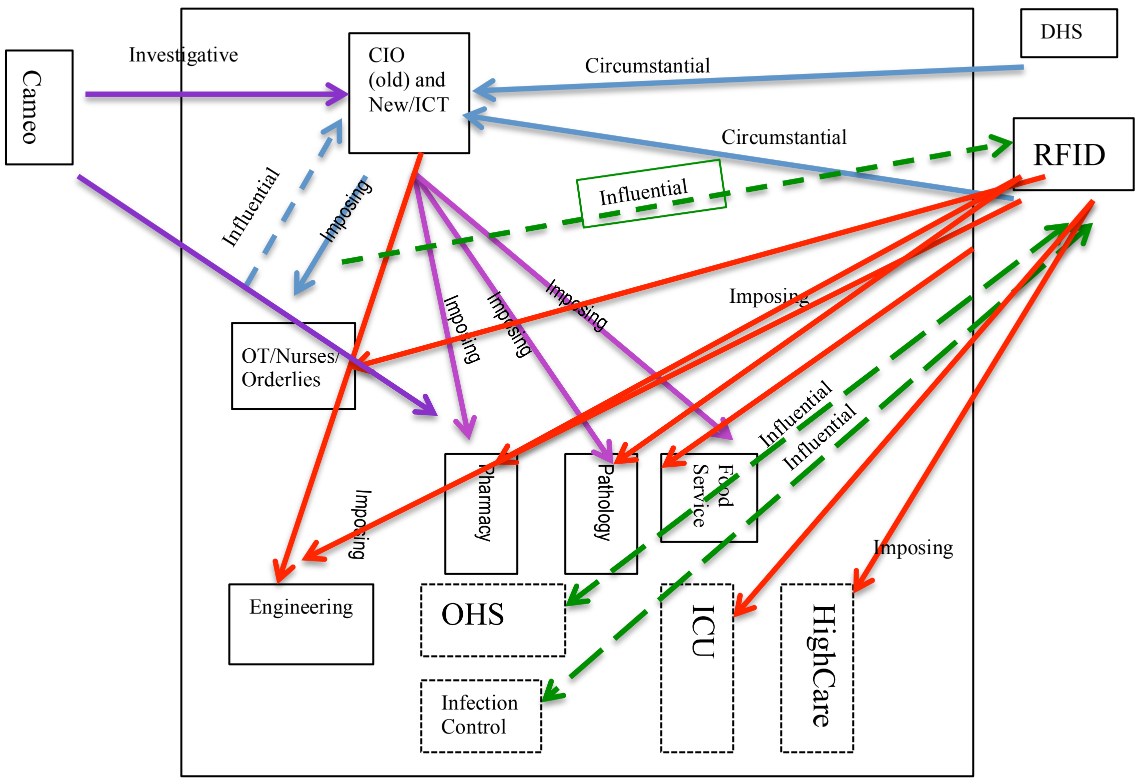

Figure 5.6: Actor-Network Relationships after Act-4

While RFID as a debut actor was being recommended by other actors who interplayed with this actor through Act-1 to Act-4, it was also transforming itself in nature (in terms of two different type of tags, and utility). RFID had an imposing relationship with theatres, including nurses, but did not find it ‘disempowering’. Rather, the relationship was invited in the beginning, although an ‘imposed’ one. This network friendship was the beginning of a lasting relationship wherein the nurses recommended the actor to be taken into other ‘scenes’ in the blackbox. The nurses also had an ‘influential’ relationship with the ICT department to introduce the actor into the ICU for an asset-tracking role.

A different capability of this actor made the champion (CIO) enable a ‘tempting’ relationship with Pharmacy. The success of this relationship then prompted the CIO to enable further ‘tempting/imposing’ relationships with Pathology, Food Services and Engineering.

The capabilities of RFID in tracking resulted in it being referred to the ICU and high-care in the form of duress alarms. The actor also interplayed with Infection Control and OHS, and both of these actors were also influencers in the blackbox, as they had to recommend RFID as an actor and also give it a clear reference, such that RFID could become the ‘superstar’ in this movie.

In summary, in this blackbox, RFID had entered as a debut actor and won the hearts of all actors that it interplayed with, resulting in improvements wherever it went. Equally, it also enabled a web of relationships within the milieu, although subtly and indirectly, via its champion. Ultimately, it has emerged as a superstar, having won the prominent role in the new movie (the new building), where the script is entirely built around Wi-Fi capabilities and RFID tracking.

As an actor, the debut touched almost all of the actors in the blackbox—some of them more closely than others. The debut actor being versatile and many-faceted (via additional/sample tags provided) was then considered by other actors in the movie, one at a time. Positive performance results from one department led to actors in the other departments taking the debut actor on for a full role. Thus, the actor was infused into the milieu.

At the end of this Act, ICT is in an influential/imposing role with all departments. RFID is imposed on all departments concerned. Infection Control and OHS are in an influential role to recommend RFID in a primary role for the new hospital at the beginning.

5.6.3 Summary

In this last Act, it was confirmed that RFID, which had debuted into this hospital as an actor, had emerged as a 'superstar', translating well into the context. It had not only influenced every actor involved, but also blended into the network of relationships without becoming an obvious outsider. The multifaceted capabilities made this actor an obvious choice for all actors involved.

5.7 Chapter Summary and Outlook

RFID is firmly embedded in the hospital. It was introduced into the hospital through a grant given by the DHS to track the patient journey to operation theatres. It was a legal requirement to enter these data into the Patient Management System, which was acceptable to *HealthSmart,* the program for modernising ICT in Victoria. At the end of the successful trial, RFID tagging results could be obtained in a very presentable fashion. However, the results thus obtained had to be manually entered via the iPMS—the acceptable patient management system. The results directly from the RFID systems were not acceptable by HealthSmart. Instead of making the nurses' job easier, it was doubled, as they still had to enter the data manually. This resulted in the nurses deciding to abandon RFID-facilitated tracking. However, they suggested that the ICT department essentially took the tags/equipment to utilise elsewhere in the hospital.

Therefore, similar to Case-1, where the RFID equipment was moved to the Public hospital, this hospital also moved the tracking equipment and tags to ICU and high-value asset-tracking using the same equipment and tags. It was evident that nurses were key influencers in the uptake and movement of RFID into the hospital. As confirmed in the focus group session, nurses regarded this as another process and did not find it ‘disempowering’. Orderlies who moved equipment and patients were not involved in the decision-making. However, they were not responsible for tagging patients.

Subsequently, when the RFID tags were moved to asset-tracking in the ICU, orderlies were trained continuously to put the tag on and off. They also did not find it ‘disempowering’; rather, they were dismissive of the process as ‘part of their job’. They found it useful because they often forgot where the assets were located and had to search for them. Their job became easier as the hospital had also made the computer screens within the hospital such that the orderlies could track assets from any screen via a webpage. Unlike the Case-1 hospital, this was a clear advantage. Constantly passing on the knowledge regarding attaching and removing tags soon became a habit, although they are still not fully trained.

During the time that RFID entered the milieu, the technology vendor also provided additional ‘temperature monitoring tags’ for trialling if the hospital so wished. The ICT department decided to trial this in the Pharmacy fridges to monitor temperatures. A successful pilot and full implementation followed, where the department then requested further grants to obtain tags/equipment from the DHS as well as the hospital internally through Finance. The results obtained in improving Pharmacy’s efficiency (time and cost savings) were shown via the RFID results data to Pathology and Food Services. Both departments decided to come on board with temperature tags, as they were convinced almost instantly.

Subsequently, Engineering also heard about the temperature tags and was shown clear results by the ICT department. This triggered Engineering to take on the temperature tagging using RFID to monitor the air-conditioning in their work areas. At this stage, an OHS audit had also influenced this uptake, as staff had complained about the air-conditioning.

At this stage, triggered by an incident in the hospital (a cleaner had a heart attack while on duty), and supported by the success stories of RFID, the ‘Simpkin House’—a high-care facility for mentally traumatised patients—decided to trial RFID for a staff duress alarm. There were existing alarms; however, the noise emitted by these alarms made them inefficient in a high-care facility. The new staff duress alarms are now fully implemented in the high-care facility, which supports the clinical staff in their day-to-day operations. In addition, the hospital is also planning to introduce it to low-care areas for staff in ‘compromising situations’. Clearly, RFID is firmly entrenched and has translated well as an innovation into the context. As confirmed by the CIO, RFID is being considered for the new building from the bottom level, for full implementation. It has the support of the government (public), private entities and the hospital in relation to funding. The hospital has put in several bids, including the DHS.

This chapter examined RFID in a second large Australian hospital that successfully implemented it. The implementation was enabled by a government grant and championed by the ICT department and the diverse capabilities of the technology that had transformed itself during the past decade. The diverse capabilities of the innovation made it easily translatable into the context. In addition to improving the efficiencies that it had set out to do, it also enabled a web of congenial relationships within the hospital. Finally, the innovation permeated in such a way that the new hospital building had RFID being deployed from a ‘ground up’ level. It is important to note that it was a nurse who initiated the implementation and enabled the translation of the technology as an innovation into the context.

The next chapter will compare the two case studies from the Actor–Network Theoretical context and closely examine the ‘tokens exchanged’ for facilitating the network of relationships and how the quality of the social network has improved subtly by this technology translation.

Chapter 6: Findings and Discussion

This chapter presents the thematic interpretations from the two case studies channelled through the moments of translation of the innovation translation theory, adding dimensions to the conceptual framework constructed in Chapter 2. Specifically, the case analyses visualised through the ANT lens in Chapters 4 and 5 are discussed and analysed further, using the cross-case method. This analysis informs and completes the conceptual framework built in Chapter 2, based on the literature review and eliciting knowledge gaps. These knowledge gaps are now addressed through the learning from the two case investigations conducted in an effort to answer the research questions posed in Chapter 1. I have used the framework to funnel the moments of translation initially from each case into a picture that completes the conceptual framework presented in Chapter 2, thus addressing the research questions, which are described in the concluding Chapter 7.

For the purpose of this interpretation, I have used the view of innovation proposed by ANT (Tatnall 2011), sometimes known as a 'Sociology of Translations' (Latour 1993), which considers the world full of hybrid entities—both human and non-human elements—and offers the heterogeneity to help in the explanation of technology adoption (Tatnall & Davey 2007). Innovation Translation informed by ANT combines the view of heterogeneity that helps in explaining technology adoption and the concept that innovations are often not adopted in entirety but only after translation into a form that is more appropriate for use by adopters.

The four moments of translation presented by the theoretical framework of innovation translation, as explained in Chapter 2, create the conceptual framework. The questions presented for addressing each moment were clarified and are now explained in the following sections. Each moment is drawn from the acts and scenes presented in Chapters 4 and 5, which are visualised through the Actor–Network Theory Framework. It should be noted that this chapter will have excerpts from quotes in Chapters 4 and 5 that are relevant to the analysis. Further, the quotations/excerpts from Act-1, Chapter 4, are reconstituted from the 'interviews with the industry report' (considering it a non-human actor/participant) rather than direct interviews with participants. The case investigation began with documentation and analysis provided to me by the hospital. Nonetheless, the documentation was re-confirmed by the participants when I had undertaken 'real interviews' at the venue, reported in Act-2 of Chapter 4. Therefore, human actors in Act-2 have voiced the non-human actor, namely the report. This was also stated in Chapter 4.

6.1 Moments of Translation: Cross-Case Analysis

The four moments of translation—namely, *problematisation, interessement, enrolment* and *mobilisation*—occurred for both cases, although not sequentially or in a structured manner. The questions leading from the conceptual framework are presented again to anchor the moments.

6.1.1 Problematisation

In this section, I will synthesise and compare the problematisation moments from both cases. For ease of summarising relevant moments, I will follow the sequence of case-1 and case-2 in all moments.

What are the benefits perceived to be achieved by key actors while introducing RFID? What are the roles of the actors? What is the Obligatory Passage Point?

In Case-1, the Pioneer Group took a typical vendor-driven approach to RFID implementation, as described in Chapter 4. In Act-1 (which narrates the RFID pilot implementation in the Private hospital), the technology vendor came in with the proposition to introduce RFID (as a debut actor) to the CIO of the hospital. This 'circumstantial' relationship translates into a coaxing relationship with two significant department heads of the hospital by the CIO. The technology vendor had influenced the decision to introduce RFID into the hospital. The problem itself was almost non-existent until the vendor approached the CIO of the hospital with the proposition to trial RFID. At this juncture, the CIO was also looking for ways to improve efficiencies and reduce costs within the hospital. There was no clinical staff, including nurses, involved in the initial discussions. The problematisation was triggered by an external vendor with vested interests. This is in alignment with the literature review in Chapter 2, which found that most decisions regarding the deployment of RFID in hospitals is vendor-driven, without real consultations or involvement of users.

In this hospital, as the non-human actor, RFID was indirectly imposed on the two departments, coaxed/coerced by the CIO/ICT department and the CIO. The two department heads, who then became key actors in the translation, imposed RFID on the users, namely nurses and orderlies. Specifically, the problem in the hospital was to improve efficiencies in tracking assets within the hospital. This was experienced by department heads and clinical staff (nurses) and extended to patient care orderlies, who were the users. The problem had to go through the Obligatory Passage Point (i.e., asset-tracking using RFID).

Notably, the technology vendor was the biggest influence for the top–down approach to implementation. However, this key actor exited at the end of Act-1, Chapter 4. Specifically, the technology vendor had implemented the pilot and exited the hospital. He never re-entered for implementation into the hospital. The CIO had almost ignored the clinical and other staff, who were the main users.

CIO: *Let us trial at the Private hospital…trial at the private is under my discretion. Let us do it…You meet with our technology manager, and the head of Sterilising Services Department (SSD)—which supports the Clinical Services Unit (CSU) at the Private Wing. These are the two departments that are transporting equipment with patients (bariatric wheelchairs), around the building. They need to be consulted and in agreement (Chapter 4, Act-1, Interview with Non-Human Actor).*

When the 'debut' of RFID occurred, the CIO had entered into a circumstantial relationship with the technology vendor. This relationship continued until the pilot was implemented and the company had exited the site. In Act-2, briefly, the technology vendor returned to meet with the Cameo to share his experiences with RFID translation and encourage full deployment. The technology vendor remained the biggest influencer, indirectly imposing on the CIO, and through the CIO, RFID was imposed top–down to the hospital.

The technology vendor had driven the problematisation that RFID technology would be ideal for tracking assets for the hospital, particularly in relation to operating theatres, where there is always an emergency situation in regard to critical assets. The influence for problematisation was on the CIO/ICT department and another two key departments that related to operation theatres. That is, the problematisation originated from an external vendor for the internal group. Even within the internal group of users, clinicians were not consulted, and only two department heads were involved or rather convinced by the CIO/ICT department. The problem owner was an external vendor, who was also then the solution owner, and the relationships that evolved were mainly imposed. The OPP was when RFID was piloted as a solution in the Private hospital, involving all users as well. However, the problematisation moments re-occurred in this hospital further, as follows.

