THE ROLE OF RADIO FREQUENCY IDENTIFICATION (RFID) IN IMPROVING THE SUPPLY CHAIN PERFORMANCE OF SMALL AND MEDIUM CONSTRUCTION COMPANIES IN AUSTRALIA AND ENHANCING THEIR COMPETITIVENESS IN THE MARKETPLACE

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ABSTRACT

Radio Frequency Identification (RFID) is being utilised more in Information Technology due to its features and capability that assist in enhancing productivity, efficiency in improving supply chain systems, and minimising cost. It is predicted to provide several advantages for both public and government organisations. RFID can increase the consistency and scalability of IT systems that permit organisations such as regional governments to focus their attention on their key business functions, including strategy formulation and adaptation. Limited studies have been conducted on the implementation of RFID in the construction industry to develop supply chain systems to improve performance. Moreover, there is an absence of exploratory research and studies that offer a comprehensive and holistic examination of the factors that impact the implementation of RFID. To date, there is also an absence of empirical studies regarding the factors that impact the employment of RFID in Australian SMEs in the construction industry.

This research examines the adoption and use of information communication technologies, in particular RFID technology, for improving the performance of supply chain management systems in SME construction companies in Australia. The research objectives are to analyse the state of supply chain management systems in SME construction companies in Australia; and the potential of RFID technologies in helping to overcome the problems and challenges facing these companies.

This study aims to explain the capability for creating value resulting from the adoption of RFID in SME construction companies in Australia. This research identifies the factors that are expected to impact its implementation and ascertains the factors that are essential for management to focus on when planning to implement RFID. These factors include emerging policies for adoption of RFID, expected advantages of implementation of RFID, along with highlighting the challenges and issues created by the adoption of RFID. The research model adopts a combination of three theories derived from the literature, namely, Diffusion of Innovation Theory, the Technology Organisation-Environment (Stoekel and Quirke) framework, and the Actor Network theory.

This study aims to enhance knowledge about how information communication technology can play a role in improving supply chain performance, and how to optimise the use of supply chains to improve the performance of these businesses. A quantitative approach is used in this study to identify the key themes and constructs in a comprehensive survey of IT decision-makers within SME construction companies in Australia.

The intention of this research is also to increase knowledge regarding factors that impact decision-making regarding the adoption of RFID within SME construction companies based in Australia. The research method used for the research is quantitative. As an in-depth study, this empirical study has involved IT managers in Australian-based SME construction companies and their employees' interaction with RFID suppliers. Through this, the study achieves the aim of providing in-depth insights into those factors that are perceived most likely to influence their employment of RFID; and identifying all vital factors on which to focus when planning to implement RFID, including the emerging legal setting that influences RFID implementation, expected merits of RFID implementation; and problems and issues that face SMEs when deciding to employ RFID. The study was conducted among 297 IT employees from 47 SMEs in the construction sector and RFID suppliers to conclude the outcomes of the exploratory stage. Factors such as compatibility, complexity, cost, security concerns, size of the firm, and expected advantages from the adoption of RFID are examined. The results and conclusion of the research can be used for firms' decision-making on whether to invest or not in the adoption of RFID.

Certification of Thesis

This thesis is entirely the work of ***Tarik Mabad*** except where otherwise acknowledged. The work is original and has not previously been submitted for any other award, except where acknowledged.

Student and supervisors signatures of endorsement are held at USQ.

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Abbreviations

IS	Information System
ICT	Information Communication Technology
RFID	Radio Frequency Identification
SCS	Supply Chain System
SMEs	Small & Medium Enterprise
ACC	Australian Construction Company
DOI	Diffusion on Innovation
TOE	Technology-Organisation-Environment
ANT	Actor Network Theory
AIDC	Automatic Identification and Data Capture
IC	Integrated Circuit
NLIS	National Livestock Information System
EAS	Electronic Article Surveillance
CSIRO	Commonwealth Scientific and Industrial Research Organisation
EDs	Emergency Department
NEAT	National Emergency Access Targets
ATS	The Australian Triage Scale
CPM	Construction Project Management
MTRC	Mass Transit Railway Corporation
HA	Housing Authority
RTLS	Real Time Location Systems
UHF	Ultra-High-Frequency
IOT	Internet of Things
TRA	Theory of Reasoned Action (TRA)
TAM	Technology Acceptance Model
UTAUT	Unified Theory of Acceptance and Use of Technology
TPB	Theory of Planned Behaviour
ERP	Enterprise Resource Planning
EDI	Electronic Data Interchange
CIOS	Customer-based Inter-Organisational Systems
H	Hypotheses

HREC	Human Research Ethics Committees
USQ	University of Southern Queensland
CFA	Confirmatory Factor Analysis
SMC	Squared Multiple Correlation
CR	Composite Reliability
SEM	Structure Equation Model

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CHAPTER ONE: INTRODUCTION

1.1.Background

Information Technology (IT) is considered to be one of the critical imperatives by which countries can upgrade their advancement and accomplish better living benchmarks (Hanna et al., 1995, Avgerou, 2008). IT not only has socio-economic impacts (Cohen et al., 2004), it also encompasses an assortment of human needs (Roche et al., 1996). IT provides a process by which countries can develop and succeed within worldwide monetary, political, and social areas (Cohen, 2004). IT can be utilised to create authoritative administrations in terms of benefits and adequacy, as well as in resource usage (Baark and Heeks, 1999). Ongoing improvements and presentation of ICT concepts such as Radio-Frequency Identification (RFID) have received critical consideration from government organisations, trade associations and others to improve the communication between their customers (Curtin et al., 2007), as these concepts are seen to be exceedingly viable in decreasing the costs of administration (Smart et al., 2010). Papert et al. (2016) asserted that administrations depending on RFID have openness from anyplace and at any time, which sets it apart due to this key distinction it has of being a clear advantage in improving Supply Chain Systems (SCS) to enhance the trust with organisations' suppliers. RFID has the capacity to coordinate development of SCS errands by the client, as well as provisioning to transfer information between suppliers and organisations (Choi et al., 2017). RFID is one of the advancements that have attracted consideration within the Data and Communication Innovation (ICT) segment (Hawkins, 2011).

This research focuses on the role of technology, particularly the use of Radio-Frequency Identification (RFID), in supporting the supply chain systems in the Supply Chain Systems (SCS) of SME construction companies in Australia. RFID technology plays an increasingly important role in SCS to improve business performance in Small and Medium Enterprise (SME) construction companies in Australia (Alamgir Hossain and Quaddus, 2011). It is useful in many ways - it enables these businesses to be placed in parallel with larger companies in the tender market (McDonald and Wilson, 2016). Also, it engages in global business competition directly such as participation in the tender market and provides confidence in the entry to that environment (Kubickova and Procházková, 2014). The research will also investigate the factors that have an impact on improving the performance of the SCS by using RFID technology, and the challenges and the problems facing SMEs in the adoption of this technology. This research will specifically focus on Australian SMEs construction companies because of the challenges that these companies are currently experiencing (Michaloski and Costa, 2010), for example, transferring material from their warehouses to project sites and from their suppliers to their warehouses a time and cost-effective manner. Such companies also vary in size and type in terms of potential, and also by capital and number of employees. The focus on SMEs relates to the lack of studies related to the use of RFID in SCS to improve the performance of SMEs construction companies within Australia, (SCCA; (Zhu et al., 2012). This study investigates the potential benefits of RFID for SME construction companies in Australia. Previous studies highlighted the use of Information Communication Technology (ICT) in SME construction businesses and a study by Gunasekaran and Ngai (2005) looked at 218 SME construction companies in Belgium with a specific focus on the performance of construction companies. This study recommends the need to support these companies because they play a major role in the building of state institutions. Research conducted by Irefin et al. (2012) suggests that SME businesses with skilled employees who are knowledgeable in the area of ICT are more likely to adopt advanced ICTs. Other research conducted by Saffu et al. (2008) identifies three main points that help to develop SME companies: operational support; managerial productivity; and strategic decision aids. These points have a direct connection with applying RFID technology in controlling time and SCS.

1.2. Focus of the Study

This study aims to provide knowledge on how information communication technology can improve the supply chain and, in turn, how the supply chain is used to develop the performance of SME construction companies in Australia (Terziovski, 2010).

This research focuses on the main role that RFID technology play in SCSs to enhance the performance of SME construction companies in Australia (Alqahtani and Wamba, 2012a). The focus of this study comprises three parts. The first is to determine how Australian SME construction companies can develop their operational and management capabilities to gain a competitive advantage. The second part of the study will focus on how to improve the SCS performance of Australian construction companies. The third part, which is the focal point of this study, is the potential use of RFID technology to improve SCS performance which can reflect positively on development; and encourage SME construction companies to upgrade their performance and become more successful. This research will investigate how RFID can help support SCS performance to improve the level of performance of SMEs in ACC and will also examine the performance of companies using ICT. This research will focus on the rate of growth in SME construction companies in Australia. It will also examine increasing literary debate to provide more information about how RFID is used in SME construction companies in Australia, including the benefits and challenges of using RFID in SCCA and SCS.

1.3. Research Problem

In general, there are many companies that have adopted RFID technology to increase their effectiveness in managing their SCS (Kim and Garrison, 2010). The Australian Government continues to use traditional methods in many commercial and industrial organisations in terms of transferring the material in the field of construction and is still in the early stages of considering the adoption and utilisation of RFID technology (Zhu et al., 2012). The main problem in this research is detecting the actual obstacles facing SMEs and determining some solutions which could help to develop SCS performance by using RFID technology and, in turn, to improve the performance of SME construction companies in Australia.

There is a dearth of studies related to the adoption of RFID technology in SME construction companies in Australia. This research will concentrate on an investigation using RFID technology to enhance the performance of SC specifically in Australia, where studies have been limited to areas such as airports, marketing, health, toll roads, livestock, the trucking industry and libraries (Alamgir Hossain and Quaddus, 2011, Landt, 2005). For more details see Figure 1.1.

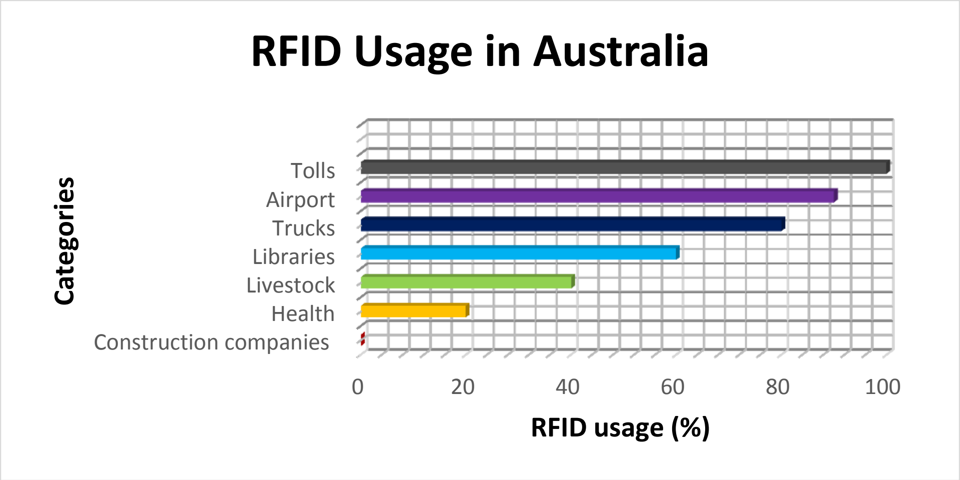


Figure 1.1: Overview of studies in Australia by Categories

Source: Landt 2005; Alamgir & Quaddus 2011)

SME construction companies are far behind in the adoption of this technology. Specifically, SME construction companies in Australia have, to date, not adopted RFID technology.