In Act-2, I entered this hospital as the Cameo to investigate what happened with the RFID pilot, as the CIO and ICT department felt that the pilot had more or less been abandoned. The CIO found that while the SSD head was still keen to promote RFID, neither other departments nor users were keen on the implementation. He also felt that there were communication gaps between the users, department heads and his own department, as the users' voices were not reaching him. He had realised that the top–down approach using a technology vendor had not reaped good results, and there were also other hiccups. The following excerpts from quotations are highlighted from Chapter 4 in alignment with the above discussion.

CIO: *The pilot did not cover all the areas completely, so if the orderlies had to trace the equipment, they would find it in the vicinity, but a few metres away maybe…that much less accuracy was expected in a pilot.*

The external vendor as a trainer—was not exactly the best fit…he was not a people person…and really did not empathise with the users…but we still decide to go with him.

Learning a new interface, particularly if that was going to be changed again…is rather an ask from the users…we noted this so that we can come up with a user-friendly interface, integrated to the clinical resources support system.

Involvement of users are required…we are very aware of this issue (Chapter 4, Act-2)

So, there were still discussions occurring between them and the heads of SSD and CSU to revamp the RFID effort. As part of these attempts, I had been invited into the hospital to make an independent assessment of issues and consolidate all suggestions from users. At the time of Act-2, there was recognition that there was a communication gap between the actual users (nurses, orderlies and staff) and the department heads that owned their operations and the ICT department staff.

At the end of the pilot, after RFID was implemented, it was found that tracking using the RFID system was almost abandoned. Specifically, the department heads had advised users to track the assets using the RFID system, which did not occur. On probing this further, I found that the user-friendliness of the system was not sufficiently convincing for users. The orderlies felt that it was a waste of their time. There was a problem that was arising from the pilot implementation itself that was not addressed. Equally, the two department heads felt that the ICT department did not really understand their issues, and was imposing technologies on them without completing the implementation.

Clearly, there was a communication problem that surfaced, and as a solution to address this problem, the CIO brought in a BA to liaise with the two departments and the users and the ICT department. The following conversations are evidence for this re-problematisation process.

BA: *Well, I joined after the deployment of the pilot. CIO felt that there is no communication with the users in the departments or hospitals, or rather their views are not reaching him. Perhaps it is due to the fact that only heads of departments speak with CIO. A strong need was felt for a 'go-between' person, who is also technologist, at the same time a* *business/strategy analyst, who can gather requirements/feedback of users of the system and revise it in terms of today.*

Cameo: *So, it will not be out of place to say that it was RFID that brought you into this hospital?*

BA: *Yes, very true. I have spent 15 years in the profession, in hospitals and the CIO wanted someone who knows such contexts, for revising the radical technology being deployed. At the beginning, when I was given this project, I noted a key problem. When a technology is introduced in hospitals, usually it is not by pilot/business case, which is then approved by the board. Yes, it is necessary at some later stage. However, at the beginning, department champions (mainly heads or users) need to speak to each other and promote it. For this to happen, they need to have played with the technology for sometime. If one department takes it up, promotes it to the other, it can spread. However, if there are no champions, it is unlikely to succeed, even if a pilot built the case for it. This is what has happened here.*

At the end of Act-2, re-problematisation moments continued to occur after RFID became invisible to an extent as a result of abandonment by users.

The key actors were then the CIO and the two department heads, along with the BA, who re-analysed the issue and decided to recognise the suggestions by users at the end of the pilot (or Act-1, Chapter 4). The key issues highlighted by users (orderlies/nurses) from Act-2 are relevant here, as these were recognised and worked upon to improve the communication gaps that hindered the technology translation.

To begin with, the orderlies felt that they were wasting time trying to learn a new interface for RFID-based tracking, as it was not integrated with their paging systems. Further, when they tried to use the system, it was not efficient, as it wasted their efforts, as voiced in the excerpts below.

Orderlies: *We receive orders for equipment, with patient details on a pager. To use RFID interface…we spend time looking up the computer system for the equipment. Frankly, it is a lot easier to manually look for the equipment which may be available on a corridor and then transport the patient to the destination…more efficient!*

…we work on shifts, part time and most of us are casual…learning a new interface is not our priority.

We find the equipment down the corridor where it usually is…by the time we track a wheel chair that may be on level 10, and get there, someone may be have already taken it…then we have to go hunting again for another one on another floor…it makes us waste a lot of time! (Chapter 4, Act-2, Scene-3).

However, the CIO had another interesting dimension to add to the milieu. While the orderlies were complaining that they could not find the right equipment on the right level, he felt that there was sufficient equipment on each level to find from any system. The following excerpt highlights his view.

CIO: *On every level, there are sufficient number of wheelchairs present…so if the nurse needs a wheelchair on level 10, an orderly can easily locate it on level 10…he does not need to go from level 3 to level 10…it is just that he wants to chat up the nurse…that is the real reason!*

While this may or may not be true, I inferred that there is a communication problem between users of the system and the ICT department, which is largely being ignored. The communication channel between the nurse and orderly is also a necessary relationship in a chaotic hospital environment.

In contrast, the orderlies felt that if the RFID tracking was location-enabled through their paging systems, it would make them more efficient. Specifically, they worked on pager messages sent by nurses. These messages contained what equipment was required, which patient and where they needed to be transported. However, the messages never contained the location of the equipment needed, and the orderlies needed to find these manually. The excerpt below is of significance.

Orderlies: *We take the patient and collect all the equipment on the way. If this message really also came with the 'location of the equipment'—it is much more optimal—saves us the time looking up the computer. Anyway, all the information comes in the pager message—why not just add this information? It is much easier for the nurse who is already looking up the rest of the information and sends us a message to do this (Chapter 4, Act-2, Scene-3).*

However, my interviews with the nurses revealed yet another dimension to this problem. The nurses felt that if the orderlies could not use the interface, then it was their job to find the equipment manually. They did not feel that it was their job to find equipment.

Nurses: *Finding things like wheelchairs is not our job…it is their job…let them go hunt for it. They know all the hiding places anyway (Chapter 4, Act-2, Scene-3).*

As an observer, I deduced that there is a question of work intensification in their words, as well as the fact that their communication with the orderlies was being indirectly cut off, which is a 'given culture' in hospitals for the staffs' well-being to an extent in chaotic emergency situations.

The CIO and his team had realised that a process redesign was needed for implementing RFID, and there was also reluctance from the nurses to add to their work by tracking the location of the equipment using RFID. The nurses had considered this the orderlies' job. As the main users of this system, the orderlies felt that RFID was adding to their work. As confirmed in the literature (Fisher & Monahan 2008), RFID was being abandoned due to fear of 'work intensification'. The users had temporarily abandoned the OPP, namely tracking using RFID.

Nonetheless, the post-implementation reports and my conversations with users revealed that they recognised the benefits of RFID. With the incorporation of users' suggestions in RFID customisation, the OPP could be reached, namely asset-tracking using RFID. Upon this realisation, the champions of RFID (namely the department heads), along with the new BA, who became a negotiator between the users and implementers, re-problematised RFID-based tracking in the hospital.

Specifically, my research indicated that with the new actors (BA and the Cameo) in the milieu, problematisation re-occurred in the hospital. Specifically, the head of SSD (champion) began a process redesign with consultations from me and the ICT department. While he was aware of users' issues, it did not appear that he was involving the users in the process redesign. As a department head, he was conducting the redesign of an existing process to suit RFID implementation with me and consultations with the BA. To an extent, I felt that the re-problematisation was occurring again, without the active involvement of users. However, it could also be said that the department head was the 'one voice' for orderlies.

Later, at the beginning of Act-3 (Chapter 4) I was invited by the CIO and his pioneer group, as they had received funding for implementing RFID within the ED at the Public hospital. Similar to SSD and CSU in the Private hospital, the Public hospital had Wound-Care Wards and the ED itself as the main areas for deployment. Existing RFID-related equipment and tags were taken into the Public hospital, and additional requirements were met with the new influx of funding. It was evident that the CIO and his team were still pro-RFID. Further, the Private hospital department heads of SSD and CSU supported their efforts. At the beginning of this exercise, the head of Wound-Care Wards was in conversation with the head of SSD through the BA. With this support, the Wound-Care Wards initiated the implementation.

My conversations with participants from the Public hospital depicted the benefits of RFID as perceived by the two departments. They also showed that the problematisation moment occurred with the involvement of the department heads as well as the CIO/ICT department. For example, the head of Wound-Care Wards in the Public hospital used to keep all of the equipment-tracking information in a paper diary and personally tracked them. As a nurse, he found that it took much of his time away from patients. Then the

ICT department brought in the possibility of tagging some equipment and tracking them using RFID, which he agreed to. He found that it was useful to have this information electronically rather than in a paper diary. Further, he saw a benefit in tracking a high-value item such as a wound-care pump. There might be only 6–7 that are in the hospital, which may be attached to a patient or in an emergency surgery area. RFID tracking had reduced the time taken to track the item from two hours to less than one hour. He felt that if the system was fully accurate with the location (at the time, a trial had occurred with only a few pumps being tagged, and not all locations were covered), then the time taken to find this equipment could be 10 minutes. In his words:

> *If it was fully accurate, it could reduce to 10 minutes, which is time I could spend with patients in need, in a 300-bed hospital. It is time and efficiency improvement…There is only 6–7 pumps available for whole hospital. If they cannot be found, we end up renting them for $75 a day, which increases the costs considerably. If we could avoid this, costs could go down (Chapter 4, Act-3).*

He also pointed to another example of tracking bladder pumps, which are used only in one ward, but that tend to go 'wandering away' to ED, and from there to another location. Currently, the department has a 'whiteboard', which the orderly uses when taking the pump. However, from the first location, it can go anywhere, and the whiteboard entry becomes a 'black hole'. Apparently, the staff takes two hours in a week to find them, and RFID tracking could reduce this time.

The problematisation moment had undoubtedly occurred again, with benefits perceived by the key actors and influenced by earlier pilot implementations. The key role of the actors was that of influencers and facilitators. The OPP of tracking using RFID had partially occurred.

In Case-2, the Victory Group, the pilot implementation took place as initiated by nurses in the orthopaedic department, who were armed with a Department of Health Services grant given to enable the tracking of the patient journey in the ED. The problematisation was done by nurses, who recognised the need for tracking the patient journey into theatres and wards, which included not only assets, but also the patients on wheelchairs, gurneys etc. This hospital did not have a private and public separation at the location, and the entire hospital was regarded as one big blackbox. However, when the pilot occurred, this was in a specified orthopaedic surgery area.

The problematisation was done by nurses (who were the problem owners). The benefits of RFID implementation were perceived by nurses in the ED, who then requested and obtained the grant. Tracking the patient journey through operation theatres and emergency was the OPP in Act-1. The pilot was implemented successfully, with nurses being the key actors and the ICT department facilitating the deployment. The solution was provided by an external vendor, through the ICT department, on the recommendation of nurses. The nurses had sought the best available solutions through the ICT department, and selection was done through a merit-oriented process.

CIO: *Orthopaedics wanted to track patients through the theatre process, to see if there was any particular point where the patient's journey was delayed or where there were undue problems and that's where it began…The original idea was to track a patient journey through the operation theatre suite and record dates and times for use in the patient management system…the theatre manager (nurse), was the driving force behind it because she had been elsewhere Tags were attached to ankles and wrists (wristbands) of patients as well as equipment. The hospital was able to accurately record patient flows, including entry into the theatre, various stations along the journey, could view tags moving on floor plan in real time and get information on which patient was in which theatre or at various stations in real time.*

The pilot involved only hip/knee surgeries…the system logged the exact time and with that they could see exactly how long it took the patient to go through the entire process. As part of the patient check-in, they got the wristband, their details were recorded in the system and the system then tracked that wristband as them for the rest of their journey (Chapter 5, Act-1).

The problematisation moment is evident here with RFID benefits perceived by the nurse, who was the caregiver. The IT department facilitated the technology deployment by following through with the problematisation. It should be noted that involving the theatre nurse ensured that the users had been involved, and they had 'one voice'. There is evidence of a successful pilot and results from tracking the patient journey as depicted in Chapter 5, in Act-1, Scene-1.

Notably, in case-2, RFID was introduced to track the patient journey initially, which meant tagging the patient en-route to surgery along with all of the equipment relating to theatres and orthopaedic surgeries. The RFID solution itself had been introduced in two different formats, namely the regular RFID tag, which enabled tracking people/equipment, and an RFID temperature tag, which was used to monitor temperatures.

In Case-2, re-problematisation occurred. Towards the end of Scene-2 (Chapter 5, Act-1), it became evident that although the pilot was successful, full-scale RFID implementation in the theatres/emergency area did not occur. The rationale is evident from the following excerpt:

> *HealthSmart in Victoria did not approve to send HL7 messages to iPM to enter data into the PAS in real time, and therefore, the project was abandoned, as efficiency was minimal. A nurse had to still physically enter details and be present throughout the patient journey, in addition to using the RFID system…The nurses accepted it at the beginning but—after six months they said, 'you've had a good trial, we don't need to do this any more, use the tags for something else', which is what we did, we just repurposed them and used them for something else, they weren't lost or anything (Chapter 5, Act-1, Scene-1).*

Upon probing this further with the CIO/nurses in the theatre, I found that the RFID tags were repurposed for the ICU and related areas. Specifically, the initial problem was 'tracking the patient journey' in the orthopaedic surgeries. The problem owners were nurses. In the re-problematisation, the problem was owned by the ICU department, driven by nurses as the head of the department. Although it is a different department, nurse remained the problem owner. The solution owner did not change in this case; RFID was simply re-purposed. The problem was to track assets in the ICU using RFID (the OPP):

> *Asset management and some of them have actually gone up to the ICU for the bed tracking…they are using it to track their beds, because their beds wander off over the weekend and they want to know where they are on Monday morning. Something as simple as that, it's a start. Some of their critical resuscitation equipment is taken as well so they lose the area…The beds go down to the catheter lab or the beds go down to the theatres, and they put them straight in the beds. Sometimes the beds come back to ICU and sometimes they go somewhere else. Someone else grabs them and they end up in another ward or they end up sitting in an alcove off a corridor somewhere.*
>
> *high-value assets are tracked…Computers on wheels, ICU beds, emergency resuscitation equipment—it all came back from the fact that after Emergency Dept had their little rework last year, there was a $30,000 piece of equipment that no one could find anywhere—it had been submerged somewhere during the refit (Chapter 5, Act-1, Scene-2).*

Clearly, a re-problematisation moment was visible. The benefits of RFID were realised not only by nurses who recommended that it be repurposed (almost six months after the trial), but ICU staff also accepted it. Two different departments—namely OHS and Infection Control—had to be involved in the trial, as it was a requirement. Thus, the tracking of equipment using RFID passed the OPP with a set of new actors.

In Act-2 (Chapter 5), I discovered that RFID had taken another role in the hospital. Accidentally, a new form of tags—namely temperature tags that could monitor the temperature of equipment such as fridges—came into the hospital.

CIO: *The supplier gave it to us…threw a box of temperature tags…said 'here have a temperature tag to play with as well'…Well, once we got it and put it in the first fridge and found the fridge was faulty…results of this simple exercise was brilliant. We then went to Pharmacy and said* *'would you like to be able to give a five-minute result on all your fridges?' and they said, 'yes, thank you' (Chapter 5, Act-2, Scene-1).*

The CIO and his team had taken the temperature tags concept to Pharmacy for a trial, outlining its benefits.

CIO: *I sold the idea of temperature monitoring to Pharmacy for refrigerators…RFID tags to all pharmacy fridges were deployed. Data was logged in real time at five-minute intervals, which then set alarms to notify the Pharmacy when temperature varied outside a pre-set range. This data was then used to identify fault fridges. This project was successful.*

Pharmacist: *It was IT came to us and said, 'hey this is possible—we've got the Wi-Fi'. Before we had Wi-Fi, we had manual tags, which recorded everything, we manually pick them up—each week—I would download everything and then see…Wi-Fi gave us ability to set alarms, ability to have real-time monitoring…saved us at least a couple of hours a work week. Now, we get reports once a week and look at them, but if we get any alarms, basically we follow them up.*

There is a new problematisation moment visible here. Obviously, the two key actors here are the CIO and head of Pharmacy, who saw a clear benefit in the temperature tags. The Pharmacy decided to take up the trial, which was successful, and it decided to implement temperature tagging using RFID, which herein is the OPP. Problematisation was initiated by the CIO here and driven by Pharmacy (users), and the OPP was to use the RFID temperature tags to monitor temperatures.

When I explored the translation of RFID into the Victory Group, I chanced upon the fact that there was 'staff tagging' that had occurred to monitor staff duress in the high-care and mental health facility of the hospital. Upon exploring this further, I became aware that it was introduced by customising the regular RFID tracking tags that were used for patients and equipment, and were worn by staff. Thus, another problematisation moment was revealed. The key actors for problematisation in Act-3 (towards the end of my case study) were the OHS and ICT departments:

> *The OHS department had an audit…they needed a solution for managing staff duress. And there was also an incident. A theatre cleaner had a heart attach in the middle of the night and no one came running. So before he came back to work as part of his OH&S plan, they needed a process to be able to prevent further recurrence of being isolated (Chapter 5, Act-3).*

It was evident that the problematisation occurred with the key actors planning to use RFID tags for staff in high-care facilities in order to reduce staff duress and isolation. The staff tagging using wearable RFID tags were fitted with a button that could trigger alarms elsewhere (the OPP). The problematisation moments continued to re-occur throughout the year for the Victory Group.

The differences between Case-1 and Case-2 are summarised as follows for the problematisation moment.

Case-1: Problematisation was done by external vendors; subsequently, re-problematisation was done by the ICT department. Case-2: Problematisation was done by nurses initially and also re-problematised by nurses. A varied form of RFID was problematised by users (Pharmacy) driven by ICT, which then led to convincing others (interessement moments).

Case-1 had originally problematised ‘asset-tracking’ as the problem that could be solved with RFID technology (OPP). Case-2 had originally problematised for ‘tracking the patient journey’, which included assets and people with RFID technology (OPP). In the re-problematisation process, they realised additional uses such as tracking temperatures (OPP).

In Case-1, the network of actors was still unstable, with orderlies and nurses not really buying into the problematisation and solution using RFID. Actors who were involved in problematisation never completely finished it and continued to re-problematise with another set of actors. In Case-2, for each problematisation, the network of actors stabilised with RFID-tracking passing the OPP with a set of new actors. That is, for each problematisation, the actors were successful in getting others interested in the solution and successfully implementing it.

6.1.2 Interessement

How did the champions of RFID negotiate with other actors to establish and extend their network? How did they get others interested?

In Case-1 (Pioneer Group), the champions of RFID in relation to Act-1 were the CIO and the heads of the SSD/CSU departments of the Private hospital. However, my findings indicated that the technology vendor was the key influencer (or rather imposer), as the technology was pushed into the hospital rather than being negotiated by users. The external technology vendor did get the CIO/ICT department, and through the CIO, managed to convince the heads of two different departments to trial the technology for asset-tracking.

The department heads were further coaxed by the CIO/ICT department, thus negotiating and extending the network. The department heads were interested in improving the workflow of their respective teams of nurses and orderlies. However, they were imposing the workflow changes with RFID without initially consulting with users. Specifically, the decision to pilot RFID was already made by the CIO, who was convinced by the external vendor. The users (namely orderlies) were then informed of the proposed changes in the workflows by the technology vendor, who was then implementing the pilot with a separate set of equipment (RFID tags, readers, systems and interface). The OPP at the time was that the key department heads and the ICT department had agreed to deploy RFID to track equipment.

As presented in Act-3 (Chapter 4), I entered the hospital after a gap of one year since Act-2. During this time, RFID implementation had been shelved due to budget constraints and other areas taking priority. For example, there was a new system for payroll, e-health records implementation and Wi-Fi refreshment throughout the hospital group. These implementations took priority for the ICT division of the hospital. The CIO had kept RFID implementation in abeyance mainly due to budgetary constraints, which now required board clearance. However, the RFID equipment that was in place after the pilot (including tags, equipment, interface) was still in the private hospital.

At the end of Act-2, it was evident that the CIO of the Pioneer Group (Case-1) had introduced the BA into the hospitals with a view to revamp RFID implementation. Through the BA, the SSD and CSU departments were coaxed again to be interested in redesigning their workflows using RFID. The head of SSD was more interested in the technology and its implementation from the beginning, as reflected in the following conversation.

Head-SSD: *Yes, when the pilot project was launched, I was really pleased, because tracking equipment is one of the key issues in the hospital. And I also felt that the technology had much potential…SSD experienced major time savings as a result of the RFID pilot…With the RFID deployment, the process of day-to-day work became more efficient…much time was being saved through better equipment recycling…*

The BA leveraged the interest of the SSD head by making him involved as a champion of RFID for other departments. It should be noted that the SSD and CSU are two departments that need to work closely due to their criticality to the emergency services. Whatever the SSD department recommends is taken and promoted by CSU. In Act-3, the IT department in the Pioneer Group negotiated with key players:

Head of Wound-Care Ward: *In January this year, the IT Department said that there is some equipment possibilities with RFID, which can track some equipment currently available from the previous pilot, which they can trial. So we trialled this (Chapter 4, Act-3).*

Subsequently, the head of Wound-Care Wards, who was also a trained nurse, influenced the ED with word-of-mouth propagation. In summary of Case-1, a complex network of actors were involved in interessement. There was initially the external vendor, who then exited. However, he continued to maintain a relationship externally through the CIO, although not influencing others in the hospital. As an independent investigator who entered the milieu, I inferred that although the external vendor had ‘exited’ the milieu, he never really left in terms of influence. The CIO brought him in when I begun the investigation. The CIO placed significant faith on his judgement in relation to technology, perhaps due to the fact that the company pioneered RFID into Australian hospitals.

CIO:	*The external vendor was not exactly the best fit…really did not empathise with the users…but we still decide to go with him.*
Vendor:	*There were only technology integration issues…the orderlies do not really understand new technologies…so there need to be some training…we can provide that too (Act-2, Scene 4, Chapter 4).*

Therefore, there was a strong relationship between the CIO and the technology vendor who got him interested in the technology. Equally, the heads of SSD and CSU had a strong relationship with each other in that if SSD took up a technology, CSU would follow. The reason for this is that every equipment that orderlies tracked had to be sterilised; therefore, the two operations had strong interdependence. On another level, the nurses and orderlies were really within the CSU (operational staff), while the equipment was under the purview of SSD. Therefore, getting the two departments on board was a necessity for the CIO. However, this relationship was more of an imposed one compared to the relationships between the orderlies and nurses.

The orderlies serviced across the hospital under the nurses' orders, and nurses belonged to all departments. Communication among the two groups was pivotal in getting others interested in the cause of RFID. Therefore, although there was a strong imposed relationship from the CIO on the departments, these did not effectively materialise because of the complex network of communication between user groups. Despite the imposition by the department heads, making RFID operational did not materialise, as the technologists (CIO/external vendor) did not speak their language or in their terms. The complexity was slightly lowered with the entry of the BA as a liaison person from the ICT department, who asked the department heads and users about their interests and issues. Once the ICT department thus started talking to the end users indirectly, the real problems surfaced. Then, when the Wound-Care Wards in-charge, who was also a nurse, intervened (was influenced by the department head of CSU, who was also a nurse), he was able to propagate the idea and get users interested by explaining it in their language. The complex network was thus stabilised slowly in the public wing. The same person also spoke with the head of ED and BioTech areas regarding the benefits as realised by RFID and got them interested. All of these department heads, being trained nurses and in-charge of sections, were able to stabilise the network by getting all users interested.

In Case-2 of the Victory Group (Act-1), it appeared that there was an interest among theatre nurses in a white paper from the US that discussed surgeons causing the delay in attending to patients from surgery by tracking the patient journey using RFID. The CIO indicated that in Australia, to track delays in attending to patients, the situation had to be handled differently. Specifically, if surgeons felt that their productivity was being tracked, that would raise privacy issues, and unions would also enter the fray. The following excerpt is relevant.

CIO: *…you can't tell surgeons they're the delay, so they ended up putting a big display board up, which tracked the patients through and after…so the surgeons could sit there and say, 'Hmm, there's a patient there waiting, and they're waiting for me—maybe I should be doing something, yes'. If someone is sat in the holding bay for a period of time…or say 10 patients are in the holding bay, alarms could be set up.*

The nurses who went into RFID tracking became interested by the white paper, which could monitor clinician productivity. Equally, clinicians in Australia, who could not be tracked or monitored by law, were implicitly driven into interessement, as they could visualise the patients in the waiting bay. The CIO and the ICT department were consulted on this, and they felt that that they could improve efficiencies by facilitating RFID deployment. Thus, the ICT area became interested.

At another time, the conversation with the CIO revealed how the ICU became really interested in RFID tagging:

> *The biomedical people, we'd given them a little taste…tracked a few of their fusion pumps. When they go to do a service on the fusion pumps it can take them three and a half to four weeks to locate them all—they loved the fact that*

> *they can press a button and at least find four of them in a minute and a half. So they're quite happy to go down the 'yes let's tag everything' path because it saves them a lot of time. And we use the simplest interface—just have a webpage that shows you a picture of where they are (Chapter 5, Act-1, Scene-2).*

Thus, RFID was able to capture the attention and interest of related areas of emergency, namely ICU and wards. The champions of RFID in Act-2 were the CIO, his team and the pharmacist. The success of the Pharmacy area was shown to Pathology, which then became interested. In this case, it is the user (pharmacist, regarded in this investigation as clinical staff or equivalent to nurses).

CIO: *We mentioned the success of Pharmacy to Pathology. They decided to install tags for fridges, including sub-zero freezers.*

Subsequently, Food Services began using temperature tags for monitoring cabinet temperatures…it worked too.

Engineering…once they saw it in place and saw the results, they thought 'this is a good idea, we'll buy some of them ourselves' (Chapter 5, Act-2, Scene-1).

Thus, it can be seen that multiple departments—Pharmacy, Pathology and Food Services—became interested in the concept, influenced initially by Pharmacy and enabled by the CIO/ICT department. The important fact is that each department saw the results from the earlier departments and subsequently decided to 'go for it'. The ICT department had been the champion, although it had worked indirectly. It was the actual users of the system who propagated and got others interested.

Subsequently, the OHS area was looking for options and negotiated the new tagging with the ICT department. The following quotations revealed that the actual users became interested through the negotiation of the ICT and OHS people. The key element in this conversation was that the CIO was influenced by the residential manager of nursing facilities to push the concept of duress alarms. This residential manager was also a nurse.

CIO: *The earlier residential manager of nursing facilities was pushing the concept of duress alarms at some stage…and here was an option, it works better.*

Subsequently, there was a question raised from the nursing staff about the use of RFID in staff tracking, when the CIO realised that they had the back end for RFID already, so they could make use of it. This resulted in three levels of tracking in high-care facility—namely Wi-Fi tracking, ward tracking as patients move in and out, and room tracking for accurate location. As they already had the RFID tags and Wi-Fi, they therefore had a roaming duress alarm that covered 2–3 areas with just one staff member.

CIO: *…the theatre cleaner had a heart attack and was on the job, and it was a couple of hours before anybody found him. He was quite happy, he was fine, but now he has a tag.*

More important was the fact that nurses recommended it and the staff user became interested because it assisted him to call for help when needed. He felt safe with an RFID tag.

In summary, in Case-1, the interessement was initiated by an external vendor. The interessement was mainly an 'imposed' one, resulting in a complex and rather reluctant set of relationships between department heads, the ICT/CIO and user groups. The lack of communication and involvement of users resulted in rapid loss of interest. Recognising the problem, and during re-problematisation, the CIO introduced a BA into the network as a key actor to coax users. He found that there was significant resistance to change by users. To a large extent, the resistance due to technical issues, such as user interface problems, were solved, thus reducing user reluctance. Eventually, technology also evolved, facilitating touchscreens and better navigation software. The BA had a strong role in facilitating re-problematisation and getting everyone else in the system interested. For example, he had the head of SSD involved in the RFID implementation concept, making him the champion. However, competing projects for the existing budget in the private wing of the hospital affected interessement.

BA: *The infrastructure (for RFID) need to be refreshed fully, some reprogramming need to be done. In the meantime, we have been asked to implement e-health records in the Public hospital, which has taken priority now (Scene-3, Act-3, Chapter 4).*

A complex web of relationships ensued, resulting in user groups in the private wing of the hospital speaking with the public wing, as well as the BA getting a nurse-in-charge of the public wing interested. With this interessement, the network complexity stabilised, with almost all user groups becoming interested in the concept because the nurse was speaking in their language.

In Case-2, the interessement was initiated by a nurse and always enabled by the CIO/ICT taking a supportive role; however, being proactive. While the nurses were able to get all other user groups convinced, the CIO/ICT department was also able to convince the pharmacist initially for a different type of tag to monitor temperatures. The pharmacist was also considered a key ‘clinical’ person in the hospital in charge of trauma fridges, emergency blood etc. Through this person, other related departments, such as Pathology, Food Services and Engineering, became interested. From another viewpoint, the interessement was really through the influence and propagation of nurses, who were also convinced about patient and clinician safety, using duress alarms. Here again, the nurse was the pivotal element in getting all others interested.