The Australian Government has called for more research relating to this field to determine the challenges and benefits of this technology because research in this field could contribute to enhanced performance in SCS (Jung and Lee, 2015). Because many construction companies do not use technology extensively, those companies experience the problem of delayed access to materials—especially in remote areas—resulting in lost revenue and loss of credibility between the supplier and customers (Doloi et al., 2012).

1.4. Research Objectives

The main objectives of this research are the following:

1. To investigate the factors that impact the use of RFID technology to improve the performance of SCS in SMEs ACC.
2. To identify the challenges and problems that decision-makers face in Australian SME construction companies regarding SCS.
3. To study the potential benefits of adopting RFID in Australian SMEs construction industry.

4. To develop a theoretical model to help SMEs construction companies adopt RFID technology.

1.5. Goals of the Study

The proposed research aims to explore the creation of potential for value from the adoption of RFID technology to improve SCM performance in SME Australian construction companies through achieving the following three goals:

1. First goal: To investigate the factors that impact on using RFID technology to improve the performance of SCS in SMCCA.
2. Second goal: To determine the challenges and problems that decision-makers face in Australian SMEs construction companies in relation to SC.
3. Third goal: To study the potential benefits of using RFID in Australian SME construction companies

The significance of this research is its attempt to identify the potential factors influencing successful RFID adoption to improve SCS performance in SMEs ACC.

1.6. RESEARCH QUESTIONS

What are the factors that are likely to influence the adoption and use of RFID technology to help improve the performance of Supply Chain Systems (SCS) by SME construction companies in Australia?

Based on the research problem and the main research question above, three research sub-questions have been formulated to provide a clear answer to the main research question.

RQ1: What current technologies are being used in SME Australian construction companies for SCS management?

RQ2: What benefits and challenges are anticipated in the adoption of Information Technology solutions for SCS by Australian SME construction companies?

RQ3: How can RFID technology, as an example, improve the performance of SCS in Australian SMEs construction companies?

1.7. Research contribution

This research will support SME construction companies in Australia to make decisions that can develop supply chain systems to improve the performance of their companies by adopting RFID technology and identifying factors that affect the adoption of RFID. The contributions of this research are to:

- Inform the managers of Australian SME construction companies of the varied ICT factors they can employ to develop and enhance their performance.
- Provide information to the managers of Australian SME construction companies on the benefits and challenges of using RFID technology.
- Introduce to these managers concepts and strategies about how the adoption of RFID technology can improve SCS performance in SME construction companies in Australia.

The research aims to increase knowledge in all SME construction companies in Australia to assist them in the evaluation and adoption of RFID.

1.8. Research outline

This section of the thesis will provide details of all six chapters of the study. Each chapter is described as detailed below.

Chapter 1: Introduction

This section presents a concise diagram of the research topic. It provides a foundation for the research problem and outlines the research questions. Additionally, it presents the research objectives and the principal research contributions. It closes with the thesis outline, which gives a concise depiction of the substance of each section of the thesis.

Chapter 2: Literature Review

This section gives an overview of the literature review setting of SME construction companies in general; and, specific SME CCA. In addition, this section presents a summary of SCS and RFID technology in general. It presents information on the investigation into RFID and its qualities, advantages, and its difficulties and issues. The literature review likewise examines the innovation adoption theories on the selection of adopting RFID as a new technology to develop SCS.

Chapter 3: Research Model Design

This chapter expands on the hypothetical establishments to build up the structure and related theories dependent on the literature. Additionally, it plots the exploration plan regarding the research questions; and it features the hypothetical and experimental investigations of the factors that can be included within the conceptual framework of the theoretical system that presents the theories for the research.

Chapter 4: Research Methodology

This chapter explains the research methodology that was utilised to assemble and investigate information to answer the research issue that this thesis addresses. This chapter is separated into four sections—the first of which outlines the primary plan to clarify the research philosophy. The second section explains the choice of the research approach. The research design is then laid out; followed by the last section which provides insights concerning research data collection and analysis stages.

Chapter 5: Quantitative Data Analysis

This chapter reveals the results of the quantitative investigation. It begins with the results of descriptive analysis of the survey respondents by demographics of company staff, followed by the approval of the research validation, including Confirmatory Factor Analysis (CFA) of the information collected from the exploration proposed model to investigate its validity, reliability, and quality. It portrays the Structural Equation Modelling (Gündüz et al., 2013), followed by an analysis of the results of the hypotheses. Finally, there is a discussion on the general findings.

Chapter 6: Conclusion, Limitations and Future Research

This chapter presents the outcomes of the research objectives and the research hypothetical contributions. It presents a discussion on the functional contributions which incorporate suggestions for innovation experts and specialist IT staff and decision-makers. It provides a discussion on impediments and future research exploration, and a conclusion of the research study.

1.9. Summary

This chapter has given a concise outline of the issues that this research has intended to design and investigate. It then introduced the research background and the focus and goals of the study, followed by identifying the main issue, the objective of the research, and the research questions. It also introduced the research contributions; and closed with a short depiction of the substance of each chapter in the thesis. The accompanying section highlights a review of the relevant literature and investigates the developing field on SME construction companies in Australia and an overview of the role of SCS in developing companies and assisting their adoption of RFID technology as a new technology to improve SCS in SMEs in Australia.

CHAPTER TWO: LITERATURE REVIEW

2.1 Overview

The enormity and makeup of SMEs provide benefits such as speedier communication amongst staff and supervisors and faster decision-making. Yet downfalls exist such as limited resources and cost to HR (Welsh and White, 1981). Such issues weaken SMEs and affect aspects including planning, authorisation and professional development (Zhang et al., 2008). Maintaining finances is therefore a vital component within SMEs; and vast spending on IT is not always plausible (Bernstein and Haas, 2008). There is also a danger of failure within IT projects with 20 percent of projects cancelled and less than a third completed by deadlines—or at all (Kappelman et al., 2006). Research has been executed to consider enhancing SME operations in terms of financial and risk factors and ways in which to gain better growth. Such benefits may be as a result of public policies (Lasagni, 2012). The construction industry has indeed not been regarded as a leader in technological developments (Badi et al., 2017). As there is the uncertainty of IT gain, this industry has remained behind in this regard. As a result, this has become the central focus of much research surrounding ICTs within the construction industry (Hosseini et al., 2013). However, owing to the IT demand, many studies have considered the potential of ICT (Osabutey et al., 2014). The essential barriers have been considered within such studies to determine the divide between industries and ICTs (Alkalbani et al., 2013). Developing countries have also been considered in such research where ICTs are known, but less commonly implemented (Ahuja et al., 2010). The future of IT within construction is one of compromise, where using IT is indeed mandatory, but balancing this with what the companies wish to achieve—which they cannot do without ICTs (Jewell and Flanagan, 2012). However, it is vital that this move is a beneficial one addressing political, structural and existing limitations (Brett et al., 2008). Adopting such changes requires motivated workers, consequently, increasing their motivation is the primary focus when implementing ICT. Furthermore, effective ICT has been found to improve ability within construction industries, increasing their competitive opportunities (Sin Tan et al., 2010). Yet ICT adoption comes at a financial cost with multiple projects increasing budgets due to factors such as process improvements, maintaining systems, storage and regulatory concerns (Jurrus et al., 2010).

Above all other service industries, it is the construction industry that can have the greatest impact most on Gross Domestic Product (GDP) owing to its services, enormity and employment opportunities. A case in point is a 10% rise in Australia's construction industry could lead to the economy's service industry contribution growing by over two percent (Stoekel and Quirke, 1992). Similarly, findings from the Latham Report in the UK showed how appropriate implementation of ICTs could actually lower expenses by thirty percent across projects (Hall and Purchase, 2006). Despite the growth factors, issues within construction are more extreme compared to other industries, for example, financial aspects and assessing advantages (FLANAGAN and MARSH, 2000). This could be attributed to frameworks, scope, inconsistent supplies and capitalisation. RFID IT is assisting with SME performance, which is beneficial to smaller companies due to aspects like scale, expenses and adaptability.

Australian contractors have implemented IT for the use of automatic operations, but the IT advantages have decreased through each cycle (Love and Irani, 2004). In another study, contractors were seen to be recreating processes in order to reap IT benefits and, in turn, improve productivity (Enright and Roberts, 2001). However, most IT applications are limited to communication automation (Love et al., 2004). Although some companies are viewed as not effectively adopting modern-day IT, larger companies, who have moved forward with this era's IT, are seeing profits above and beyond $A500 million. For instance, Bovis Lend Lease, who established Project Web, have had success with the implementation of their system during a landmark Australian project due to their web-based system, which was created specifically to the project's needs. Other examples include VHSoft Technologies VHBuildk (Li et al., 2002). Alternatively, rather than developing such state-of-the-art IT, SMEs could hire conducive applications from Application Service Providers (ASPs), which encompass companies such as Autodesk, Citadon, and Construct ware. This principal research served as a catalyst for developing metrics within IT operations: they could be used to compare and analyse businesses and so these metrics are viewed as integral in implementing and executing IT as a means of business support. For the greatest benefits, SMEs need to assess their existing processes by consideration of essential benchmarks to meet customer requirements in terms of advantages, expenses, and risk. All companies are required to have strategies in place to highlight IT risk and salient components to increase performance. How best to evaluate future work needs to be considered, as IT is moving forward quickly and new breakthroughs emerge constantly (Love et al., 2004).

An SME construction company comprises a group of individuals and is usually owned by one person, or groups with limited capital (Burns, 2010). In fact, SME construction companies may have limited performance outcomes, but those companies have the ability to improve their performance by increasing their capacity for innovation over a short time (Barrett and Sexton, 2006). SME construction companies can play a significant role in employment creation, innovation, and the economy in general (Lee et al., 2010).

In the present research, a thorough analysis will be conducted regarding efficiencies to be gained by using RFID technology to improve the performance of SC in Australian SME construction organisations. Research relevant information is included to enhance the credibility of the study. In the next section of the literature review, previous research conducted on SME construction organisations and crowdsourcing will be detailed.

2.2 ICT Adoption in SME Construction Companies

Increased adoption of ICT in SME organisations has a significant impact on improved communication with customers, particularly when used continuously and accurately (Bayo-Moriones et al., 2013). A previous study about the performance of SME manufacturing organisations that adopt ICT suggests that, overall, communication and operational performance is enhanced as a result of the positive impact of ICT (Tarutė and Gatautis, 2014). Adoption by SME organisations of ICT provided many benefits to developing enhanced performance and gaining the trust of customers (Martin et al., 2013). The SME construction industry is one of many that has a major role to play in Australia's economy (Hardie and Newell, 2011). It has been suggested that comprehension of SME adoption within small businesses is very restricted—yet within larger businesses, adoption seems to be better understood (Bharati and Chaudhury, 2006). This could be due to a lack of training and a lack of knowledge surrounding adoption advantages (Jones et al., 2011). It has been found that the more micro a business is, the greater the difficulties faced. These difficulties may consist of available resources, the environment, access, systems, attitudes and potential abilities (Wolcott et al., 2008). Furthermore, findings suggest that smaller businesses can gain advantages such as better customer understanding, informality and improving established adaptations (Simmons et al., 2011). ICT adoption involves both attitudinal and social aspects, so to comprehend adoption further, attitudes of authority need to be explored, which will allow for more effective implementation (Simmons et al., 2008).

It has been found that there is a shortfall in the literature regarding ICT adoption within small businesses; and existing literature has been criticised for a lack of diversity in its approach (Alonso Mendo and Fitzgerald, 2005). Effective adoption within small businesses would need to portray individual and original attitudes and strategies to succeed. Scale and grade have both been perceived as vital factors in ICT adoption (Bengtsson et al., 2007). For small businesses, these two factors would have to be even more exaggerated, especially for sole proprietors, and a stronger theoretical aspect of the business would be essential. Extending research to consider ICT adoption within small businesses would be time-consuming, yet nonetheless vital given the contribution of micro-companies. This study specifically aims to execute a longitudinal case study, which examines sole proprietor attitudes and strategic responses in adopting ICT. By doing so, this research will add to the somewhat minimal research to date surrounding micro-enterprise ICT adoption specifically looking at sole proprietors.