6.1.3 Enrolment

Did key actors coerce, influence or impose on others to enrol them into the network of acceptance?

The Pioneer Group had undoubtedly imposed RFID as a pilot in Act-1. The key actors coaxed their teams of nurses and orderlies to comply with a parallel method to their existing manual ways of tracking equipment. The enrolment moment had thus occurred, albeit through a certain level of coercion. As noted in Chapter 4 through different scenes in Act-1, each of the departments, nurses and orderlies were informed and to an extent enrolled with the bait that it would improve their existing workflows. The enrolment into the network of acceptance was only partially completed in Act-1.

The users (namely nurses and orderlies) of the RFID system were rather dismissive of this technology. The pilot was implemented such that RFID systems ran parallel with the existing systems. There were initial technical hiccups. For example, as all of the equipment was not tagged, when users tried to locate equipment on the system, it was not visible. After a few such occasions, users then reverted to their old habits of finding equipment manually, thus abandoning RFID tagging.

During Act-2, the main actors—namely the CIO, BA, heads of SSD and CSU—tried to influence each other and the users to enrol them into the network of acceptance. First, they decided to incorporate RFID tracking into the current Health Information System network. As a forerunner of this, the BA redesigned the existing *MobileView* RFID tracking system, which was a standalone system, to an in-house system called Bo-Beep. This eliminated the need to have a vendor-based separate system for RFID tracking.

It was also evident to the CIO that while the orderlies wanted RFID systems integrated with their pagers so that nurses could also inform them of the location of the equipment from their desktops, the nurses were reluctant to do so because they felt that it was not part of their work. In effect, the orderlies had parsed through the OPP (i.e., tracking using RFID), while nurses did not want to do it. This fact aligns with the views from the literature review in Chapter 2 (Fisher & Monahan 2009), that nurses felt work intensification as a result of RFID implementation, which impeded the diffusion of this technology.

Equally, the CIO felt that there were other reasons for orderlies not enrolling into the RFID system concept, rather than tracking using the computer interface:

> *On every level, there are sufficient number of wheelchairs present…so if the nurse needs a wheelchair on level 10, an orderly can easily locate it on level 10…he does not need to go from level 3 to level 10, just because a nurse from level 10 has ordered a wheelchair to take a patient…it is just that the orderly*

> *wants to chat up the nurse…that is the real reason! (Chapter 4, Act-2, Scene 4).*

I observed that communication between nurses and orderlies was necessary to keep the high-pressure work environment of the hospital flowing smoothly. It was clear that nurses and orderlies did not want work intensification, nor a redesign of the existing workflow (as confirmed by Snyder et al., 2005; Yao et al., 2011). The existing workflows enabled them to work with the nurses, thus enabling better-quality care for patients. The BA was also supportive of my view that certain tasks had to be undertaken by orderlies and other tasks by nurses, both for the division of labour and due to qualifications. I noted that resistance to change was an influencing factor in technology translation, which has long been established in various industry sectors, including hospitals. In this case, the resistance needed to be addressed in the interessement stage in order to improve the enrolment process.

In addition, the BA was of the opinion that a built-in interface integrated with the current HIS would help the typical users (i.e., nurses and orderlies) enrolled in the system. At the end of Act-2, when I investigated the issue, a suggestion was made that to eliminate potential work intensification, the concept of touchscreens on each level of the hospital should be explored. As a result, the hospital installed touchscreens as the forerunner of a full-scale implementation. The hospital had taken on board that usability and user interfaces are technological factors that also affect the translation of RFID.

Equally, the SSD department, which championed the cause of RFID tracking, accepted the redesign of its processes using RFID. Thus, the CIO, BA and SSD department head enrolled users into a network of acceptance, which was facilitated at the end of Act-2. By Act-3, the key actors in the Pioneer Group were the IT department, the SSD head—who influenced the head of Wound Care in the Public hospital, who in turn enrolled the ED—the two departments and all users.

In Case-2, the Victory Group (in Act-1), the nurses influenced the decision of enrolment on the ICT department, theatres, nurses and clinicians. The theatre nurses were then responsible for word-of-mouth propagation to the ICU and wards, while the ICT department influenced the BioMed department. Regardless of the influence, it was an important finding that the key actors managed to influence and enrol everyone concerned into the network of acceptance. Specifically, the nurses and orderlies had transformed into the role of influencers for RFID. This transformation was empowering for the actual users of the system, who then continued to propagate it.

The key actors in the second part of the propagation of RFID in the Victory Group (Act-2) were the ICT department and the pharmacist. These actors influenced other departments, namely Pathology, Food Services and Engineering, which enrolled into the network of acceptance. The enrolment was assisted by the fact that there was proof or evidence of success available to them, in addition to the word-of-mouth propagation.

CIO: *Pathology followed on from Pharmacy and then in Food Services, we just sort of gave them to them and they said, 'Yes we'll have that' because I had shown the some of the results coming out of Pharmacy.*

…Engineering…were the hardest but once they saw it in place and saw the results, they thought. 'this is a good idea, we'll buy some of them ourselves'…Engineering…have jumped on board…They use them when people complain about air-conditioning, because you can put a tag there and within 24 hours they have a complete history of the temperature within that location.

If it is a the ED trauma fridge—it sends to the Pharmacy alert staff that this alert has been triggered, as well as sending to the ED shift manager, so not only the Pharmacy manager knows about it but the shift manager knows about it and can do something about it, probably before the pharmacy guy can ring the phone and say, 'what's wrong'? (Chapter 5, Act-2, Scene-1).

It was evident that not only did the ICT people influence the decision, but the interlinked roles of Pharmacy and emergency nurses being linked together also affected the enrolment process. In an emergency, if blood is required in the operating theatres, the nurse calls for it by connecting to Pathology and Pharmacy (where blood is stored).

Keeping the temperature of the fridges correct is a requirement for emergency blood bottles kept in the fridges.

When it came to Food Services and Engineering, it was more the convenience and efficiency gains that drove the enrolment. While Food Services wanted to gain efficiencies through less wastage of food, particularly when it was needed, Engineering was driven by an OHS audit. The OHS area was already in the milieu, having been involved with the first RFID-tracking enrolment (Act-1, Chapter 5). They were looking into maintaining 'location temperatures', and with the RFID tracking of temperature, it was possible to determine whether there was a problem with the equipment, or whether a fan was not working. Thus, four different areas were enrolled based on other departmental experiences.

In Act-3 (Chapter 5), it was revealed that the key champions of RFID in the Victory Group sought a solution that was then recommended by nurses and given to them by the ICT department. The process of enrolment here was through continuous negotiations and influence. The enrolment process was successful, as the key actors were able to influence others into the network of acceptance. It is interesting to note that RFID itself, as a non-human actor, influenced the enrolment decisions.

CIO: *In high-care facilities—their existing duress system…basically a buzzer…makes a horrible noise…that upsets all the patients, so the patients come to see what the noise is and the incident increases. Whereas with the RFID version—they get Jamaica (SW) on their phones and it tells them where to go to…basically it tells everybody that you need to know about it exactly where the staff member is when the button is pushed and it continues to track the button until that incident has ceased (Act-3, Chapter 5).*

In summary, in Case-1, the enrolment occurred as imposed initially by the CIO/ICT department on two specific heads of departments, who then imposed upon the reluctant users. Eventually, the entry of the BA as a liaison person between all user groups, department heads and the CIO/ICT department occurred before he really influenced and coaxed the champions of RFID—namely nurses/orderlies—through their relevant heads of department to enrol in the concept. The buy-in had to occur with the head of Wound-Care Wards, who was also a nurse-in-charge, with much experience and influence across all other user groups. The BA successfully made him the mouthpiece for the users.

In Case-2, the enrolment occurred smoothly, as it propagated through nurses in the first place. In this case, although the ICT/CIO was a strong champion of RFID, he never pushed the technology directly. Rather, he enlisted the nurses and pharmacist, who then propagated the cause of RFID throughout the entire hospital.

In both cases, one important aspect is clear; the nurse was the strongest influencer, or 'the voice', that everyone listened to. In both cases, the ICT department had succeeded only when it made the nurses the mouthpiece for the cause. This was confirmed by validating interviews held by me in late 2013:

> *…anything to do with the clinicians…I always put the clinician in front of me and I tell them what I want them to say, educate them. And they're the ones who go and then educate. It is the clinicians made the decision to work with the technologists to make it work. The clinician was the key stakeholder and the key champion. And if ever you put technology in the clinical world, it must be led by a clinician. It cannot be led by an IT person no matter how brilliant they are or how much they know how to talk the language…So if the nurses or the orderlies, the nursers are a very powerful group of people, and like I said, it has to be clinically led which is the nurses leading it (Consulting Industry Expert: Director—Life Sciences and Health Care Industry Sector, Australia, 2013).*

> *I once was an orderly, and I was very compliant and did everything, then I would be largely ignorant to the workings of the organisation and say no problem…So if the nurse said 'jump', I would jump because if I was employed to be there for the patient I would say, 'Yeah, if you think that's a good idea, I'm happy to do it' (Nurse-in-Charge, a large Public hospital, Melbourne, 2013).*

6.1.4 Mobilisation

Has the solution gained wider acceptance? How was this achieved?

In the Pioneer Group case, after Act-1, it was clear that nurses and orderlies, who were the users of the system, as well as the department heads felt that RFID was useful technology:

> *Do you feel that patient throughput has improved, due to reduction in waiting time and therefore, this system helps improve quality of care? Users/Nurses: Yes (100 per cent) (Chapter 4, Act-1).*

There were suggestions for improvement from the same users, which may have resulted in the mobilisation moment, which completes the translation of technology and also stabilised the network of relationships. The following quotations depict reluctance in accepting the technology, as well as suggestions for improvement.

Orderlies: *The accessibility could be extended to nurses—so they can also track equipment in emergencies.*

Nurses: *The system should be integrated, so we can also view Public hospital and other areas for tracking…The accuracy of location also need to improve.*

Head of SSD: I used the system four times and I found the device each time. It has improved overall equipment availability by 60 per cent, reduced rental costs and search time reduced 15–20 minutes. It is definitely a good solution—if the decision was mine, I would implement it in all the hospitals.

CSU users (orderlies): It did help with finding small items quickly, saved time when searching by about an hour…It saved me 15 minutes to find a trolley (Chapter 4, Act-1).

This indicates that the RFID solution would have gained wider acceptance in the Pioneer Group through the word-of-mouth propagation of nurses and orderlies if the technology was customised to suit the environment. This finding is in alignment with the fact that theoretically, Innovation Translation informed by ANT in the moments of translation suggests that technologies are never accepted in the form in which they are introduced. They need to be customised to the context. Therefore, after Act-1, the Pioneer Group did not complete the mobilisation moment, nor did the network stabilise completing the translation of the technology.

Nonetheless, it is not out of place to say that the moment of mobilisation partially occurred, as the SSD department heads and the ICT department promoted and supported the redeployment of RFID in the Public hospital area (Chapter 4, Act-3). Specifically, the heads of SSD and CSU were qualified nurses who were initially involved with the RFID pilot. When the RFID implementation was being reconsidered (Chapter 4, Act-3), the head of Wound-Care Wards and the EDs in the Public hospital (both qualified nurses) were becoming involved initially through the help of the BA from the ICT department. Although indirect, there was word-of-mouth propagation from one head of the department to another—notably users of the system—which facilitated the consideration of RFID deployment again. The links between the departments in promoting RFID is implicit in the following conversations.

Head-Wards: *The wards in Public hospital already have some RFID-tagged equipment and exciters from an older pilot which happened sometime ago…The wards have WLan already and wherever the RFID is being provided, a new system that clinical nurses use, known as Bo-Beep, is the interface where they locate the tagged equipment. This is in-built by the ICT department of the hospital. The Bo-Beep takes care of all user inputs and comments from the failed trialled implementation. However, the system is still separately monitored, not linked yet to HIS (could be in future) (Chapter 4, Act-3).*

At the end of Act-1, I could visualise that there was an exchange of tokens (i.e., word-of-mouth propagation of RFID) between the SSD and CSU departments, as they were also closely connected in terms of nurses and orderlies who work as a team.

As visible from the conversations in Act-2, although indirectly, the solution of RFID tracking was fast gaining acceptance in the Pioneer Group. Where it was piloted, orderlies and nurses were talking about it, albeit negatively. No other technology solution has been talked about as much within the context of this hospital according to the orderlies (nurses as well as technologists). In off-the-record interviews, it was repeatedly pointed out that although the solution was abandoned after the pilot, there was talk about reconsidering it at all department, board and other meetings.

Specifically, in the Pioneer Group, at each meeting of the ICT group, RFID was discussed as a potential solution to help with all departments. Equally, orderlies who were involved with the pilot were talking about the usage of the technology with the BA, who still acted as a 'go-between', trying to understand user perspectives. At the time of completion of Act-2, the budget for RFID was still on hold. However, there were continuous conversations between all users, technology implementers and department heads regarding the future incorporation of the technology in their areas. Thus, it is evident that mobilisation occurred, although it was not visible or partial in the context. There was word-of-mouth propagation, albeit with suspicion among users.

Towards the end of three years since the inception of RFID (end of Act-3), it was evident that RFID as a solution was fast gaining acceptance throughout the hospital. For instance, the CIO was now looking at implementing RFID, post e-health records and infrastructure implementation throughout the entire hospital. It would not have been possible without the support of all department heads and involving all users to a certain extent. It appears that the nurses and orderlies who work across the private and public areas propagated the solution such that everyone is now looking forward to its implementation. Indeed, mobilisation has taken place at the Pioneer Group.

In comparison, in the Victory Group, by the end of Act-1, it was evident that RFID had already propagated into the hospital widely through the initial involvement of nurses, the OHS department and Infection Control, and supported by the ICT department. By involving a wider set of key actors, including strategists, technologists, medical staff (nurses, orderlies, clinicians), administrative and operations people (OHS, Infection Control), the solution was rapidly gaining a wider audience.

As revealed in Act-2 (Chapter 5), it was evident that the RFID solution was rapidly gaining wider acceptance. By the end of Act-2, the take-up of temperature tags had proliferated into other areas of the hospital; two other departments were considering RFID as a solution for completely different purposes with temperature tagging. Indeed, mobilisation had occurred with temperature RFID tags.