Unfortunately, small businesses are related to high failure rates, for example, in the UK businesses were found to have a success rate between 71-92 percent within the first three years of operation (Jones et al., 2014). Evidently, further research is needed into small business strategies that will increase growth and survival rates, whilst the economy adds increasing pressures (Kitching et al., 2011). ICT adoption is no longer a choice: it is an essential element to a successful business and micro-companies have had to embrace this owing to aspects such as email and the Internet in everyday transactions (Sin Tan et al., 2010).

Yet ICT adoption is still in the primary stages and full participation has not been taken advantage of (Chibelushi and Costello, 2009; Chinedu-Eze & Bello,, 2019). Owing to size, fewer resources and less advice from specialists, smaller businesses are limited in opportunity (Ashurst et al., 2012). Disparities amongst regularity and forms of ICT can be linked to their size and grade (Bengtsson et al., 2007)—which should be considered in future implementations and, indeed, small businesses are doing so and reaping the rewards (Loebbecke and Schäfer, 2001). Furthermore, attitudes from supervisory positions need to be given greater attention, particularly in relation to the competitive market (Higón, 2012).

Continuing on from the work of (Tornatzky and Klein, 1982), this study dissects perceived advantages of ICT adoption and expenses. One finding was that smaller businesses hold back on investing in e-commerce due to a lack of resources and a lack of awareness of the advantages. Furthermore, small businesses are more fragile in terms of adoption expenses and components such as industry pressures (Lewis and Cockrill, 2002), market strategies and online risks impacting the attitudes of authoritative figures who are responsible for ICT decision-making (Beckinsale et al., 2011). This could be attributed to the fact that successful adoption can be influenced by sector and customer and stakeholder needs (Arbore and Ordanini, 2006). Therefore, specific training needs to be implemented to ensure customer and stakeholder values are embraced (Drew, 2003). Research suggests that adoption should be tightly related to customers' interpretations (Levy and Powell, 2004). It has also been suggested that companies should conduct customer orientation studies to enable them to understand the values behind online and offline performance (Quinton and Harridge-March, 2003). This is based on the vital role that customer impact plays in effective ICT adoption (Fillis and Wagner, 2005). If this knowledge is unknown, strategies are ineffective and can lead to the failure of ICT adoption (Jones et al., 2014). Disparities in adoption are huge. While many companies only adopt ICT for minimal purposes such as email, other companies seek comprehensive e-commerce solutions (Simpson and Docherty, 2004). ICT is simply not viewed as vital by many companies, with only one third adopting e-commerce according to one particular study (Quayle, 2002). It is argued that adoption is low in contexts where managers unenthusiastically perceive ICT (Consoli, 2012).

Although SMEs' needs vary in comparison to larger companies, it is still necessary to understand the utilisation of SCM and IS. Despite the knowledge regarding benefits to SMEs, there remains a lack of research in relation to SCS practices and how this connects with SMEs. Within large companies, IS brings about opportunity and value (Beckinsale et al., 2006). SMEs influence supply, distribution and consumers, therefore, playing a vital role in economic growth (Chin et al., 2012). Specialty production and support are amongst the highest with large SMEs companies (Demirbag et al., 2006). SMEs make up over fifty percent of employment and added value in the majority of countries: a similar pattern is true of Turkey where SMEs make up 99.5% of businesses and 61.1% of staffing (Clarke et al., 2012).

SME construction companies are classified as SME organisations owned by one person or an SME team, with employees mostly coming from local areas (Taylor, 2001, Dvouletý et al., 2020). See Table 2.1 for an overview of classifications. The class *SMEs* may be further subdivided under micro-businesses of under 10 workers; also sole entities that employ no workers (Taylor, 2001).

Table 2.1: Overview of SME construction companies

Standard	Small companies	Medium companies	Large companies
Number of Employees	<50	50-250	More than 250
Income (million ECU)	<7	7-40	More then 40
Equilibrium piece total (Million ECU)	<5	5-27	More than 27
Max. % owned by larger company	25%	25%	

Source: European Commission Recommendation (Dvouletý et al., 2020).

The production capacity of organisations helps divide them into various categories, classes or centres (Iriye, 2002). Even if an organisation is large in size, it would have a limited capacity in its performance. Improving the performance of the companies depends on the capacity of management to devise plans and measures which help raise the level of performance of those companies, whatever their size (Raymond and Bergeron, 2008). The long-term economic success of global organisations is mainly led by SME companies, due to their level of continuous innovation (Terziovski, 2010). These companies play a major role in developing many nations (Dulaimi et al., 2006). One of the main points of the current study is to assess and understand the performance of these SME organisations. While assessing the implementation of ICT within the construction industry, it was observed that there is an innovative characteristic behind the use of ICT when it is applied for design reuse of SME projects or for motivation in the use of large projects (Lindkvist et al., 2013). For SME construction companies, it is possible to attain higher returns if the work being carried out is repetitive (Love et al., 2004).

2.3 Nature of Construction SMEs

SMEs are different from other industrial companies and organisations. These organisations are featured with limited financial resources in terms of limited capital and borrowing. As a result, these organisations are limited in taking the chance of change. There is a higher level of competition in the SME environment than in a large business organisational environment (Saleh and Ndubisi, 2006). These types of organisations have less capability to monitor their competitors than large business organisations. Therefore, implementing advanced technologies in their organisation is beyond their resources unless these organisations can do so through an industry network. It leads these SMEs to survive in the market rather than experience growth. For SMEs, both risk and cost of change are too expensive (Love and Roper, 2015).

The positive side of the SME situation is that the leaders of SMEs are mostly very capable and talented and have rejected working in a large business organisation as these organisations' bureaucratic systems neglect their ability and creativity (Afriyie et al., 2019). A person with creativity and talents is capable of being an effective leader of the organisation for enterprise growth and industrial change. Additionally, they also work with novel systems and products. These sorts of individuals are known as champions of innovation (Purcarea et al., 2013). The fact that the industry features so many small businesses can be considered as both a strength and a weakness. It also impacts the restriction of capacity and resources. However, it allows the creative individual to move in a novel direction quickly and formulate a new and effective solution for industrial problems. Studies conducted in this sector employed the approach of dynamic capabilities for a better understanding of readiness and capability for creativity (Lee et al., 2016). The approach of dynamic capabilities allows self-examination that makes the firm capable of identifying and seizing opportunities for innovation through reorganising its resources to identify changing circumstances (Kowalkowski et al., 2013). This gives an understanding as to how it may be probable for smaller organisations to keep their attention on innovation, even though there is a lack of extra capacity that Schumpeter assumes axiomatically. Additionally, it is identified that partnerships with universities have to allow collaboration in innovation. These sorts of collaborations have fewer negative impacts on SMEs in the process of innovation (Ratti et al., 2019).

2.4 Measures of growth performance of SMEs

The growth of a small firm is the growth of a firm in the form of changing organisational size is a multidimensional phenomenon that automatically happens over a long timeframe. Large business firms grow in the form of acquisition, while SME firms usually grow gradually and naturally. In the study of firm growth from the perspective of change in size, growth has been examined with the help of different indicators such as firm's sales, revenue, profit, employment, assets, physical output and market share (Davidsson et al., 2006). In some specific industry analyses, more specialized measure indicators are conceivable. For illustration, improving sales turnover and employment are frequently used growth indicators in the construction sector (Saridakis et al., 2018).

2.5 Overview of Australian SME construction companies

Comparatively, the investment made in technology is not sufficient for SME construction companies. There is strong support and interest from SME construction companies for such technologies in Australia. The Australian Government takes responsibility for overseeing the management activities or projects of such companies (Lin and Mills, 2001). The SME construction companies of Australia play a vital role in the institution-building of the state (Spicer and Sewell, 2010). Australian SME construction companies face various difficulties such as delays in receiving material, timing, and a lack of trustworthiness. The future of these companies is dependent upon the economy of their countries; however, small and medium-sized companies are de-motivated if economic inefficiencies are present (McFadden, 2015). In the UK, for example, there are few SME scale companies that have routine work plans being followed and, according to research, these companies are the most successful (Howorth and Westhead, 2003). In Australia, at times, the innovations being introduced are not documented or applied effectively, causing further setbacks. The manufacturers may also not commercialise these innovations (Weeramanthri et al., 2015). A research by Reichstein et al. (2005), carried out empirical research using the 'UK innovation survey' data on Australian SME companies and the results indicated that in the construction sector, product or process innovation within the industry is much less compared to other sectors. The construction companies have limited research and development programs, the external environment is restricted and external opportunities are absorbed at a lower rate (Hardie and Newell, 2011). There are few researchers who do not believe that the SMEs construction industry has a low performance level compared to the rest of the industrial sector (Cheng et al., 2010a). Further, it was established that construction firms are less open to the external environment and they tend to have poorly-developed research and development (R&D), with a low capacity to absorb ideas externally (Berchicci, 2013). Some researchers are sceptical about the so-called conclusive evidence of the poor performance of the SME construction industry compared with other industrial sectors (Kulatunga et al., 2006). When considering the use of virtual reality within the construction industry, (Zhou et al., 2012) state that virtual reality is being used innovatively within large unique projects, as well as SMEs' reuse of design projects. For an SME company where repetitive work is carried out, with an investment in technology it is then possible to attain higher returns. At the same time, for large companies, large investments need to be made to manage the practical issues associated with large projects (Kulatunga et al., 2011). In Australia, the SME construction industry is one of many different companies that have a major role to play (Australian Bureau of Statistics 2001). There are different types of SME construction companies, such as construction SMEs, that provide house building, commercial building, offices and industrial building; or SME maintenance companies which build roads and bridges (construction., 2017). Therefore, this study will focus on SME building (construction and maintenance) companies that are accredited by the Chamber of Commerce in the various States. The Australian Bureau of Statistics classifies what types of SME building and road maintenance are included: for example, the number of employees is between 50 and 200 and those companies deliver a diverse range of construction projects for both the private sector and government clients; and the size of the projects range from $1M to $ 150 M. The sample that will be the focus of this study is according to the criteria used by the Chamber of Commerce in all States and encompasses those SME building companies that have a significant role in the development and growth of the country in all States. These companies play a vital role in providing job opportunities, including the implementation of housing, schools, building of public markets and government buildings and road maintenance projects (industry., 2018). Table 2.2 shows the specific types of SME building companies in Australia.

Table 2.2; Sample of SME construction companies

Company	*Types of service*	*No of Employees*	*Location*	*Information*
Apollo patios	Building	180	QLD, NSW and VIC	SME building service since 1995 building construction
Kurrajong	Building	100	QLD	Small companies over 20 years' experience
Blackwatch	Building	150	QLD	27 years' experience in building construction
ROHRIG	Building	140	QLD, VIC and NSW	24 years' experience in building
Ozpave	Road construction and maintenance	120	NSW	20 years' experience
KERB DOCTOR	Road construction and maintenance	100	Perth	SME companies with 18 years' experience

Source: (industry., 2018).

Within Australia itself, SMEs are essential in developing a healthy economy (Hosseini et al., 2016a), although they remain constrained in keeping up with the market owing to a shortfall in human resource incentives, which is a key indicator in construction industry success (Saridakis et al., 2013). Research has found SMEs to be behind other larger companies particularly regarding innovation and IT performance (Hosseini et al., 2016b). Owing to the following issues, Building Information modelling BIM has found this to be true (Poirier et al., 2015).

SMEs vary enormously compared to other industries in areas such as monetary considerations, which results in an inability to execute alterations within the company whilst trying to maintain a level of competition with other companies (Hardie et al., 2013). SMEs also have the disadvantage of less adequate supervision of resources in comparison with larger businesses, which means that staying current with IT results in a loss of potential. Furthermore, a mentality exists in the industry to simply cope rather than develop, which brings about financial penalties and increased risks (Abbot et al., 2006).

However, what must not be overlooked is that many managerial incumbents have chosen to work within SMEs to avoid bureaucratic barriers and to enhance their creativity. These opportunities can grow into leadership roles, models and systems and become a catalyst for change—often known as ‘champions’ of innovation (Nam and Tatum, 1997). The construction industry is made up of micro-businesses, which creates both problems and opportunities. It brings about creativity and eliminates barriers to industry problems whilst also experiencing limitations on resources. This research aims to find enabling factors for non-micro-SME construction companies. ‘Dynamic capabilities’ is a term whereby resources are reconfigured to better adapt. Dynamic capabilities have been used in current literature to help comprehend capacity for innovation and how ready companies are in this regard (Gajendran and Perera, 2017). Furthermore, this empowers smaller businesses to join in innovation without the extra capacity, which may be viewed as unquestionable**.** Another vital aspect pointed out by Brochner and Lagerqvist (2016) is university collaboration and how beneficial such a partnership can be for SMEs.

2.6 Contribution of the Australian Government to SMEs Construction Companies

In Australia, public policies for supporting SMEs in the information and communication technology sector are spread among numerous public bodies. The business entry point of the Australian Government provided a unified portal for all SMEs through which they can access support policies and government programs. Four ranges of support are offered for SMEs: grants, advice, support, and personal counselling services (Alismaili et al., 2020). SMEs in Australia can receive the support of ICT sectors to form the unit of communication, information technology, and the arts. The government of Australia has organised Backing Australia's Ability program worth $3 billion. In the same way, the government also offers other initiatives for supporting the growth of the ICT sector, most especially in SMEs (Dwyer and Kotey, 2015). The policy developed by the Australian Government in support of Australian SMEs is considered a well-established and well-organised government policy and also provided a favourable environment for small businesses to gain government procurement contracts since 2008 (Xiang and Worthington, 2017).

2.7 Challenges and Issues for Australian Construction Companies

The construction industry within Australia has contributed significantly to its growth and development; and plays a key role in the Australian economy (McAnulty and Baroudi, 2010). The construction industry, as the fifth largest employer in Australia, can produce employment opportunities for more than 995,000 people. The industry is playing a significant role in the Australian economy by contributing more than $67 billion to Australia's national GDP. Due to this, the industry is seen as the fifth largest sector in the country (McAnulty and Baroudi, 2010). Currently, activities related to construction have been increasing because of the boom in resources and increasing demands for raw and semi-raw materials from both internal and external clients (Findlay, 2017). Large numbers of construction activities are taking place in remote locations in Australia. For example, recent remote projects are taking place in rural areas of Australia including the Karratha mineralogy iron ore project in Western Australia, the Olympic dam expansion in South Australia, and the Bowen/Surat Basin project in Queensland (McAnulty and Baroudi, 2010). All these are resources projects have billions of dollars of capital cost in construction, housing, and infrastructure. Moreover, these project leaders have to face several issues that are unique in nature to construction projects. The emerging issues in the construction industry include issues of a remote areas, communication breakdown, access to funding, delay in arrivals of necessary materials, and so on (Mc Carthy et al., 2018).

Issue of remote locations

There exist several issues in remote construction work. Initially, communities nearby to the remote work locations are key facilitators for construction activities. Their stakeholders involve mining firms, contractors, suppliers, banks and financial institutions, retailers, government agencies, and so on. Even though the regional communities have lacked the capabilities to undertake the necessary tasks, the economic gain of large projects suggests that they have a have vested interest in the project's success (Senarathna et al., 2016, McAnulty and Baroudi, 2010).

Issues related to communication

The study reveals that there is a high ratio of infrastructure to the population in Australia due to the spread of a small portion of the population in the large landmass. Research conducted in Northern Australia concludes that the developments of these regional communities are connected to infrastructure and communications (Burns, 1999, Bandias and Vemuri, 2005). These regional communities are ultimately influencing remote projects. The research shows that effective communications between the worksite and decision-making in the office can pose risks in the project being successful (McAnulty and Baroudi, 2010). Monitoring the communication process becomes a major concern for some remote projects. Past studies identify that there are multiple numbers of threatening factors for construction firms that are operating their functions in remote locations. The key issues are related to human resources and skills, availability of labour, production, procurement, and associated cost issues, and the requirement of sufficient infrastructure and communications. Moreover, the issue of delays in the arrival of raw materials and lack of necessary equipment is also a concerning factor in making the project successful (Gündüz et al., 2013, Durdyev et al., 2017). If the construction companies have to meet supply issues in urban areas, then this ultimately increases the costs in remote locations. The research concludes that there is a significant connection between appropriate material management systems and project success (Hughes et al., 2004). Irregular and risky surroundings also influence company productivity. It is complex to measure or calculate the cost of lost productivity because of several incidences like extremely hot weather. These issues led the experiential research to measure or analyse exiting situations within Australian remote projects (McAnulty and Baroudi, 2010).

The issue connected to accessing finance

The world financial crisis of 2007 created fear among various financial persons such as borrowers, lenders, and investors. The fear of those financial providers becomes the major issue for SMEs while accessing necessary funds. The fear of the world financial crisis of 2007 still exists in Australia (Wanna, 2015). It becomes the bottleneck for SMEs. Therefore, it is essential for careful monitoring by legislators, regulators, and international financial agencies. Additionally, these entities need to formulate or introduce remedial policies and procedures. SMEs operating within Australia need to have easy access to funding for their sustainability and growth, especially in an ambiguous economic period (Torugsa et al., 2012).

Delay of projects in the construction industry

Delays within construction projects can be due to multiple factors. The reasons must be known to avoid future delays. A study conducted in Malaysia highlighted the principal reasons for ineffective site management: inappropriate preparation, lack of experience, and inadequate funds, lack of materials, lack of labour, issues with subcontractors, poor equipment performance, poor communication, and errors in the construction period. This research was carried out across 150 consumers, contractors and advisors in order to determine the principal delaying factors (Sambasivan and Soon, 2007). Alaghbari et al. (2007) conducted similar research in Malaysia, which determined 31 delay factors. The most influential were found to be expenses, problems associated with the economy, costs associated with contractors, ineffective decision-making and delayed monitoring, lack of materials, ineffective management of sites, errors in manual work, delays in resource delivery and inexperienced advice.

A survey conducted in Hong Kong looked more significantly at the impact of the delay factors and the main factors were prioritised and categorised according to construction time and two principal groups: role and type (Chan and Kumaraswamy, 2002). The five main delays were found to be ineffective site management, unpredictable conditions, slow decision-making, client value variations and variations of mandatory work. In Ghana, a study was carried out on similar criteria (Fugar and Agyakwah-Baah, 2010). From this study, 32 potential delays were found to exist, which were then sub-divided into 9 groups: the delays were then analysed through a survey of 130 respondents. The findings identified 10 principal factors: delayed honouring of certificates, higher than expected costs, unexpected complexity, barriers to achieving bank credit, ineffective advice, unexpected time to complete projects, lack of resources, ineffective management, fluctuation costs and ineffective site monitoring. Research carried out in Egypt by Abd El-Razek et al.

(2008) also determined delay causes through a survey, which categorised the principal delay factors into five aspects: financial aspects due to the contractor during construction, delays in contractor payments, design alterations during construction, only part payments during construction, and ineffective utilisation by management. Similar results were found by Sweis et al. (2008) who also conducted research in Egypt. Again, financial barriers were found to be principal delay factors, along with changes made by the owner midway through construction. The severity of the financial aspect will therefore be incorporated into the questionnaire survey of this research into Western Australia's construction industry.

Project delays are a major concern for all industries, yet this seems more prevalent in the construction industry—resulting in huge costs. Consequently, understanding these delay factors can save time and money. Delays span across shipping and resource supply and have the potential for project failure. If a warehouse faces shortages of materials, this has a knock-on effect and delays are imminent, and although other suppliers can be sought, this ultimately creates delays and poor consumer relations (Perea-Lopez et al., 2003).

The construction industry in Australia is one of the principal industries and is a major contributor to the growing economy. Other issues may be overrunning, which leads to issues of cost. This is a common occurrence in Australia and a major concern; therefore, effective knowledge of how to avoid this is essential. Material shortages within construction are a major reason for delays (Kazaz et al., 2012). The main reason behind shortages in materials occurs when demand is higher than the potential supply (Majid and McCaffer, 1998). The main three resources in construction are cement, formwork and steel. Without such materials, construction projects would not be feasible. When there is a shortfall in these materials, construction delays are inevitable. An example may be tiling, whereby the labourers are ready but there is a shortage of tiles—this would cause a delay in the project. Materials being delivered beyond the agreed date can cause companies huge inconveniences. The delayed arrival of materials is one of the main causes of project delays (Aibinu and Odeyinka, 2006). Suppliers making an error owing to market demand or incorrect orders from the administration are two reasons behind material shortages and, therefore, delays. Postponement can also occur due to ineffective equipment to transfer the resources from the warehouse to the construction site. As a result, appropriate equipment, through purchase orders and provision of materials, is essential for an effective project without delays (Doloi et al., 2012).

2.8 Supply Chain System (SCS)

The supply chain has become very important in developing the performance of companies (Lavastre et al., 2012). There are studies that show that many companies need to assess and monitor how supply chain administrator policies might be executed adequately toward clients, consultants and contracting associations (Gosling et al., 2015). The Supply Chain System (SCS) is the main focal point of economic activity for processes and management. It crosses all the networks of organisations that comprise the supply chain (Pettit et al., 2013). Supply Chain Management (SCM) is an effective way to achieve success despite its challenges, and several steps encompass successful supply chain design (Jacobs and Chase, 2013). SCSs depend on developing strategic performance and management, which includes marketing and sales strategies, global freight management strategies, strategic fit, competitive strategies, customer focus strategies, strategic sourcing and product development strategies (Robinson and Malhotra, 2005). SCSs are very important for SME construction companies in pointing the process of performance in the right direction (Briscoe et al., 2001). This process is depicted in Figure 2.2.

Figure 2.2 shows the interaction between construction companies and the supply chain. Both meet on-site production as the supply chain delivers the products to the project site.

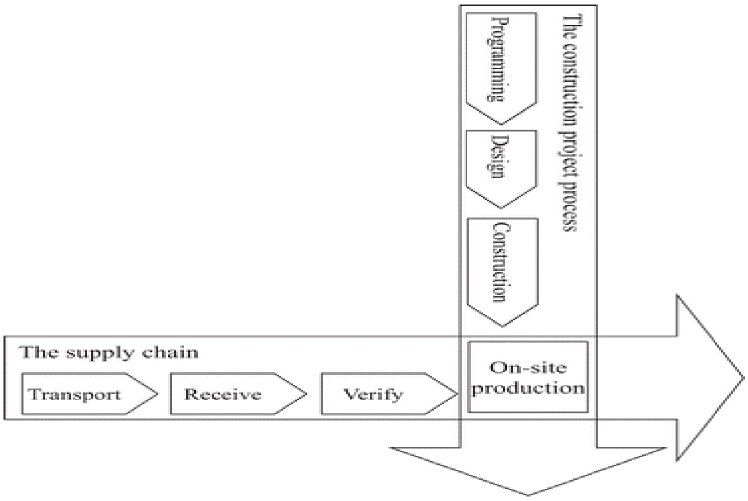


Figure 2.2: Supply Chain Process

Source: (Olsson, 2000)

2.9 SCS Performance Measurements

Numerous stages are included in the supply chain process (Council of Supply Chain Management Professionals, 2013), while construction entails three stages—planning, design and production—which all occur on business premises (Johansen and Wilson, 2006). Figure 2 portrays the potential for combining the two processes of supply chain and construction which can occur on the same site. The construction project site can then be utilised for analysis and to combine supply chain and project processes.