Towards the end of my case study with the Victory Group, my findings revealed that the RFID solution has gained wider acceptance in this hospital, as visible in Act-3 and 4:

> *So it's expanding—so there's the theatre, there's another facility where there is just one staff member looking after low-care patients that are on their way home basically or going to go into surgery first thing in the morning, there's all of the food service people who work after hours, and it's just been expanded again—there's a ward that only has one staff member over night so that means a tag.*
>
> *We now also have the roaming duress alarm for staff involved in another facility, under maternity. A lot of young mothers come up here to deliver without telling their husbands in Melbourne for particular reasons that they're delivering up here, and the husband usually if he finds out…storms into the place. The reason is usually that there is an intervention order…so staff have to say 'go away'. For instances such as this, staff may be working out of hours…they use a roaming tag (Act-3, Chapter 5).*

By the end of Act-3, mobilisation had already occurred. Further, RFID had proved itself as a solution that fits in, integrates and is versatile. Minimal training was provided, but users (medical staff including nurses, orderlies, clinicians and administrative staff) did not need much training. The tracking used a web-based system and the tags were wearable and anonymous. Specifically, an RFID tag only had a number and was wearable around the neck. It only traced the person who was wearing it as the number on the day. When the day was over, the tags were returned, and the person could no longer be tracked. No individual names or persons could be stalked using the tags unless they chose to wear it for specific purposes within the hospital. For example, a person working in mental health facilities or a clinician in a highly sensitive area felt safer with a tag that could help him or her find assistance quickly.

In Act-4, where I consolidated what was happening with RFID translation in this hospital, it was clear that mobilisation had occurred as the solution gained wider acceptance.

CIO: *It's certainly in our specifications…We'll have the Wi-Fi system set up six months before if we can. And the equipment won't leave the loading bay until it is tagged and on the database…basically the tag will become ubiquitous across the entire hospital, and it's engineered at construction. And with the new electronic patient record, it fits in very—it's one arm of the new patient record—you need to have some form of patient tracking, so the only way to do that is with RFID.*

Thus, in the Victory Group hospital, RFID as a solution assumed many forms, permeated into many departments and completed all moments of translation. The network of acceptance is now stabilised, as the hospital is planning to integrate RFID from the ground level into the architecture of the new building, and also with the e-health records' implementation.

In summary, for Case-1, mobilisation occurred partially, as RFID as a solution had gained wider acceptance across the two wings of the hospitals (or the blackbox). While the implementation has not occurred completely, it is a technology that is widely spoken about and is still being considered. For Case-2, mobilisation occurred with nurses propagating it, enabled by the ICT department. RFID had not only tracked assets and patients, but had also been used to monitor temperatures and as a duress alarm. It has been widely accepted.

6.2 Reflections on Moments of Translation

My findings suggest that RFID was only partially translated into the context of the Pioneer Group hospital without involving the whole hospital or key areas such as emergency. At different times (years), certain key departments were involved in RFID implementation. The acceptance of the RFID solution throughout the hospital gained impetus after a pilot was implemented in 2007 and then abandoned. It was revamped in 2009. However, during this period, the IT department and the departments that had originally considered a process redesign using RFID felt that the solution had potential for process efficiencies, but it also made them rethink some of their own processes that needed refreshment.

The ICT department refreshed the infrastructure of the hospital using Wi-Fi, which was initially triggered by the RFID pilot. Orderlies and nurses had raised awareness on how they could find equipment faster. They pointed to the integration of communication for process efficiencies in tracking equipment. While nurses were sceptical about work intensification, they were aware that RFID could improve their work efficiencies.

For specific departments, such as SSD and CSU, the process redesign using RFID pointed out their skill gaps and identified workflows that could be restructured. By the time the solution was translating into the full hospital, the users no longer felt disempowered. Rather, by involving them halfway through, the feelings of scepticism had given way to empowerment, as they felt that their suggestions were being heard. Nonetheless, in this hospital, RFID translation was incomplete at the time I completed the study. Some moments of translation of RFID are visible, but none of them are complete, involving all or at least 90 per cent of the users. As a result, the moments of translation had not resulted in the stabilisation of the network.

Compared to the Pioneer Group, my findings reveal that RFID has translated into the context of the Victory Group completely through all moments of translation. The acceptance of the solution across the hospital gained impetus from the beginning, as the key users (nurses) recommended it to others. In addition, as the technology itself had advanced in 2010, there were other uses, such as tracking temperature movements, which helped the hospital's major departments, including Pharmacy, Pathology, Food Services and Engineering.

As this hospital had begun with the Wi-Fi infrastructure, it had the advantage of better accuracy in tracking and linking all departments. Equally, they were also completing the e-health records implementation as recommended by the national government. At the beginning, there was support from the government for implementing the technology within the emergency area, which is regarded as a crucial point for any technology take-up. Specifically, if the solution worked in emergency, most medical staff would accept the solution. In this case, that was indeed the experience.

Nurses, who are the key users of the system, instilled confidence in this technology to all other users within the hospital. Thus, it penetrated through to the ICU, wards and related areas. Equally, the OHS and Infection Control, who were administratively involved with the implementation, also found RFID useful, as they were linked in from the beginning. While the nurses recommended and influenced its translation, the ICT department facilitated it.

Equally, the new avatar of temperature tags that were incidentally left by the technology vendor implicitly found its way into other departments. OHS, which was seeking a solution to address staff duress subsequent to an audit, found a different use to RFID tags (i.e., to assist staff in duress situations by triggering alarms using a tag). A wearable tag is attached with a button that helped lodge the call for assistance without making a noise, which could upset the patients. This aspect of RFID made it beneficial to improve the quality of work processes within the hospital and made it popular among the staff.

Nurses did not find the process as a work intensification, as RFID was originally recommended by them and was well integrated into the hospital systems. Clinicians did not consider it a surveillance technology for monitoring their productivity, as the technology was used to track the patient journey rather than them. Patients in the waiting bay were tracked, and a screen indicated the number of people in the bay. If there was overcrowding in the waiting bay, clinicians could visualise it on the screen, which alerted them to their own duties without ordering them. This subtle persuasion helped to improve the quality of care.

Overall, the medical staff accepted the technology as a helpful solution for improving their workflows. Equally, the enhancements over the past few years had improved the use of technology and its initial hiccups, making it conducive for hospitals as well. For example, the Wi-Fi infrastructure-based location helped remove additional tracking equipment, and it improved the accuracy of the location.

In summary, problematisation continued to occur in both hospitals, suggesting that the moment of problematisation is not a ‘one-time’ affair. In the case of the Pioneer Group, problematisation continued to occur, albeit partially, without the stabilisation of the network of actors. The moments of translation remained fluid, the OPP had not been parsed, and the stability of the actor–networks remained in question. In the Victory Group, the problematisation moment flowed into a ‘closing the loop’ each time, with the moment being completed through interessement, enrolment of actors and mobilisation.

6.3 Completing the Conceptualised Framework

Table 6.1: Completing the Conceptualised Framework with Research

Moments of Translation Innovation Translation and Actor–Network Theory (ANT)				
	Moment 1 ***Problematisation***	**Moment 2** ***Interessement***	**Moment 3** ***Enrolment***	**Moment 4** ***Mobilisation***
Literature Review	The key champions of RFID technology in hospitals seem to be technology vendors, systems integrators and administrators in hospitals (O’Connor 2005; Fisher & Monahan 2008; Chen et al., 2008). Users of the RFID system, such as nurses and orderlies, are ignored or forced to use the system. The moment is characterised by the acceptance of technology for	As the literature revealed, there is little evidence of getting users (nurses and orderlies) interested in the RFID solution. Rather, driven by the vendor and administrators of hospitals, other key actors are largely forced into the moment (e.g., Coustasse 2012; Lorenzi & Riley 2005; Fisher & Monahan	Enrolment into the RFID enablement network is forced or pushed through by vendors and administrators.	The RFID solution has relatively low acceptance or rather skepticism from users. As the users were sceptical, the solution did not get promoted (Fisher & Monahan 2008; Chen et al., 2008). Literature in the above sections reveal that despite the skepticism, RFID as a technology was being promoted in the health sector via IT strategists and vendors.

	tracking equipment in order to reduce costs and improve efficiencies by hospital administrators and strategists.	2008).		
Case-1	The problematisation moment in this case is characterised by imposing RFID technology on the pretext of improving processes by vendors, the technology department and some department heads. The promise of RFID is evident, but not realised eventually. The moment is not completed, as all hospital users (medical staff) have not accepted the solution, resulting in partial and abandoned implementation.	Nurses and orderlies felt disempowered by RFID and were not really interested. While nurses felt that their workflow might be intensified, orderlies felt that it was a waste of time. Both actors (factors) felt that communication, which enables the smooth flow of work processes, would suffer. While there was interest from department heads, users were not interested.	The users of the system were forced to accept it. Hence, they chose to take it as a parallel process and abandoned it quickly with many excuses, such as location inaccuracy and inefficiency of time taken.	Mobilisation did not occur completely. The main users of the system, namely orderlies and nurses were sceptical of the RFID solution, and the reluctance resulted in an unstable network. Currently, RFID remains partially implemented and is not promoted by users in the hospital.
Case-2	In this hospital, problematisation for implementing RFID was a decision involving key users, namely nurses, the ICT department and administrative infrastructure people. Thus more or less everyone to an extent was involved in the problematisation. As a result, the OPP (i.e., tracking using RFID solution) gained momentum. The ICT department, which was conversant of the privacy laws in Australia, found an indirect method of tracking the patient journey and highlighted the number of patients waiting in the bay using a monitor to clinicians. Rather than monitoring their productivity, this method triggered a	The nurses got all the other medical staff interested directly and indirectly. The ICT department facilitated the infusion of temperature tags as an RFID solution among many other departments. OHS department, facilitated by ICT, indirectly captured the interest of administrative and other medical staff, leading to offering RFID tags incorporating duress alarms. This promised the improvement of work quality of the staff.	Enrolment occurred sequentially and fully as nurses were convinced by the RFID solution initially, and this permeated into enrolling varied departments facilitated by ICT.	The hospital has accepted RFID as a solution completely and is building infrastructure into its redesigned processes.

	sense of duty and resulted in improving the quality of care.			

As shown in this table, Case-1 reflects the issues surrounding RFID translation into Australian hospitals. In the literature, the non-involvement of the users from the beginning is the major flaw that has been highlighted for unsuccessful RFID translation in hospitals. Case-1 is consistent with this view that the technology was imposed without involving the key actors in the milieu, resulting in its incomplete translation. The potential of this technology was realised by some key actors, who were largely unsuccessful or partially successful in promoting it further. More importantly, not involving users at the beginning resulted in the unsuccessful translation of the technology in the hospital.

Equally, Case-2 indicates that by involving all key users of the technology, not only did RFID translate well into the current hospital, but it is also gaining wider acceptance. Medical staff who were tagged with an RFID tag felt safer in high-care and certain areas where their safety was under threat. Clinicians did not feel monitored (which would have been against the privacy law in Australia), as they were not tagged. Rather, patients in the bay on a monitor indicated indirectly to them that their attention was needed. The hospital had thus found a way around the privacy implications in Australia. Further, by making the paramedical and other staff feel safer (rather than being monitored), they also worked around the potential union problems that could have emerged. The success of this hospital is the way in which RFID was introduced, negotiated through users and translated indirectly, thereby realising its versatility.

The complexity of the Actor–Network Relationships as depicted in Figure 6.1 indicates that the moments of translation in relation to RFID in hospitals is indeed complex.

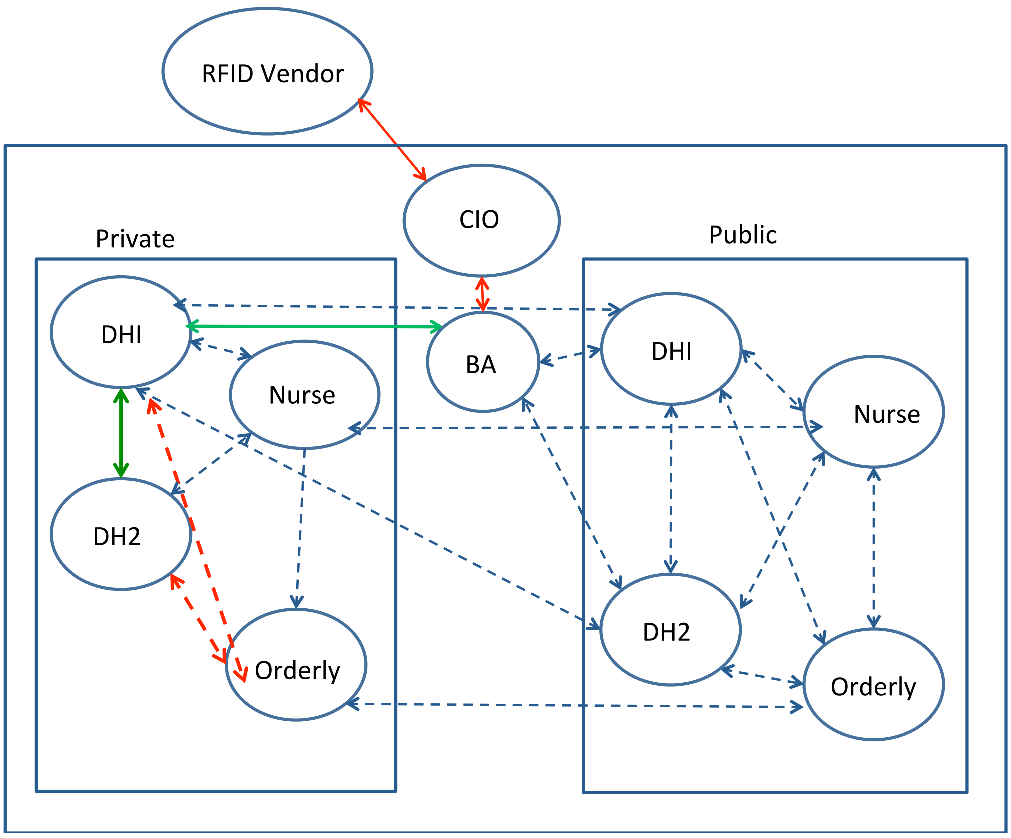

Figure 6.1: Complexity in Actor–Network Relationships (Cross-Case Comparison)

Legend:

Actors/Factors

Imposing and Direct/ Indirect Relationships

Indirect Negotiations

Influencing Relationships (Key actors/negotiations)

In the case of the Pioneer Group, the private and public hospitals are in the blackbox of the hospital (figure above). While they may appear to be separate entities, it is evident that there is a relationship that is 'invisible' but 'strongest' in the propagation of RFID. RFID was imposed into the milieu in a top–down manner, and the strongest influence remains the technology vendor, who is external to the blackbox of this hospital. To refresh the abandoned use of RFID, the strongest influence was the SSD department head, who influenced the Wound-Care Wards head in the Public hospital. In the private hospital, SSD supports ED, and in the public hospital, the Wound-Care Wards support ED. Without being explicit, the relationship between the two departments is very strong, in that RFID was recommended by SSD to the Wound-Care Ward head. Both department heads are also qualified nurses who are in charge of a set of nurses and orderlies in their departments. While RFID implementation were abandoned by users at the beginning, it had begun to reappear only through the silent but strong communication between the two department heads at the two ends of the spectrum within the group.