The performance of business operations used by SME construction companies is directly affected by SCS techniques and structures (Guang Shi et al., 2012). SCS practices can enhance operational performance by reducing expenses, improving flexibility, enabling better planning of materials and improving predictions (Wang et al., 2006). How would they do this? Better operational performance can be achieved by SMEs with increased SCM. The latter is also predicted to improve sales figures, collaboration, and enhanced consumer relations. It is thought that SMEs with greater levels of SCS practice will greatly improve performance regarding SCM (Bayraktar et al., 2009).

Construction companies have the potential for considerable improvement according to recent research. It is believed that further integration of SCS will reduce existing challenges (O'Brien and Fischer, 1993). Such integration would entail a merge of supply chains and construction projects in order to maximise opportunities. This can be implemented both externally with stakeholders and internally with contractors (Lindhard, 2013). Problems in this adoption phase could be overcome initially by the collaboration of project planning in the first stage of the project (Hoegl et al., 2004).

2.10 Impact of SCC on SMEs construction industry

Vastly disparate companies make up construction supply chains, partly owing to the need for diversity amongst projects where differing trades, from architects to labourers are required. Such projects entail material and service supply from a multitude of companies and these roles of supplying and subcontracting by small and medium enterprises (SMEs) are paramount to success (Cheng et al., 2010b). Exemplary communication across SMEs is vital to ensure fluidity across all companies. All materials must be tracked on construction sites. SMEs do not oversee site planning due to reduced numbers of workers and the required skills, therefore, companies arrange deliveries and then delegate (Eriksson, 2015). Technology such as the Internet, RFID, GPS, tracking technology and extranets can assist with this. Interaction between corporate competitive capability and supply chain operational capability was researched by Wook Kim (2006) in order to examine the influence of this on SME construction companies and their performance. Individual identification of products, ease of communication and real-time information are some of the advantages of RFID (Liukkonen, 2015). These advantages can be seen through different systems, ordering processes, transportation and logistical planning (Chen et al., 2013). Unpredictable demand cycles and product conditions, project specific demands, and the requirement for a vast range of specialist skills within geographically dispersed short-term project environments (Dainty et al., 2001) has resulted in many challenges in the SME and medium construction sector. In relation to SCS, the construction industry is seen to be behind many others owing to its failure to adopt techniques such as Just in time, partnering with suppliers and SCM—all of which have proven results (Arbulu et al., 2003, Dubois and Gadde, 2002). Implementation of SCS is vital for enhancing performance within construction companies, although this is still viewed within the industry as primary from the perspective of more effective procurement system selection and implementation (Meng, 2012).

Measuring the supply chain management (SCM)

Supply chain performance has been measured using productivity and effectiveness as major metrics. Cost-containment and operational dependability constructions are two well-known metrics. Cost-containment efforts includes inbound and outbound expenses, warehousing expenses, inventory-holding expenses, and boosting asset rotation. Order fulfillment rates, inventory shifts, safety inventories, stock obsolesces, and the frequency of goods warranty requests are all included in the reliability indicators. Supply chain performance is linked to supply chain productivity in this research(Liukkonen, 2015).

Efficiency of the supply chain performance

In organization theory, there are two basic methods to the idea of efficiency: extrinsic and intrinsic methods. The most generally used efficiency criteria of a goal-attainment framework, the extrinsic method to organizational efficiency, defines organizational efficiency as the achievement of a set of organizational aims and objectives (Liukkonen, 2015). On the other contrary, the intrinsic method to organizational success relies on a well-managed structure and effective internal procedures.

If an organization's participants are strongly connected, communications circulate efficiently, and employees accomplish good productivity, have work satisfaction, and are devoted to the company, it has a well-managed structure. Effectiveness is defined as the capacity to acquire resources and relates to the quantitative amount of end achievement(Eriksson, 2015). The proportion between real and typical or predicted production is also known as the ratio. It has been defined as the capability to meet pre-specified goals defined logistical efficiency as the amount to which the logistical function's objectives are achieved in the logistic field(Cheng et al., 2010b).

Supply chain management practices (SCM P)

The term SCM practice refers to a comprehensive set of measures taken by organizations to increase the efficiency of their intrinsic supply chain. The current assessment of SCM strategies, which includes cooperation with supplier, system of outsourcing, cycle time reduction, process flow continuity, and exchange of information and technologies (Cheng et al., 2010b)., is based on buying excellence and customer relationships. SCM practises are defined as a set of measures taken by a company to improve supply chain management . SCM corresponds to how organizations use their suppliers' methodologies, technology, and functionality to improve supply chain performance and advantage in the marketplace, and how production, logistical support, equipment, dissemination, and transportation operations are meticulously planned within organizations(Bayraktar et al., 2009). In addition, states that SCM in practice involves the associated companies' preparatory work and strategic planning for supply chain synchronization and cooperation between each other. SCM procedures are also characterized as methods for integrating and coordinating supply, demand, and interactions to fulfill customers cost-effectively and economically planning (Chen et al., 2013).

2.11 Radio Frequency Identification (RFID) Technology

Radio Frequency Identification (RFID) is an information transfer system that uses radio frequencies to wirelessly identify tagged items. RFID systems have three basic components: the tag, the reader, and the controller. The tag, also called the transponder, comprises a semiconductor chip and an antenna. The reader, or interrogator, comprises an antenna, and RF electronic module, and a control electronic module. The controller, or host, is the database in which real-life data is matched to computerised records (Finkenzeller, 2003) as shown in Figure 2.3 below of the process work of RFID system.

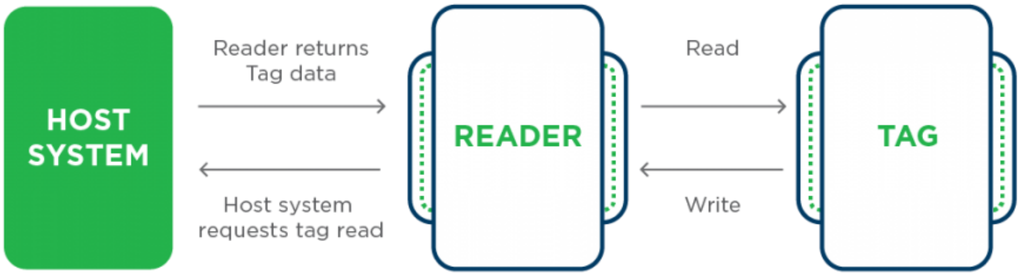


Figure 2.3 of RFID system

(Finkenzeller, 2003)

In addition, RFID has diverse potential applications, ranging from goods tracking, newborn identification, access cards, and automatic duty stations (Hunt et al., 2007).

RFID fills the same utility niche as barcode technology; however, RFID technology is more advanced and versatile. One key difference is that while barcodes can only identify a single object at a time, RFID can identify a large number simultaneously. Another is that barcode technology requires proximity line-of-site access to the tag, whereas RFID tags can be read quickly and accurately at distance and through most materials. Also, RFID technology has three main disadvantages to its widespread implementation: there is no single standard form; its implementation is complex and high-effort; and it remains more expensive than its main competitor, barcode technology (Banks et al., 2007).

RFID technology identifies tagged objects and transmits the data using radio waves (Want, 2004). It is primarily used for automatic data capture and could revolutionise modern business operations and performance. RFID is a wireless information link system that can uniquely identify tagged individuals or items. It has three major components: the reader; the tag; and the host computer system. The reader is a radio signal receiver. Tags, which are affixed to units, comprise a silicon chip and an antenna and transmit unique identifiers when within the reader's radio transmission zone. The reader receives and decodes the signal. The decoded information is matched with records in the controlling computer database for storage and analysis; and the integration of the computer component is fundamental to producing functional information from the radio identification elements (Bhattacharya et al., 2007).

RFID technology is classified as a wireless automatic identification and data capture (AIDC) technology system (Wamba et al., 2008a). RFID is a system of techniques for the recognition and determination of objects using radio waves. It is therefore a technique that could help in electronic labelling. RFID is a faster system in the identification market and it is the fastest-growing segment of automatic data technology (Teo et al., 2011). RFID has added to the development of many different industries; therefore, it plays a crucial role in logistics by controlling time and reducing costs. It has a quick response system to improve the performance of supply chain management SCS (Zhu et al., 2012). In many industries, RFID has a specific role to improve the performance of SCM, and there are some studies that indicate that the technology of RFID supports new businesses because it can intervene to provide a higher level of electronic integration between supply chain members (Wamba et al., 2008b). Over the last few decades, a greater diversity of IT has been available and utilised by supply chain stakeholders to optimise supply chains and consumer-provider relations. Yet in recent years, RFID and AIDC IT has appeared; the latter in relation to data storage and RFID utilizing an automatic identification system by wireless connection. Such systems are referred to as inter-organisational systems with the intention of improving supply chain processes for many companies and business practices (Wamba and Chatfield, 2009).

2.12 RFID History and Fundamentals

RFID technology developed from a variety of pre-existing technologies and research (Fera et al., 2017). The first key development occurred in the late nineteenth century, with improvements in understanding of radio and radar technology. By the late 1930s, radio and radar technology were sufficiently advanced for it to be usable for the identification of aircraft in the Second World War: this is arguably the first use of RFID. In 1947, the invention of transistors facilitated the development of smaller, cheaper components, which decreased their size and increased the potential utility of RFID tags. In 1948, Harry Stockman contributed several key advances to radio technology: he developed a method by which radio waves could be sent to a receiver and an improved power supply which facilitated the return signal. These advances formed the basis for modern passive RFID tags (Banks et al., 2007). Subsequent research explored potential applications, resulting in the first commercial use of RFID technology in the late 1960s. At this time, RFID tags were still prohibitively large; this barrier began to lift in 1971, when microprocessor technology allowed tags to become smaller and more sophisticated. By the 1980s, commercial RFID applications included key fobs, access cards, marking cattle, and some rail transport functions. In the 1990s, the coinciding development of IT technology provided a new avenue for RFID development; and computerised databases could efficiently manage tagged information. RFID use correspondingly increased, but material costs and a lack of unified standards prevented comprehensive adoption (Hunt et al., 2007). For more details about the RFID history see Figure 2.4 below.

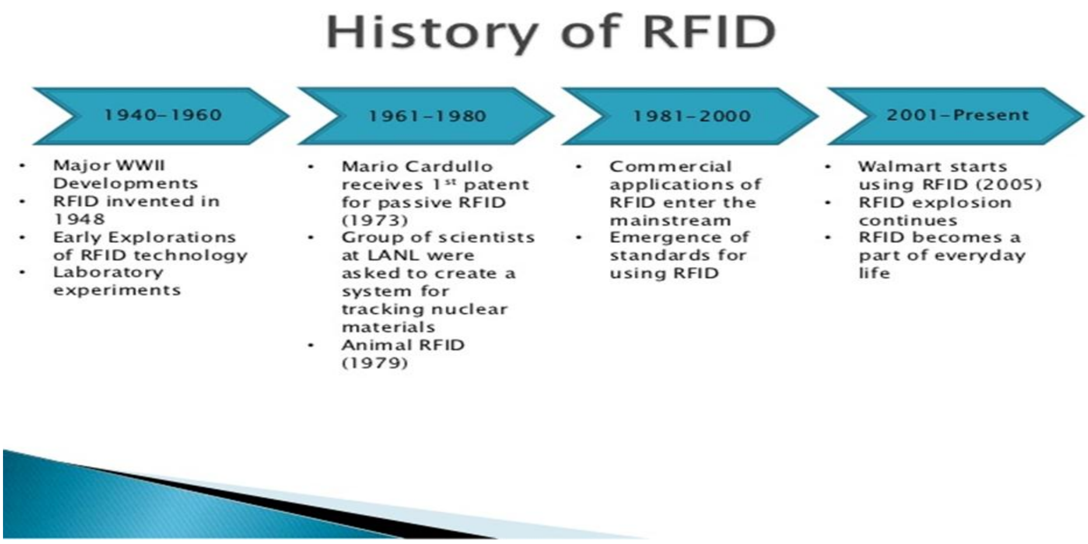


Figure 2.4: RFID history

(Banks et al., 2007)

The development of RFID technology began in the early 1920s, with the development of radar systems. It was further developed in World War II when unique radio-transmitted identifiers were used to distinguish friendly and enemy aircraft. More recently, its potential commercial applications have received attention. These applications centre around supply chains, with their capacity to provide automatic identification and real-time visibility, potentially revolutionising business processes (Wyld, 2005). In June 2003, Wal-Mart mandated its top 100 suppliers to initiate the use of RFID tags on pallets of shipped items by January 2005, sparking widespread interest in the technology's potential (Bhattacharya et al., 2007). RFID is increasingly regarded as a major development in commercial evolution (Swedberg, 2006). Table 2.3 below provides a brief overview of the history of RFID technology.

Table 2.3: Overview of the history of RFID technology

1960-1970	New applications for RFID unlocked by the development of Sensor Matic and Checkpoint Systems, including in Electronic Article Surveillance (EAS) equipment.
1970-1980	Development of the modern passive RFID tag. First applications in animal tracking and factory automation.
1980-1990	American and European companies begin manufacture of RFID systems. RFID starts to be used in automatic toll payment systems
1990-2000	Standard developed for RFID equipment specifications, intended to improve interoperability
2003	Renaming of the MIT Auto-ID Centre to EPC-Global, with a corresponding shift in focus to the promotion of EPC technology
2005	Wal-Mart launched a pilot EPC program in its supply chain

Source: (Castro and Wamba, 2007)

2.13 The main component of RFID technology

RFID IT is not complex in its structure. An RFID tag holds an antenna; and a chip stores and analyses data about the product that has been tagged (Zare Mehrjerdi, 2011b). When a reading location acknowledges the RFID tag, a two-way communication is set up between the reader and the tag via radio frequencies (Finkenzeller, 2010). The item identification is sent from the reader to RFID IT where greater configurations are processed. The reader may be 'mobile' or 'fixed' and has the ability to read and write data (Amaral et al., 2011). It is formed so the timing communication is conducted with the RFID tag or responds to communication from the tags (Zhang et al., 2016). An RFID system is composed of three layers: For more details see Figure 2.5.

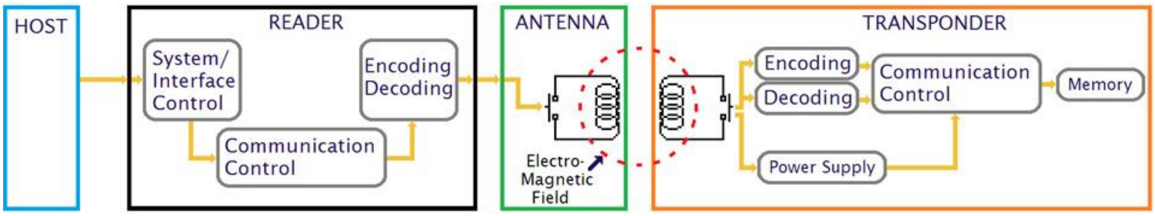


Figure 2.5: Main Components of RFID Technology(Zhang et al., 2016)

- A tag containing a chip, which is attached to or embedded in a physical object to be identified.
- A reader and its antennas, which allow tags to be interrogated and to receive a response without making contact (in contrast to bar codes, which require a line of sight and must be read one at a time).
- A computer equipped with a middleware application that manages the RFID equipment, filters data, and interacts with enterprise applications (Fosso Wamba et al., 2007).

2.14 Tag (Transponder)

Tags take on the form of barcodes, which are connected to products and contain the individual ID of the product (Preradovic and Karmakar, 2010b). Two components are typically included, which are “the Integrated Circuit (IC) chip” and the “antenna” (Saad et al., 2016). According to business needs, there are sensors to measure aspects such as humidity or temperature (Zelbst et al., 2012). The tag communicates via electromagnetic waves (Ngai and Gunasekaran, 2009). In cases where tags are semi-active or passive, antennas conduct searches for the power source so as to operate the on- board IC chip. This saves the individual ID of the product in numbers as demonstrated in Figure 2.6 below (Preradovic and Karmakar, 2010a).

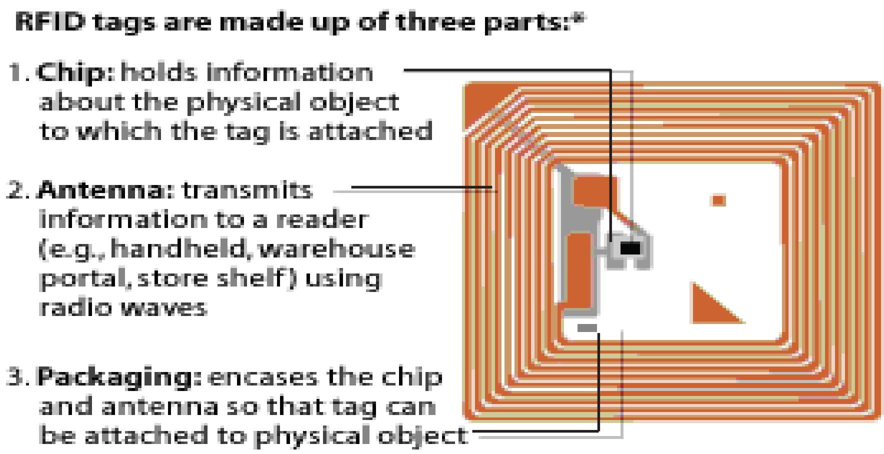


Figure 2.6: Structure of RFID tag

(Source: Ton et al. 2009, p. 14)

RFIDs are emerging faster and being adopted from governmental and business agencies, for example, retails suppliers such as Wal-Mart and U.S.DOD, in addition to agricultural agencies, for example, the National Livestock Information System (NLIS) within Australia. A multitude of RFID tags has been created so as to address supplier requirements (Preradovic and Karmakar, 2010a). This research explores RFID tags solely based on power supply, for more details see Figure 2.7.

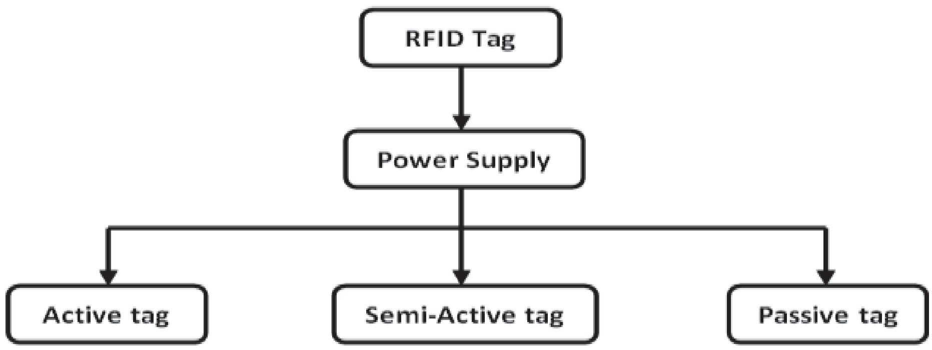


Figure 2.7: Classification of RFID tags

2.15 Power supply classification

The most salient category within RFID concerns power supply needs. These tags are usually categorised according to the type of power supply and can be separated into three groups (Hassan and Chatterjee, 2006):

Active tag

The primary mode is considered by the power supply, referred to as 'active tag'.

This comes with an onboard provision like a battery (Kasiri et al., 2012). This utilises battery power so there is adequate power for the tag operation over a given period needed (Ton et al., 2009). As such, these tags do not require energy from RF carrier signals to process data and therefore have greater longevity of reading range, as illustrated in Figure 2.8 (Banks et al., 2007).

Figure 2.8: Illustration of active tag and reader communication

Active tags are able to contain and process greater data than passive tags can owing to the onboard power supply; this is less vulnerable regarding the intensity of the reader's interrogation signal (Kasiri et al., 2012).

Semi-active tag

The second RFID tag that is considered according to the power supply is the 'semi-active tag'. The main disparity between semi-active and active is that the former has an onboard power supply for less significant signal processing jobs, yet this is not used for increasing received and transmitted signals. As such, a semi-active tag requires considerably lower power from the battery and the life longevity is better in comparison to the active tag. Although the power allocation is low, the reading range is also lower than those of active tags. Consequently a semi-active is regarded as midway between a passive tag without a battery and an active tag (Banks et al., 2007).

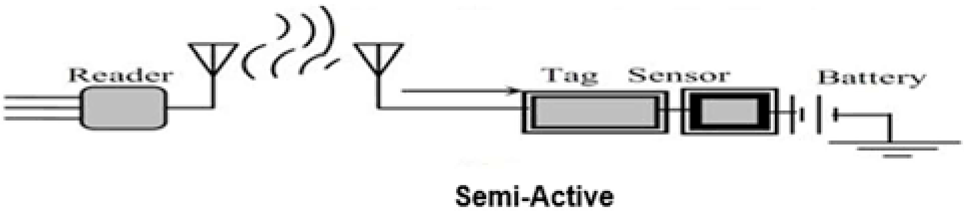


Figure 2.9: Semi-active tag process

(Source: (Gonzalez García, 2017)

Passive tag

The third type, also based of provision of power, is the passive tag. Without a power supply, it is dependent on power from the reader in terms of transmitting and processing information (Kasiri et al., 2012); Figure 2.10 below explains the presses of Illustration of passive tag and reader communication of RFID.

Figure 2.10: Illustration of passive tag and reader communication

Three circuits are associated with passive tags: "antenna, rectifier and Manchester encoder", also known as RFID chip (Na et al., 2004). While some passive tags result in processing information, many do not and usually appear in the form of Electronic Article Surveillance (EAS) transponders available from retail stores and usually in relation to security needs. Many of these tags use minimal power and are relatively cheap owing to the design, being independent on the emitted energy from the reader so as to select the required energy (Banks et al., 2007). Table 2.4 shows detailed information about the comparison between active and passive tags based upon some important characteristics.

	Passive tags	Active tags
Power	Not self-powered (derive power from the electromagnetic field generated by the reader); require higher powered readers.	Battery powered (internal); can be effective with less powerful readers.
Read range	Typically under 3m	Can be 30m or more
Performance	Lower data transmission rates; subject to noise; greater orientation sensitivity; fewer tags can be read simultaneously; no self-reporting capability.	Higher data transmission rates; better noise immunity; less orientation sensitivity; more tags can be read simultaneously; self-reporting capability.
Read/write capability	Mostly read-only; may also be WORM (write once read many) or EEPROM (electrically erasable programmable read-only memory).	Read many, write/rewrite.
Tag cost	Less than $1 a piece.	As much as $20 apiece or more.
Physical size	Can be as small as a dust particle; less weight due to no internal battery.	Larger than passive, may be as large as a brick; greater weight due to internal battery.
Life	Long operational life (no electrical expiration).	Limited due to battery life (up to 10 years)
General application	Suitable for tracking low value consumer goods; supply chain tracking.	Suitable for tracking high value items over long ranges; security/personnel access control; asset tracking.