Nonetheless, with the strongest influence being the two department heads, RFID is still to gain momentum in the group. The reason for this is again the strong communication between the user groups—namely nurses and orderlies between the private and public hospital. Specifically, RFID technology was regarded as a 'threat' to users or causing them 'work intensification' and 'surveillance skepticism' and propagated negatively to the nurses and orderlies in the public hospital. The close network relationship of these actors resulted in the incorrect passage of tokens, resulting in breakdown of networks and lack of punctualisation. Orderlies were exchanging negative tokens among themselves, as well as in relation to nurses. Specifically, nurses did not want work intensification with the added burden of locating RFID tagged equipment on the system, nor did they want to cut the communication lines with orderlies. Orderlies did not want to locate RFID-tagged equipment on the system, as it wasted time and they wanted nurses to give them more instructions, as it is enabling an indirect but positive communication line within the hospital. The tokens thus exchanged between orderly–orderly, orderly–nurse and nurse–nurse remained negative in this hospital in relation to RFID. While heads of departments and the ICT continued to problematise with suggestions from orderlies and nurses being incorporated—with some reluctance—orderlies and nurses decided to dismiss the propagation of the technology altogether. The complexity of interrelationships in the actor–network resulted in the non-translation of RFID technology in this milieu.

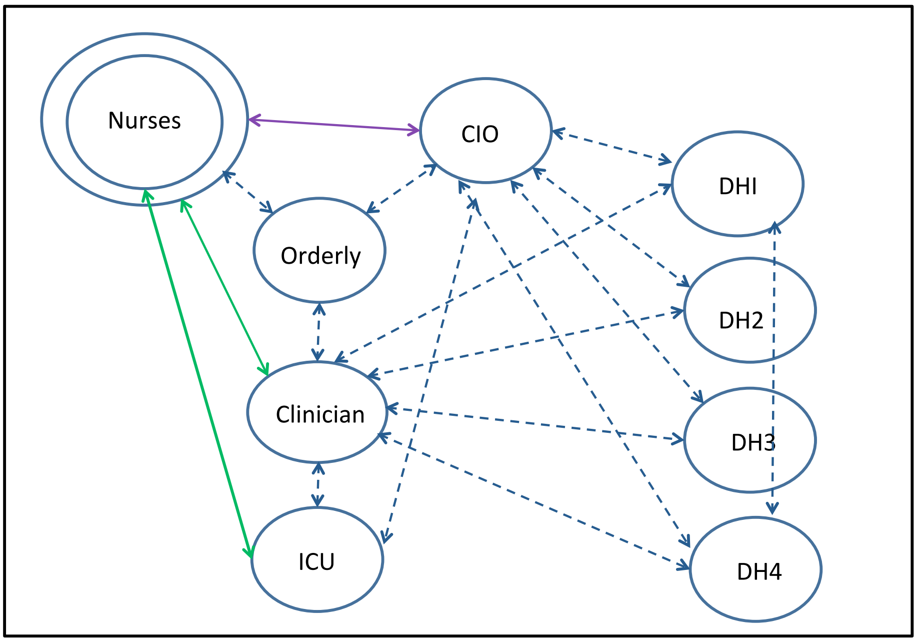

Figure 6.2: RFID Translation – Key Actors and Networks

<u>Legend</u>:

Actors/Factors

Imposing/Indirect Relationships

Indirect Negotiations

Influencing Relationships (Key actors/negotiations)

Supportive/influencing negotiations between key actors

In the case of the Victory Group, the tokens exchanged between nurses, orderlies, clinicians, department heads and the ICT remained positive, resulting in the successful translation of RFID. Compared to the Pioneer Group, this hospital did not separate the private and public into separate management areas or business units. However, the ED had the highest power in relation to implementation of RFID technology. Confirming the literature, the ED is the area where RFID technology has the largest effect. Having a strong network relationship with nurses, clinicians and orderlies across all departments, the positive exchange of tokens was done with ease. In this case, the ICT department played a supportive, facilitating role, and an evidence-based coaxing strategy to implement the technology. In addition to all nurses and clinicians being aware of the use of RFID (being initiated by them), the ICT department was also conversant with the health and hospitals sector for many years. The confidence of the varied department heads in the suggestions made for RFID implementation by the ICT regarding temperature tags were taken positively because there was evidence supporting it that was visible almost immediately. The positive exchange of tokens between medical staff (nurses, clinicians, orderlies) and IT staff resulted in correct punctualisation. In this case too, the web of relationships is invisible but strong in enabling the translation of RFID.

6.4 Emerging Themes from the Moments of Translation

6.4.1 Theme 1: The key to innovation translation in the health context is its introduction and involvement by influential caregivers

In Innovation Translation theory (Callon 1986; Tatnall 2011, as discussed in Chapter 2), problematisation is a key moment where a group of one or more key actors attempts to define the nature of the problem and the roles of other actors. This is done in such a way that the key actors are seen as indispensible to solving the problem. The problem is often refined by the terms of solutions offered by these key actors. To pass through the OPP, all actors need to accept a set of specific assumptions and ways of operation specified by the assorted engineers. If this occurs, a stable network of relationships will result (Callon 1986).

In Case-1 (as presented in Chapter 4), RFID as a technology was imposed on the context by the ICT department in conjunction with an external technology provider. Although a successful pilot to introduce the technology ensued, it was not adopted into the context at the time. Probing into the context revealed as follows.

The decision to deploy the technology was initiated by an external entity and prompted by commercial reasons. They persuaded the CIO and the ICT department sufficiently to impose the solution in the hospital in two key areas where processes were well defined and user-driven. The head of departments in the two areas then imposed it on the end users (or orderlies in this context), who felt that the rationale for deploying the technology was more power-based rather than aimed at improving the efficiency of workflows, which might subsequently result in better quality of care. The indifferent attitude of the users to the technology resulted, and subsequently the abandonment of its use, albeit temporarily. The ‘caregivers’ or orderlies were not persuaded to use the technology, as they felt it was wasting time that could be better spent providing the requisite attention to patients.

In comparison, in Case-2, as presented in Chapter 5, although RFID was imposed by the CIO and his ICT department, the RFID solution was initiated via the orthopaedics department, which had successfully applied for a grant from the Department of Health Services to track the patient journey into operating theatres. The caregivers (nurses) had the solution in mind for enhancing the quality of care rendered to patients.

For operational reasons relating to the PMS, they could not continue the adoption of technology at the time. However, the nurses influenced the decision to pass on the RFID tags to the ICU for asset-tracking, which did not require the use of PMS. It should be noted that the decision to deploy and repurpose was initiated and influenced by caregivers in this context. Further, the ICT and other administrative departments were facilitating the technology by demonstrating it and on the recommendation of nurses. This supportive attitude to caregivers also helped the permeation of the technology in the hospital.

As a result, this hospital site is progressing rapidly towards the adoption of RFID more completely, rather than as a sporadic deployment within some areas.

6.4.2 Theme 2: Innovation translation in hospitals occurs through persuasive champions who understand the context of care

Innovation Translation theory purports ‘interessement’, which is a series of processes which attempt to impose identities and roles defined in the problematisation, on other actors. This process means interesting another participant by coming between the proposed technology and the actor. According to Law (1986), the ‘enrollers’ attempt to lock the other actors into roles proposed for them. Gradually existing networks are dissolved and replaced with networks created by the enrollers.

In Case-1, the interessement or ‘getting them interested’ was a concept identified by the BA, who spent 15 years in the health care profession. The BA was introduced into the hospital as the original introduction of RFID failed to succeed into a full implementation. According to the BA:

When a technology is introduced in hospitals, usually, it is not prompted by a business case…the champions (mainly users) need to speak to each other and promote it…For this to happen, they need to have played with the technology for sometime. If one department takes it up, promotes it to the other, it can spread. However, if there are no champions, it is unlikely to succeed…This is what has happened here.

By the time the BA could become a key actor, bringing users and strategists together, negotiating best interests, a few years had passed and RFID was still not accepted as a solution.

Compared to Case-1, the second case study revealed the success of champions and the persuasive power. CIO (1), who was the champion of the technology in the hospital, did not introduce it himself or impose it on the hospital. Nonetheless, the CIO and the ICT department were not only aware, but also championed the technology by providing the results of the successful deployment to other departments sequentially (Chapter 5). One success followed the other due to the subtle persuasive skills of the champions—namely the CIO and ICT staff in this hospital.

I validated this theme of having persuasive champions during interviews with industry experts:

You've got to have champions who will be leading the way and making sure that this works really, really well…there's one hospital I looked at last year, a Private hospital here in Melbourne, where they implemented RFID for all their stores, of everything coming in and out. They were able to scan their consumables for their theatre, and were able to get, they reduced their costs in their theatre waste, you know, wastage of their consumables by RFID tracking. Tracking to the point where they had sensors in the theatres, so when a prosthetic came out or something it'd track it, and make sure that they were, you know, making sure that they were charging every single prosthetic, so they were able to save money. But it took them a long time, and they had a very *strong stores person, manager, who was running the project and getting everybody involved and working through each of the processes step by step…and that's the reason why it was successful in this particular hospital (Industry Expert: Senior Consultant, Melbourne, Victoria, Australia).*

The ANT purports tokens, which are successful outcomes or functions of actors that are passed on to other actors within the network. When the token is increasingly transmitted, it becomes increasingly punctualised and reified. In Case-1, the tokens were word-of-mouth propagation regarding the function of RFID as an actor. The champions passed on the case of RFID from the private wing to the public wing, where it was increasingly punctualised. In Case-2, results of successful implementation and improvement in the workflow were passed on as a token to other departments by the champions. These tokens resulted in increased punctualisation.

The ANT also suggested that an incorrect passage of token could break down the social network. In Case-1, the token was 'incorrectly' passed on by the orderlies to others, temporarily shutting down the network of translation. The entry of the BA as an actor into the network resulted in re-alignment, and the 'correct' passage of the token, thus re-establishing the network. In Case-2, the nurses correctly passed on word-of-mouth recommendations as well as actual results through the ICT department to other actors in the network, which in turn stabilised the network.

6.4.3 Theme 3: The strength of innovation translation in hospitals is in number of caregivers enrolled in the network

In the Actor–Network Theory (Latour 1986) purported that:

Power vested in a person or technology does not automatically confer the ability to change or cause change in a context. Potential adopters need to be persuaded to adopt a technology. The more the number of people willing to adopt in the situation, the better is the proposed adoption.

Equally, as McMaster, Vidgen & Wastell (1997) pointed out, innovations do not wait passively to be invented or discovered, but are created from chains of weaker or stronger human and non-human associations. Each actor enrolled in the translation influences the innovation to shape it into the ultimate form, which is adopted in the blackbox. The ANT purported that a network of materially heterogeneous actors that is achieved by a great deal of work that both shapes those varied social and non-social elements and disciplines them so they work together is necessary for successful technology adoption.

In Case-1, the initial network was formed 'circumstantially' by the external technology with vested interests and the CIO. From here, the network then began to develop between one of the departments (SSU) that trialled RFID, and then to another department (CSU). RFID was imposed on these departments, which then enabled it to work in the private wing of the hospital through the network of nurses and orderlies who were involved in the tracking of equipment using RFID. From an 'imposed' relationship that involved RFID as a non-human actor and human actors in the social network of the Private hospital wing, the heterogeneous network evolved, and the aligned interest was to 'track equipment' so as to improve efficiencies in day-to-day operations. This heterogeneous network then expanded to the public wing of the hospital, where the BA entered into a coaxing relationship with head of wards and ED and successfully persuaded them to take RFID for their solution.

In Case-2, the initial network was formed 'circumstantially' by a set of actors influential actors who were enrolled selectively in the context. From this network, a set of coaxing relationships ensued into other departments, via the ICT department. These coaxing relationships ultimately resulted in a harmonious heterogeneous networks and successful translation of the technology. The key to innovation translation is the creation of a powerful consortium of actors to carry it through and the ability of those involved to construct the necessary alliances amongst other actors (McMaster, et al., 1997).

From the view point of innovation translation, if interessement is successful, enrolment will follow through a process of coercion, seduction or consent (Grint & Woolgar 1997), leading to establishment of a stable network of alliances. However, enrolment involves more than one actor to impose their will on others, and others do need to yield (Singleton & Michael 1993).

In Case-1, both the process of problematisation and interessement had flawed. The introduction of the technology was not by care-givers, but rather an external entity with commercial rationale. The interessement was partial in that, the CIO imposed the technology on 2 department heads who in turn imposed on to the care-givers in the frontline. As such, the champions of RFID were the department heads in this case, who were also technically care-givers with persuasive power. However, the front-line staff were the more important actors in this situation. They felt disempowered by the technology, as it de-stabilised their relationships as well as made them less efficient. The following voices are representative of this claim:

Orderlies: *We are used to taking orders from a nurse on the phone at times…and find the equipment down the corridor where it usually is…by the time we track a wheel chair that may be on level 10, and get there, someone may be have already taken it…then we have to go hunting again for another one on another floor…it makes us waste a lot of time!*

Equally, the CIO had the following comment regarding the orderlies' dissatisfaction, which brought out another interesting issue.

CIO: *On every level, there are sufficient number of wheel chairs present…so if the nurse needs a wheel chair on level 10, an orderly can easily locate it on level 10…he does not need to go from level 3 to level 10, just because a nurse from level 10 has ordered a wheel chair to take a patient…it is just that the orderly wants to chat up the nurse…that is the real reason!*

The above statement shows that in the course of the hectic work atmosphere in the hospital, the communication between orderlies and nurses—both care-givers—is necessary to ensure smooth flow of operations, which flow into the quality of care. If an order from a nurse is delayed by an orderly, who really feels that there is no need to be 'that efficient' to get the patient to the theatre—would in turn disrupt the workflow and lower the quality of care within a hospital. Communication between caregivers is a key in this context. Therefore, the weaker and stronger care-givers enrolled into the context would have raised the numbers and helped adoption of the technology. However, this aspect was clearly overlooked by the CIO, who was the champion of RFID in this case.

As against this, in Case-2, the champion of RFID, namely the CIO was able to enrol 4–5 departments of care-givers beginning with nurses. It would be correct to suggest that enrolment occurred initially through the consent/persuasion of nurses; and other departments through 'seduction' where the participants yielded willingly. The strength increased in numbers as the number of participants rose. As reflected in this voice: 'basically RFID will become ubiquitous across the entire hospital, and it's engineered at construction'.

Innovation translation theory also purport the concept of mobilisation when the proposed solution gains wider acceptance and even larger network of absent entities is created through some actors acting as spokespeople for others, mobilisation is said to have occurred.

In Case-1, the champions on the two departments continued to speak for the cause of RFID, even though it was not deployed in their contexts. As a result, the deployment began in the public wing of the hospital although RFID is now non-existent in the private wing, where it was originally deployed. In Case-2, the champions continue to propagate RFID to other areas such as 'high and low care'—where a new adaptation of the technology is being initiated for 'duress alarms'.

6.4.4 Theme 4: Technologies had to be customised before being adapted into the health context

Innovation Translation theory suggests that innovations have to be customised before being translated into any context. This research endorses this concept. In Case-1, the initial pilot deployment involved RFID tags, which were not of medical grade and these, had to be customised, before the pilot deployment. In Case-2, the RFID tags were accepted into the pilot only after validation by Infection Control and OHS departments of the hospital, as being medical grade—customised to the context for tracking. Further, in Case-2, the 'incidental RFID tags' supplied in addition to the original customised

RFID tags, resulted in a set of new functions for RFID. This had resulted in the technology being translated into the context faster.

As both cases reveal, the technology had to be customised to fit the perceptions of the caregivers (users) before being adopted into the context. Specifically, the caregivers had to be satisfied that the technology will enhance their workflows and empower them with the ability to provide better care, with efficiency. As endorsed by Case-2, only real results from implementation as a token passed on successfully in the network, could effectively help in successful adoption of the technology.

6.5 Reflection on ANT

As presented in Chapter 3, ANT was used for visualising the moments of translation in Chapter 4 and 5, where case studies were presented. Specifically, the cases were presented in varied Acts, funnelled into an ANT visualisation that depicted the following: (1) formation of network of actors for problematisation (2) relationships that occurred as a result of problematisation (3) network of relationships as they were formed and broken as some actors exited the network (4) realignment of relationships in the network. The diagrams at the end of each Act had clearly indicated the social relationships that were negotiated due to the introduction of RFID into the context.

ANT became useful as an interpretive lens, to examine the scenes 'as it occurred'. The bits of conversations highlighted in the script format and the visualisation thereafter using ANT concepts, helped me as a researcher, to interpret the socio-technical relationships that were negotiated in the process of translation of RFID into Australian hospitals. The Actor-Network Theory Lens thus assisted in the interpretive analysis by visualising the moments of translation as they occurred (as in Chapter 4 and 5; and excerpted in this chapter).

6.6 Conclusion

From the emerging themes it is clear that in health care, as against other regular businesses, technology adoption is not based on a business case acceptance. The context of health care makes it unique in that the current processes cannot be disrupted as it involves human life. Strategists and technologists may be able to build a business case and deploy it successfully after a pilot in other businesses. However, in hospitals, the acceptance of a technology would depend on caregivers. The involvement of caregivers or frontline medical staff, who may initiate and propagate the technology is a necessity in this complex and dynamic environment.

Any technology that is deployed in hospitals is best adopted when initiated by a caregiver. Familiarity of the technology within the context by caregivers is also a necessity, before it can be considered for deployment. The rationale is that in the context of saving human life or patient care, no mistakes can be made by technology. In other words, technology and human beings are considered equal in the context—no mistakes can be made by both, which may affect lives. In such complex environment, technology adoption can only occur if customised to suit the needs of caregivers and their perceptions of care, as technology can only help extend the quality of care. The next chapter discusses the research questions and answers them based on the emerging themes presented in this chapter. It also offers future directions for research in extending the theoretical framework.

Chapter 7: Conclusions and Future Directions

In this chapter, I present the conclusions that have been drawn from the interpretive cross-case analysis conducted in Chapter 6, and specifically answering the research questions set out in Chapter 1. Initially the summary of findings are presented, with relevant validations (from interviews conducted in July–September 2013). The validation endorses and confirms that the findings are of significance and relevant in the current context of Australian hospitals.

Subsequently, key contributions to academic knowledge and practices in healthcare are highlighted. These include adding to existing knowledge in the domain of RFID in Australian hospitals, which broadly falls within the purview of health informatics, and theories explored in this investigation namely Innovation Translation and ANT. Where relevant recommendations to healthcare practices are also highlighted.

Further, I have presented some future possibilities of research exploration in this field, which is evolving dynamically.

7.1 Summary of Findings

This research began at a time (in 2007) when Radio Frequency Identification was considered an innovation for asset-tracking in Australian hospitals, for improving efficiencies in inventory management. RFID as an innovative technology was being considered as a solution for improving the processes and thus, improving the quality of care. The research was motivated by a knowledge gap that indicated that socio-technical factors relating to RFID implementation in hospitals is rather unexplored or dismissed topic in literature (as briefed in Chapter 2).

During the process of research, which lasted over five years, two landmark cases were closely examined i.e. a pioneering hospital and another hospital that had successfully implemented the technology. In the meantime, the technology had itself evolved in its own versatility as well as the costs of implementation had lowered.

In late 2013, RFID technology still remains an innovation that is being explored and not widely implemented in full scale in Australian hospitals. There are specific departments that are piloting the technology not only for tracking assets, but also for tracking people (patients and staff). People tracking have brought forth further ethics and legal issues which are of high significance in Australia. There is also a clear knowledge gap as far as the role of socio-technical factors in successful translation of RFID technology.

The key findings indicate that RFID as an innovative technology was on the radar of Australian hospitals since the second half of the last decade. In my investigation, a hospital situated in the State of New South Wales had pioneered the technology for improving process efficiencies by tracking equipment in surgical areas and operating theatres. This attempt was unsuccessful because the users of the system had not accepted it as a solution and were dismissive of the technology as such. After many false starts to redesign processes in preparation for RFID implementation, this hospital that pioneered RFID in Australia has still not implemented it completely. The reason, as I found through this research investigation was mainly socio-technical factors. In other words, the main users of the technology, namely nurses and orderlies, had to propagate the technology by being convinced themselves. The introduction of this technology had the potential to alter their existing workflows. This was not made known or negotiated at the beginning of a pilot implementation. Thus, when it became visible, and the users were confronted with the technology, users were unwilling to accept the technology.

In the first successful case of RFID translation in Australian hospitals, a large hospital in the regional area of the State of Victoria had implemented it. The users and all supportive administrative departments were involved in the design and implementation of this technology in the emergency areas. Beginning with tracking patient journey into theatres and then wards, the technology permeated to all across the hospital. Nurses recommended it, clinicians accepted it as it impacted their moral conscience indirectly, and all users accepted the recommendations of key users—the nurses. The technology was negotiated in a different format by key departments, with the ICT department supporting its promulgation. It had to be noted that unlike a large hospital in the State of New South Wales, the State of Victoria had additional hurdles in terms of ethics to cope with, where RFID technology was implemented. There are State imposed regulations such as an additional check on the privacy issues touched by this technology, which had the potential to permeate everywhere.

Notably, both the hospitals were publicised in health forums as they progressed with RFID implementation. The research findings indicate that it is indeed the negotiations between the social (user) and technical (RFID technology) factors that result in eventual unsuccessful or successful translation of RFID in Australian hospitals. Although many technology vendors had attempted to push technologies in Australian hospitals, the success of the Case-2 hospital indicates that key in translation of the technology smoothly was the social factors (users of the technology). This highly ignored or dismissed factors (in literature review) are pivotal in the translation of RFID in Australian hospitals.

Social factors include users of the technology (mainly nurses, Patient Care Orderlies or Patient Care Assistants or simply Orderlies) as well as the Champions (namely IT department and other administrative areas) of the technology, who understand the context of care and legal issues associated with technology implementation, that may be specific to Australian hospitals.

7.1.1 Answering the Research Questions

What socio-technical factors influence the translation of RFID in Australian Hospitals?
(1) Are these factors the key actors and and what roles do they play?
(2) How do they interact and negotiate to achieve effective RFID translation?

There are a few socio-technical factors that emerged that influence RFID technology adoption in Australian hospitals, from this investigation.

7.1.1.1 Timing

The time that the research was completed in 2013, there were 2 ostensible technology refreshments in Australian hospitals that were laden with legacy systems. The first refreshment was at the time when Wi-Fi revolution occurred and then, lately, in preparation of e-health records implementation. Towards end of 2013, a nation-wide wave for innovation technology usage was beginning to occur, as validated by expert opinion below recently.

> *…traditionally people aren't using electronic systems to do their recording of data or anything. Essentially, I call it the moment a bit of a wave going on in hospitals around the country. All these hospitals are starting…to look at hazards and EMRS and integration of digital technology into a hospital. So for Australia, the first few years we start to get a footprint there. Because you know that the US has been doing it for the last 5 to 7 years. So for us it's pretty brand new (Industry Expert: ICT Project Implementation Manager Digital Hospitals Project (Cancer Research), Victoria, Australia).*
>
> *We wanted to make efficiencies in the hospital…so we put a whole lot of technologies in there to make sure that we could meet those objectives. And we felt that RFID, were very much an important part of meeting those objectives, especially in the asset-tracking (Industry Expert: Technology Project Implementation Manager/CIO, A Large Public-Private hospital, Queensland, Australia).*

The first factor that emerged was timing of introduction of RFID into the hospital. In this thesis, the Pioneer Group, or Case-1, had introduced the technology, when it was in the nascent stages. Specifically, the technology itself is very dynamic and was evolving rapidly in the period from 2005 to 2010. Standardisation had not occurred world-wide, and definitely not in the type of tags being used/accepted in hospitals. A dynamic technology in a chaotic environment, was a key factor that impeded its adoption into hospitals. In addition to the dynamic nature of the technology, Australian privacy regulators were sceptical of an unstable technology being introduced—when it was not integrating well with existing legacy systems.

Specifically, a rapidly evolving RFID technology was being introduced in a chaotic emergency department, restricted with country specific privacy regulations and not integrating well with existing legacy systems. Australia had not evolved into a nation-wide electronic records system at the time. Hospitals nation-wide had legacy systems which had not been refreshed for a decade. Emergency departments were already strained with lack of resources. Into this milieu, came RFID as a 'debut' actor—and the technology was viewed with skepticism. In addition to technology specific factors, the privacy regulations in a legacy systems laden, chaotic environment in hospitals were impeding its propagation.

As revealed in the case of Victory Group or Case-2, RFID did translate well into the hospital because the *timing* was indeed *appropriate* by the time of implementation in this environment. It was already 2010 when RFID had evolved as a technology. Hospital grade tags were already in the market and the technology standards had stabilised. Australia was rapidly transitioning into e-health records systems and many hospitals had refreshed their existing legacy systems with the help of national and State level government grants. During 2004–2009, e-health, HealthSmart, HealthConnect initiatives as presented in Chapter 2 occurred. The national e-health strategy was released in 2009. Nonetheless, privacy issue is still of concern to many experts in the industry as validated below.

> *I found the single biggest challenge were the privacy issues, the ethical issues, the use of the data. And even, the laws in Australia don't necessarily protect a staff member in the workplace from having information they gain from being abused in the context of, a manager can track a staff going everywhere,. There's no laws that protect a person from that. So it's very much on the organisation itself to come up with the appropriate usage policies of the actual technology to make sure their staff protected. I'm very strong on making sure that usage policies are very, very clear (Industry Expert: Technology Projects Implementation Manager, A Large Private-Public hospital, Queensland, Australia).*

The timing being a factor also involved infrastructure issues before Wi-Fi had become common as well as handheld devices that could be used for tracking. To validate, here is another expert opinion:

> *Trying to put the sensors in the ceiling was a lot of, was very difficult because it was a very old building built in the 1920s, and drilling holes in the ceiling was very difficult as well. So there was a physical infrastructure issue that we had (Industry Expert: CEO, A large public hospital in Western Australia).*

From 2007 to 2012, it is evident that much has occurred in the Australian context relating to healthcare contexts, that has impacted hospitals. As the nation is gearing up for e-health record systems, having technology refreshments in all hospitals nationwide, enabled by Wi-Fi and handheld devices; RFID will emerge as versatile actor and super star, sustaining itself as the expert comments:

It's a push from the clinicians to the technology, and there's a big push in the space, especially around BYOD, or bring your own device, into hospitals. They want to have access to information, to their systems, to their environment. So that is becoming very prevalent, especially with the introduction of iPhones and the iPads. It is changing the way we do business in hospitals and with technology, and that's quite fundamental. So that's also changing too. So you're getting the push from different avenues…RFID is a very good technology and it should be the norm, not the exception. At the moment it's the exception (Industry Expert: Director—Life Sciences and HealthCare industry, A large Consulting Practice, Melbourne, Victoria).

7.1.1.2 Social

The next biggest influencing factor was the actor-network relationships between caregivers in hospitals. In this thesis, I have named these 'factors' or 'people' as social factors in hospital environments or users of RFID technology in hospitals. The findings reveal that the negotiation and network of relationships between the users are pivotal in promulgating the technology.

As presented in Chapter 6, the network of actors in hospitals are complex. Nurses and orderlies are the life of hospital operations. They are the key social actors (factors) who impacted the translation of any technology in the system. These factors need to be involved at the beginning as any introduction of technologies impact their workflows. If the users were able to negotiate changes in the workflow successfully, that would enable translation of the technology into the milieu.

In the case 1, both nurses and orderlies were threatened that their workflow was getting affected. The negotiations between them were not facilitated by the champions of RFID. Rather, the champions (ICT) imposed the technology on them altering their existing workflows. In case 2, the negotiations between nurses and other medical staff was facilitated by the champions. The hospital champions also considered the privacy regulations of the Australian environment, and successfully worked around them such that the technology did not alter the workflows of medical staff. As a result, there was successful negotiation/interaction between all the social factors (actors) and also the non-human actor, namely RFID technology. Clearly, there is significant indictors that the socio-technical factors do impact the successful translation of RFID technology in the Australian context.

More significantly, the findings reveal that there is a complex, yet silent web of relationships between the key actors in hospitals, in relation to promoting RFID technology. The department head that supported emergency in the private wing of the Pioneer Group and his counterpart in the public area had a silent, yet powerful connection that was not visible at the beginning. It was only on the recommendation of the first department head that the public hospital even considered RFID implementation. Equally, the constant communication flow between orderlies to orderlies, nurses to orderlies, and nurse to nurse across the private and public areas of the Pioneer Group of hospitals impacted RFID translation significantly. Similarly, in the Victory Group, nurse–nurse, nurse–clinician and nurse–ICT relationships, which are not clearly visible at the beginning, is indeed the most powerful social factor for RFID implementation.