Table 2.4: Passive vs. active tags

(Tajima, 2007)

2.16 Reader (Interrogator)

The second aspect is the reader, which is a RF transmitter and receiver that is governed by microprocessors or digital signals which connect with the tags (Banks, 2007). An antenna is utilised to obtain information and then shares this in a computer to process (Kärkkäinen, 2003). However, readers send an energy wave that literally 'wakes up' the tag and gives power for operation within passive systems. In active systems, batteries are used to enhance the operating range, spanning from centimeters to five or six meters according to the tag type and frequency. Readers take the form of many disparate models and can be incorporated into computers to act as barcodes (Attaran, 2007).

Antenna

A third main aspect of an RFID system is the antenna. This sends radio signals from the transmitter and receives RF responses from the tags (Banks, 2007). Antennas take two forms, firstly, the linear antenna, which sends an RF vertically or horizontally and is effective over long distances. While this is advantageous, the band emitted is narrow, which can deter reading. Secondly, a circular tag sends signals in circular motions and can handle numerous signals and functions: the reading distances are generally less, yet the ranges are better (Bhuptani and Moradpour, 2005).

Computer (Backend system)

Fourthly is the backend system, which is close to readers and related to computers in position. Coming with two main functions, the backend system obtains information and processes jobs like filtering. It also ensures the reader is effective in operation and privacy and instructions are functioning correctly. These are connected to readers via networking IT or serial connectivity (Attaran, 2007).

Frequencies

RFID tags utilise four main frequencies for sending information, which are as outlined (Lin et al., 2009);

Low Frequency (Ortiz and Benitez)

Initially, LF tags were the most utilised, operating between 125 kHz and 134.2 kHz. They can be read whilst connected to elements such as liquid, wood, metal and tissues owing to their electromagnetic properties. Suitable for close range, they also have minimal transfer of information across all frequencies and only low storage is feasible.

2.17 Anticipated benefits of using RFID technology

RFID IT has a wide range of benefits which are evident when contrasted with conventional AIDC bar-coding IT. These consist of individual identifications for products, the ability to read and write information, line of sight being no longer essential, maximised storage and numerous product tags read (Asif, 2011). RFID could be considered as an unwelcome intervention in IT owing to its drastic change to existing supply chains and techniques (Thangamuthu and Middleton, 2008). However, when RFID is utilised to its fullest, supply chains are maximised (Bose and Pal, 2012); (Michael and McCathie, 2005a); (Loebbecke, 2007); (Loebbecke and Huyskens, 2008); (Moon et al., 2012), greater creativity is made possible within companies (Wamba and Chatfield, 2009); (Loebbecke and Palmer, 2006b); (Wamba et al., 2008b), incorrect data is reduced (Heese, 2007) and management and collaboration is enhanced (Zhu et al., 2012). Furthermore, data is able to be stored and dispersed amongst stakeholders more easily (Bose and Pal, 2005); (Boeck and Fosso Wamba, 2008) and IT collection and tracking is enhanced (Chai et al., 2017).

If such technology is implemented, supply chain businesses will have enhanced potential to supply new items and services, thus increasing competition (Loebbecke and Palmer, 2006a); (Leimeister et al., 2009). Some drawbacks need to be addressed for the advantages to be fully utilised. Firstly, an unreliable connection may exist between the RFID reader and the tag: this can result in broken signals, multiple IT paths and decreased energy levels (Xie et al., 2014). RFID IT is sensitive to excessive audio in contrast to battery-powered devices. As such, amendments need to be made although tags are unable to be reprogrammed, yet the reader can be. Also, all aspects for improvement need to conform to a standardised model (Syrett, 2010). Further advantages are decreased expenses, automated processes, greater efficiency and enhanced revenue and consumer relations (Sarac et al., 2010a). Figure 4 identifies the advantages of RFID technology (Leung et al., 2007) and categorises them into three groups: revenue, operating margin and capital efficiency. Capital is able to grow owing to decreased space and reduced plant and maintenance expenses. Currently, existing IT is expensive in comparison with RFID technology (Zipkin, 2007). This is due to the great cost of implementing IT, which is categorised as hardware costs, software costs, system integration costs, installation services costs, personnel costs and business process reengineering costs (Banks, 2007). Figure 2.11 portrays the central costs of RFID implementation.

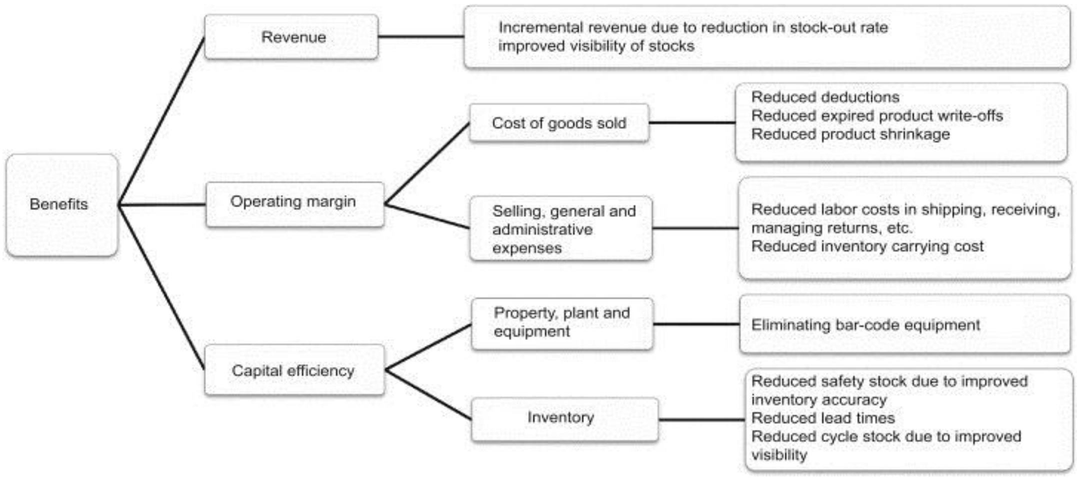


Figure 2.11: RFID Anticipated Benefits

(Sarac et al., 2010a)

2.18 Challenges of RFID technology

Nationally and internationally recognised regulations and measures, not unlike barcode standards, are essential for effective RFID technology (Michael and McCathie, 2005b). Many in the field mention that privacy is not a major problem. Tags are to be removed by customers upon purchase and are not read in stores per usual price tags. Yet privacy concerns span from data collection of retail customers to library users (Zare Mehrjerdi, 2011a). Cost aspects of RFID encompass licensing, hardware, labour and educating staff on the systems (Gaughan and Meunier, 2005). The greatest challenge regarding expenses is that of the chip cost, which impacts on adoption by SME companies who are stringent on low costs (Kumar and Rahman, 2014). If RFID is utilised more widely, costs will be reduced as demand and competition improve (Fleisch, 2010).

In recent years, many interesting phases have been observed in the development of the performance of RFID. Numerous studies and experiments have been conducted to show the level of progress and success of RFID. For example, in order to make the data course automatic, an RFID gateway was implemented at a warehouse entrance. At approximately 5 km/h, trucks transport RFID tagged pallets through such gateways. The following challenges, which impacted on performance, are outlined:

- The truck moves through the gateway at a fast speed with loaded pallets.
- Reading of the tags is hindered by liquid being transported on the pallets.
- RFID waves are hindered by reflection due to metallic materials, impacting on tuning in communication zones necessary for tag reading (Cheung et al., 2014).

2.19 Impact of RFID technology on SC Performance

Companies today are re-evaluating what is most essential and re-assessing their materials in terms of principal activities and market competition. As a result, businesses are outsourcing more frequently and to make processes smoother, logistics are also more frequently outsourced (Bayraktar et al., 2009). This may consist of warehouse operations and couriers, as has been done traditionally, but today this also encompasses specialist strategies, data systems, meeting higher customer demands and tighter inventories (Boyson et al., 1999). 3PL (third-party logistics) is an example of this which handles numerous distributors externally to meet the needs across several functions (Sink et al., 1996). This is becoming more commonplace in today's construction industry with benefits ranging from lower costs, enhanced service, less staff and lowered capital expenses (Marasco, 2008).

IT is the essential foundation of current business ventures in the 21st century. SC functioning is greatly impacted by positive attributes of IT (Kushwaha, 2012) and in order to enhance this further, disparate enterprises should be connected, thus creating better SC outcomes (Kushwaha, 2012). Businesses are able to collect and interpret data through the function of IT in each stage of SC (Zare Mehrjerdi, 2010). Such SC stages are obvious in all interactions with both consumers and providers (Mohammadi et al., 2012), highlighting the importance of IT in enhancing SC. IT methodology encompasses disparate operations which collect and display data in order to determine answers to long and short-term challenges. It is feasible for RFID to become the most salient IT—providing enhanced SC performance to business and consumers through increased productivity (Ali, 2012). In the field of SCM, data is the principal factor in enhanced functioning (Kumar and Rahman, 2014). It is possible that SC scanning functions can entirely succeed with RFID, which is able to be run internally as a closed circuit either as a user-proof or anti-corruption scheme.

When RFID is run as an open circuit, the performance of SC is increased and vendors such as Metro Group and Wal-Mart have reaped such benefits. Sarac et al. (2010a) established that SC functions exhibit beneficial connections via the RFID system; thus, improving data exchange between SC operations and resulting in enhanced distribution and strengthening of a complete SCM. Furthermore, the RFID system increases the productivity of SCS in its entirety (Ha et al., 2014). RFID also serves a vital function in supply chains by aiding logistics and business processes owing to their competence in data analysis and tracking (Huber et al., 2007). Radio waves are utilised by RFID in order to obtain information and make interpretations with the SC (Bottani and Rizzi, 2008).

Technologies such as RFID, tags, satellites, GPS and mobile devices are now utilised across numerous industries including production, service, supply, logistics, medical and retail (Tzeng et al., 2008). Such IT usually accompanies IS systems so IT can be available to all of the supply chain (Ngai et al., 2008b) given that they fit amongst IS practices. Examples such as Frankfurt Airport in Germany and Wal-Mart in the USA have highlighted the necessity for enhanced tracking devices, faster processing of information, better security devices and processes, quicker orders and estimates, enhanced consumer relations and tighter regulating of products, despite adequate infrastructure within these developed countries.

This particular application and utilisation of RFID in SCS functions brings about many advantages such as data access, effective decision-making, and improved management of supplies, automated business processes and tracking products operating in SCs (Fosso Wamba, 2012).

With RFID, actual-time data can be captured and shared—resulting in enhanced SCS performance (Zelbst et al., 2010) This IT has a more central focus due to its tracking abilities, which is more beneficial than the previous organisational focus (Zelbst et al., 2010). RFID improves productivity as a significant aspect of producer and vendor communication (Zelbst et al., 2010). In some aspects, amendments need to be made such as industry SCs in areas such as staff, collaboration and inventories (Tseng et al., 2011).

SCS scanning abilities can be replaced by RFID due to the “closed-loop” option, which entails a stand-alone business utilizing it internally, such as anti-theft systems. RFID technology can also be used in "open-loop" locations to enhance SCS efficiency and is widespread amongst companies (Fosso Wamba, 2012). Due to diverse applications which aid warehouse operations, RFID has brought about greater potential (Teo et al., 2011). Moreover, inventories are simpler to execute and materials are easier to order and monitor (Kecelia et al., 2008). Other benefits of RFID in comparison with bar code systems used in SCS systems are, firstly, aspects such as time consumption. Multiple tags can be read at one time instead of individually, and contents can also be read without the packaging being disturbed. Secondly, bar codes can be difficult to read if damaged or overexposed. Finally, RFID systems can ascertain location, which is beneficial when transporting products (Li et al., 2010).