Some expert opinions that validate the powerful nature of the social factors, their influence and relationships are revealed as follows:

> *The clinician was the key stakeholder and the key champion. And if ever you put technology in the clinical world, it must be led by a clinician. It cannot be led by an IT person, no matter how brilliant they are or how much they know how to talk the language…If you try and become a know it all, as a technologist it will fail. And that's the problem we have, in this country most chief information officers are technology officers. They're not information officers and they don't understand the business (Industry Expert: Director-Life Sciences and Healthcare Industry, Consulting Practice in Victoria, Australia).*

I think in an ideal world, it would be good if it could come through IT and that IT would then go back out to the organisation and say look we've got these, now we're looking at innovating these particular products for these particular services which I think will benefit the hospital in a very big way…

But unfortunately what we find is that the vendors and the medical directors are going out doing their own things, almost like they're an island and then they come at the eleventh hour and engage us (ICT) and say, oh we'd like to implement this. Can you help us?…there's also the reality of how you also obtain funding and how you get support for a particular initiative that may not necessarily be that effective if it starts with ICT as opposed to starting with the clinicians (Industry Expert: CIO, A large Public hospital, Melbourne, Australia).

…if I said to a doctor, 'I'm watching what you are doing and I'm clocking your time', then I think they would say, 'Well, no, you're not going to do it'. And they would be able to mount a credible argument as to why that wouldn't happen. If I was an orderly, and I once was an orderly, and I was very compliant and did everything, then I would be largely ignorant to the workings of the organisation and say 'no problem'. If a nurse said jump, I would jump (Industry Expert: Nurse-in-charge, A Large public hospital, Melbourne, Australia).

You have, a technology person, an IT person coming in and telling me, 'You've got to use this, and this is really going to make your life better', they're just very sceptical. They don't, you know, whereas a nurse will come in, so that's why I've got a nurse on all of our teams, will come in and say, 'This is what it's going to look like in your workflow'. So they can explain it in the normal day-in-the-life-of really. So it has to be clinically led (Industry Expert: Clarity Project Director, Large public hospital, Melbourne, Australia).

The doctor doesn't really talk to me, the nurses do. So I listen to what the nurses have to say (Industry Expert: Personal Care Assistant (Orderly), A not-for-profit hospital, Melbourne Victoria).

Where do you hearing aids go? Where are they missing from when you're in theatre?...They're a lot of money to replace. I mean they're three, four, five thousand dollars to replace a hearing aid that goes missing. One of the sterilisation departments, they had this problem of instruments, which cost them $20,000 or something. That's why they're saying, if you can just implant the RFID in to them, so that they can be tracked where they're going. Because sometimes they go in to the patient as well.

The nurse is the lynch pin...We talk to every department, we talk to every level and every whatever...We get a balanced, candid view of whether it works or whether it doesn't...and we will absolutely promote it (RFID) to as many people as we can (Nurses in-charge, A large Not-for-Profit Hospital, Melbourne, Victoria).

The above expert comments validate the view that a nurse-led approach would work for RFID implementation, as they are listened to by all actors. While the ICT department feels imposed upon by medical directors, if the nurse is the person raising the issue, they will accept take it on board and enable it. Doctors do not question nurses neither do the patient care orderlies. Nurse happens to be the *lynchpin* in Australian hospitals. While most people say that technology needs to be clinician led, it needs to be translated into context by the key actors (or social factors), namely the nurses. A doctor may be listened to initially for reasons of obtaining a funding, but ICT department may not be really happy about the situation, as reflected in the comments. However, if the nurse is leading an issue and taking it up to the ICT department, it usually is taken on board and given sufficient consideration or immediate attention. It is indeed an interesting observation that I have come across, through the investigation of the cases as well as validated by industry experts. Equally, the nurses always seem to have 'one voice' no matter which department they are based in. None of the nurses seem to contradict any others.

In terms of ANT, the nurse becomes the pivotal actor, who can stabilise the network and enable all other actors to pass through the OPP.

7.1.1.3 Technical

Amongst the factors that emerged is the dynamic nature of the technology itself that helped it emerge as the superstar. RFID was already an accepted technology in many industry sectors although it is relatively new to hospitals. During 2005–2010, it projected versatility, by evolving in terms of usage within hospitals. From tracking assets to patients using location tracking ability, it evolved into 'monitoring temperatures' for fridges and spaces. In hospitals, refrigeration is indeed a key element that supports quality of services.

Keeping blood and life support medicines in certain temperatures is critical to emergencies. This was enabled through temperature monitoring tags—an evolution of the technology towards 2010. The technology presented a solution as an alarm device, that is non-interventional in high-care facilities within hospitals. An alarm device, if pressed made a buzzing noise, which could adversely affect patients. An RFID tag worn with a button to be pressed, reported the staff in need request as a 'call for help' silently. The staff member in need was tracked without upsetting the rest of the patients in the hospitals. The technology thus integrated itself into the environment, being supportive, yet evolving in its uses. The versatility of RFID technology, as visible in the case-2—regular and temperature tags, helped its propagation.

Expert opinions to validate this factor is listed as follows:

> *I think every department would have a use for it. In track histories. If you put an RFID on a patient history, health information services wouldn't be ringing and saying you've got it and I'm saying I don't. Tag thermometers. Because they go wandering in to a patient's suitcase…*
>
> *Whether the technology has advanced to be user friendly…is I think an important…It would be interesting for fire and evacuation stuff, wouldn't it? You know, that you've got, that would be handy. That you've got to know that your patients and your staff are out and who you've got on the floor at the time. You know, that would be very, in an emergency situation, to be able to track people, would be very handy (Industry Expert: Nurse-in-Charge, A not-for-profit hospital, Melbourne, Australia).*

Even though it’s a 96-bed hospital, one of the big things for us was, we still lose equipment, and they still need to find out where things are. So that was a big one, and everybody agreed, yes, we absolutely want to know where equipment is. Because they keep taking it, they put it somewhere else, we can’t find it, it’s in a storeroom or a sound engineer’s lab being repaired, we need to know where it is. So they all bought into that. Then we went onto the patients, and we all agreed yes, it would be great to able to locate patients at various times. So a doctor turns up, a patient isn’t there, where is he? Or a patient’s gone to surgery, or down to the lab for a bit of blood test or whatever the case may be, and we also looked at automated alerts in the system as well, so when a patient goes through a zone, it triggered something in the system to automate something. So that was a great benefit as well, so all the clinicians were buying into that.

…When a doctor walks into a patient’s room, we want the doctor’s name to pop up on the screen and the patient sees and goes ‘Oh doctor such and such is now visiting you’. Because as a patient, you’re often sitting there, all these people come in and out all the time and you’re ill, you really have no idea who they are, even though they might’ve told you their name about 50 times. And you don’t really know what process you’re going through, because you’re sick. So we’re trying to provide a nicer environment for the patients to understand what’s happening to them. So that was one benefit we thought, not so much for the doctors, but for the patients.

I noticed that AeroScout now are starting to use a combination, or a hybrid of the two, so they have Wi-Fi and ultrasonic for their exciters, or their zone sensors if you like. So it’s much more accurate in a specific spot (Industry Expert: CIO, A Private hospital, Queensland).

I think it would be extremely useful for many of the uses that it can be used for. Whether it be tracking of equipment, tracking of patients, tracking of belongings. We’re constantly recording temperatures of fridges, equipment, etcetera like that. So I think that it would be. And I think every department would have a use for it (Industry Expert: Nurses, A not-for-profit Hospital, Melbourne, Australia).

In summary, RFID has evolved as a technology, it has become versatile in a way that it can be worn by people, embedded into equipment or tagged for tracking assets. These forms of tracking are now accepted by Australian hospitals and are slowly being trialled. While the technology itself has now progressed to the level of bio-degradable RFID tags used in Oncology (Yang & Halvorsen 2010), in the US, Australia has still a long way before the technology is permeated and accepted in healthcare completely. Nonetheless, the encounters of RFID technology with its users have instilled a level of confidence in its technical location tracking ability, enabling its successful translation into Australian hospitals.

7.1.2 Limitations

This thesis is focused on hospitals in Australia and captures a view of a decade. The views are validated as currently applicable, and valuable in 2013 by industry experts. As the technology evolves and becomes part of the fabric in Australia, the findings and recommendations from this thesis may eventually need to be revisited.

There are two case studies that were the basis of this thesis. A generalisation is not possible, although the two cases provide very good indication on what is relevant in the Australian hospitals in relation to RFID technology translation.

7.2 Contributions

As pointed out when answering the research questions, the key contribution of this research thesis is for Australian hospitals which are considering or have been unsuccessful in RFID technology implementation thus far. RFID is still considered an innovation for Australian hospitals, and to an extent an intrusion to existing workflows, due to the existing privacy controlled environment. In such an environment, the users of the system—mainly nurses, orderlies need to accept and propagate the technology—so that it can successfully translate realising its potential to improve efficiency of workflows and effectively, improving quality of care.

The thesis would help hospital administrators and decision-makers to better understand the factors that make RFID implementation more difficult, in particular, convincing people to use it to the fullest ability. The successful case study (Case-2), revealed that the dynamic versatile nature of the technology where it can be integrated well with the support of users. The socio-technical factors, or interaction between the technology and the users became positive as the findings revealed in the successful hospital case-2.

7.2.1 Contributions to Knowledge

Implementing innovative technologies is not a concept that is unfamiliar in any industry sector. In this thesis, I have examined the implementation process of a relatively new and evolving technology, RFID in the health sector. As against other industry sectors such as retail or manufacturing supply chains, where RFID has been deployed over the last decade for tracking based on location, health sector is different. Initially, RFID as a technology was not accepted because of potential apprehensions regarding its interference with medical equipment. This was addressed easily as the technology evolved. Over the past decade, there was much research and implementation of this technology in hospitals all over the world. However in Australia, it is still a nascent technology for the hospitals.

The unique proposition in Australian hospitals is the current transition into e-health records and moving away from the legacy systems. This transition preordained that many legacy systems needed to co-exist until all health-related systems are linked and updated over time. In the milieu, RFID was thrown in as an innovation which was seen more as another piece of technology, although useful, but creating further upheaval within frenzied hospitals. In addition, Australian hospital sector and the environment is privacy regulated by law, and culturally, this has had a significant impact of introducing any new technology that is interventional. While the technology was meant to only locate equipment initially, the potential of location tracking with patients and staff made it susceptible to reluctant acceptance.

The views in academic literature were mainly from the USA, where the privacy regulation and the environment of hospitals is quite different. In the Australian context, RFID was still a new concept being accepted or rather translating slowly into the environment.

The case study analysis conducted in this thesis, drawing from the gap in literature (Chapter 2), presented that the socio-technical aspects of translation have been rather ignored largely in terms of this technology. In the Australian context in particular, while there are RFID implementation models being constructed, studies that elicited factors that contributed to successful translation are still to emerge (at the time of this thesis submission). Therefore, the main contribution of this thesis is that it studied the process of translation (or negotiation) as RFID translates into the hospital environments and elicited success factors. If large Australian hospitals are embarking on RFID deployment, it is recommended strongly that they take on an innovation translation approach.

For the field of Information Systems and in particular Health Informatics, this thesis offered a significant contribution in that it studied innovation translation of technology, rather than 'diffusion of innovation' based on the 'essential element of technology'. It finds that in the health sector in particular, translation occurs through consistent negotiations between stakeholders (actors). Without the active participation of all the actors, from the beginning, the translation process does not succeed. Largely, hospitals and the health sector organisations (including government health departments), need to consider the recommendations before embarking on investments with any new technology.

7.2.2 Contributions to Theory

The theoretical constructs in this thesis are innovation translation and the ANT lens.
One of the criticisms to Actor-Network Theory (as reported in Chapter 2) is its insufficiency to explain relationship formation between actors and over changes of events in relationship networks (Greenhalgh & Stones 2010). In this thesis, I have contributed to Actor-Network theory in relation to information systems research in that the conceptual framework had incorporated ANT lens to the innovation translation theory, as an augmented filter enabling a deeper view of data the presentation of data reconstructed as acts/scenes funnelled to an ANT visualisation at the end of each Act.

Specifically, actors responsible were presented and the relationships formed at each event (end of each Act), were recorded in the diagram. As each Act completed, some actors exited and others entered. These were also captured in a table.

The visualisation using ANT lens enabled that relationship formation between key actors, and event changes in real time was depicted. Therefore, the inherent insufficiency of ANT was addressed through this thesis. This augmentation to ANT is a contribution of this thesis.

The theory framework of Innovation Translation was confirmed using the data analysis and moments of translation. Extending the theory itself, it was found that the 'Problematisation' moments continues to re-occur, if a technology does not translate well, as confirmed by Case-1. These re-problematisation moments are the evidence that there is an inherent, overlooked, issue that has hampered successful translation of the technology. Equally, in Case-2, where the technology seem to have translated well and embedded in the hospital pervasively, there are not many re-problematisation moments, rather, there are 'problematisation' moments that occurred and went through *interessement, enrolment and mobilisation* sequentially. Here is an indication of successful translation of the technology.

In addition, the conceptual framework presented with the ANT lens strengthens the ability of Innovation Translation theory to recommend future strategies for successful translation of technology.

7.2.3 Contributions to Practice

In the first hospital, where I had entered in a 'Cameo' role investigating the translation of technology into the environment, the organisation had not only invited suggestions for improvement, but also taken the suggestions while re-implementing RFID in the larger context. The contributions from this thesis reflects a real-life experience within a hospital, where improvements suggested had positive outcomes for better translation of the technology into the context.

In the case of the second hospital, the successful translation as reported in subsequent publication that arose from the thesis is a good vaulting point for other hospitals that are considering RFID implementation. It is clear in Case-2 that making nurses the ‘mouth piece’ for the technology, and enabling it from ICT department (indirectly), is the best way to realise the benefits from this powerful technology. Industry expert validation is also supportive of this view, and in particular that nurses are the lynchpin in Australian hospitals. The thesis also brought out the views from ICT department view (including implementation managers, CIO, consultant) and from clinician viewpoint (nurses, orderlies). These different perspectives that form the foundation of the web of network relationships that need to be stabilised for successfully translating the technology into Australian hospitals becomes apparent to hospital decision-makers. In turn, it helps them to better understand the process of successful translation and enable the process.

7.3 Future Directions

For Australian hospitals, practitioners and technology vendors, the insights from this thesis provide a starting point for incorporating better technology implementation processes, considering the use of ANT by viewing implementation and adoption as a process of translation.

For academia, there is scope for study using ANT in the health sector, with a focus on Australian context. Actor–Network theory as a methodological approach, rather than an analytical lens would be an interesting perspective to the health sector. A multiple case analysis of hospitals as they emerge after RFID implementations in Australia also is a proposed field of investigation.

It would also be interesting to understand the negotiations and networks between hospitals and the health sector, where RFID could be a catalyst in building networks. Actor-Network Theory could be a method for future studies in the area.

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