Enhanced SCS activity can be achieved through RFID technology, benefitting producers and vendors and increasing productivity, whilst at the same time decreasing the need for inventories (Attaran, 2012). Data drives improve functioning within SCM (Tajima, 2007). Worldwide, RFID technology has been used more and more in SCS and, as such, inter-organisational systems have been implemented to make SCS productivity tighter (Xie et al., 2014). Businesses are thought to be able to completely revolutionise how business is run owing to actual time RFIDs and tracking over vast distances (Jung and Lee, 2015). Items can be categorised, tracked and established and data can be better dealt with (Ngai et al., 2007), thus increasing RFID opportunities. Bhattacharyya et al. (2010) outline RFID in terms of physical and technical components and how this relates to productivity; moreover, production methods are suggested to reduce tag expenses. More businesses are moving towards RFID as this is now more necessary for many retail companies and their IT set up (Prater et al., 2005).

2.20 Related Work

Several studies conducted since 2000 have attempted to assess barriers and opportunities for industry implementation of RFID use. Larsson and Qviberg (2004) focused on the justification for RFID implementation, while Johansson (2005) examined factors influencing RFID implementation in two key sectors (automotive and pharmaceutical). (Bhattacharya et al., 2007) Vijayaraman and Osyk (2006) used an empirical methodology to gather data on the implementation of RFID in the warehousing industry. Kärkkäinen (2003) analysed the potential benefits of RFID in supply chain efficiency for products with a limited shelf life.

There have also been various studies focusing on RFID applications in retail supply chains, which is very important to the specific focus of this study. Jones et al. (2004) explored the potential benefits and challenges resulting from implementing RFID in the United Kingdom retailers' supply chains. Michael and McCathie (2005b) identified various potential advantages and disadvantages of RFID as an SCS tool. However, they consider SCS as an element of multiple sectors, whereas there are some studies that focus exclusively on its implications for the retail sector. Koh et al. (2006) examined perceived issues and key factors related to RFID use in the retail sector; however, their research is out of date considering developments in RFID technology and implementation since 2006. Despite increasing awareness of RFID technology and its potential use among retailers, there are ongoing gaps in research around the technology's implementation and potential. This analysis aims to fill the gap in existing research of the potential benefits and limiting factors in RFID implementation in the retail industry as an SCM tool.

2.21 Chipless Sensors of RFID

Chipless RFID sensory tags, especially electromagnetic RFID sensor, make use of variations in transmitter behaviour caused by variations in the actual environmental variable being monitored . The label does not involve a chip, unlike traditional electromagnetic RFID readers. It is essentially a resonant or passive antenna. A chipless tag's electrostatic radiation is largely diffracted at the resonator's resonant frequencies, which works as spatial filters. As a result, by monitoring the diffracted signal's spectral reaction, a peak may be seen at the resonator's resonant frequencies or numerous resonant intervals in the situation of many resonators. This approach looks to hold promise for the development of low-cost, environmentally friendly, and customizable sensors (Bhattacharya et al., 2007). The sensing abilities are gained by changing the extrinsic parameters encompassing the tag, which causes a harmonic displacement of the resonant spikes in the diffracted response. The lack of a microprocessor and a cell allows for a considerable reduction in sensor budget while also achieving a theoretically indefinite lifespan. Chipless RFID detectors may be helpful in severe settings due to the lack of an electrical circuit, and conducive for functionalities in harsh environments(Kärkkäinen 2003).

2.22 RFID Sensors without Electromagnetic Chips

Chipless RFID tags may be divided into two distinct types: time domain (TD)-posited functionality, and spectral (frequency) signature- posited (frequency domain) functionality. A broadband antenna and a delayed line make up time domain sensors without chips. The tag accepts and retransmits a tweaked variant of the pulses delivered by the scanner. A mechanical and an antenna element make up the tag's time domain Radar Cross Section (RCS) (Jung and Lee, 2015). The lag line is utilised to isolate the antennae RCS spike from the most intensive structural RCS spike. The antenna responsiveness of the tag can be manipulated or deferred based on the strain on the delay line. These two techniques can be combined to create a sensor without a chip. Closing the delay line using a medium that may vary its exterior resistance as a consequence of an environmental occurrence might result in amplitude manipulation. The temporal displacement from the antenna peaks can additionally incorporate the detected signal(Wamba et al., 2006).

2.23 RFID Applications

The RFID has captivated the populace's curiosity as it can be a viable substitute to standard barcode innovation and offers extra benefits over other options. A laser-based optic reader is used to analyse imprinted bar codes, which necessitates a straight line-of-sight to identify and retrieve contents. On the other hand, RFID can be scanned even if the tag is hidden for artistic or safety purposes. Furthermore, the low price might encourage the exceptional utilization of RFID tags as widespread contextual detectors(Wamba et al., 2006). Tracking physical characteristics, automated product tampering detection, toxic substance identification, and non-invasive surveillance are all part of RFID sensor uses. Some implementations necessitate scanning passive tags from a few millimetres away, while others necessitate scanning active tags from hundreds of meters away. Since each application has its own set of limits and needs, a feasible preliminary survey in the operating context is required to determine the optimal frequencies and identifiers(Jones et al., 2005).

2.24 Status of RFID Adoption in the Retail Industry

Retail represents one of the largest industry sectors worldwide. It is the second-largest employer and category of business establishment numerically in the United States (Vargas, 2004). With increasing globalisation, the retail industry is facing more and more competition, which makes success through better performance harder to achieve (Koh et al., 2006). The retail sector is correspondingly one of the business sectors which has the most potential use for RFID technology in order to enable businesses to maintain a competitive edge and achieve profitability in the short or long term (Wamba et al., 2006). The global RFID market has experienced historically high growth rates, with a rate of 23% prior to 2008 (Chen, 2004). Major retailers, including Wal-Mart, ASDA, Home Depot, Metro, Sainsbury, Target, Tesco and Woolworths, have mandated or intend to mandate their major suppliers to implement RFID tagging at pallet or case levels in order to take advantage of the technology’s potential as an SCM tool (Maloni and DeWolf, 2006). The retail industry would comprise 44% of the RFID market by 2016, as retailers attempt to take advantage of the technology’s potential benefits. RFID is expected to replace barcode technology in retail use. Its greater information processing capacity and ability to pass information without being unobstructed directly in front of the reader ensures greater speed and efficiency. This could translate to more accurate inventory management, saving the business money on current inventory-related losses. It furthermore makes the supply chain more centrally visible and thus potentially more tightly integrated; this increases efficiency and profitability, helping retailers maintain a competitive edge (Bhattacharya et al., 2007).

There are three key components of supply chain visibility: availability, inventory, and cost (Bhattacharya et al., 2007). Park et al. (2010) determined that RFID has the potential to improve retail processes in four keyways: improved inventory management; improved in-store processes; business model integration; and a quicker retail cycle. All are connected to the business’s supply chain, and improving them could enable businesses to save hugely on expenses (Jones et al., 2005).

Most benefits considered in the existing literature focus on operational efficiency—which this study believes neglects other potential interrelated benefits.

2.25 Where RFID has been used in Retail Supply Chains

The process by which materials and information are managed, from the point of acquisition through to the point of consumption, is known as supply chain management (SCM). Retail supply chains include a combination of manufacturers, suppliers, distributors, retailers, and consumers (Sikander, 2007). A typical major supply chain, for example, might include eleven stages: merchandise planning; assortment planning; sales planning; price management; promotion planning; replenishment allocation and scheduling; warehouse management; distribution; in-store operations; sales; and returns. These elements are described as follows:

1. Merchandise planning aims to maximise ROI by mapping projected sales and inventory, aiming to maintain a balance.
2. Assortment planning involves the retailer's selection of merchandise, as well as strategic decisions as to the breadth of range and number of units.
3. Sales planning prepares the routes by which merchandise can reach customers.
4. Price management involves the analysis of pricing trends based on predictions and forecast data, and the application of this information to the company's merchandise prices.
5. Promotion planning is planning and organising promotions to create demand and thus profit, with reference to forecast data.
6. Replenishing allocation and scheduling is done to avoid stores running out of stock, potentially reducing inventory, and improving customer service.
7. Warehouse management allows businesses to improve the distribution of products to facilitate replenishment and reduce inventory.
8. Distribution is the process by which products are moved from the warehouse to the retail point.
9. In-store operations involve processes such as receiving inventory, stocking shelves, ordering products and replenishment, to maintain store operation.
10. Sales are the point of consumer contact, converting merchandise into capital.

11. Returns are the management of returned merchandise.

It is necessary for businesses to streamline the logistics of each of these processes to the greatest degree possible. RFID can most effectively streamline the latter end of the supply chain, which benefits the business overall and potentially improves the ability of planning supply chain elements to accurately forecast business requirements. Additionally, RFID use among other elements such as manufacturers and suppliers will improve services to retailers and thus improve their potential profitability(Vargas, 2007).

2.26 Past Studies of RFID Technology in Australia

In general, many studies examined the use of RFID technology to introduce concepts of information relating to this technology. In the retail industry, RFID technology plays a major role in facilitating enhanced outcomes for this sector, and studies show that the use of RFID technology in the retail industry helps to develop the performance of many companies and create firm technology competence and absorb competitive pressure (Alqahtani and Wamba, 2012b). In Australia, some successful studies have centred on RFID—which has support from the Australian Government. One of these studies is the adoption of a diffusion model of RFID-based livestock in Australia. This study was enthusiastically embraced by the Australian Government, which adopted this technology as an important aspect of livestock management in Australia (Hossain and Quaddus, 2010). Moreover, RFID technology also has a significant role in the adoption and development of SCS in Australia in the field of livestock, health, transportation, and marketing. For example, there is a recent pilot study in Australia showing that the adoption and use of RFID in SCS has the ability to increase the activity of SCS and deliver greater efficiency (Manzoor, 2017).

Also, Gs1 company (formerly EAN Australia), in cooperation with Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO), and under the auspices of the Australian National Demonstrator Project, tagged nearly 500 specially-marked pallets, as well as the products shipped in them, for about 7 months. The result of this project showed that RFID adoption can be successful if the theory is correctly applied into reality (Unnithan and Tatnall, 2014).

Another study on the adoption of RFID in the livestock industry showed that stock reduction was found to be as high as US$30 billion in the USA (Zhu et al., 2012). In Australia, this figure was an alarming US$1.8 billion or 1.39% of sales in 2007. Australian farmers use RFID to identify cattle, which is a compulsory requirement and the first and biggest RFID identification system for farmers. The capabilities of this system are assessed against user expectations and RFID efficiency—as such, some farmers have opted for continued, voluntary use. The assessment framework has two components, the first being external factors: 6 Knowledge; 6 Adoption. The second component consists of Expectations: 6 Satisfaction; 6 Diffusion and Extended Use. This assessment framework is applied with RFID adoption to diffusion models, as will be outlined. In Australia, RFID IT tracking was utilised in assessing the range on a daily basis by ISA Brown Hens within six SME broods (Hossain and Quaddus, 2010). Opinions and experiences of RFIDs were offered by five Australian providers with 15 years of experience in RFID businesses in terms of future applications and obstacles in adopting this IT to a greater extent. The opinions were honest and indeed valuable as there has been much hype in the literature about RFID adoption (Yao et al., 2012). For example, one interviewee felt that in industries utilising these IT systems, by 2020, barcodes will only account for 20% and RFIDs will account for 80%. Such insights can aid suppliers to create operations that can be utilised for enhanced productivity.

Emergency Departments (EDs) take vast numbers of unplanned admissions annually and this number is climbing with almost 7 million admissions accumulated by the end of 2013 (Australian Institute of Health and Welfare). Patient care has become compromised owing to these numbers (Health, 2012). Findings have suggested the detrimental outcomes of ED crowding such as increased length of stay (Travers and Lee, 2006) and increased patient waiting times (Terris et al., 2004) has led to concerns such as waiting time, duration of admission and greater ambulance diversions—all of which can impact on patient care and death rates (Elder et al., 2016). The National Emergency Access Targets (NEAT) commenced in 2009 to improve care within EDs and The Australian Triage Scale (ATS) was introduced to deal with waiting times: this takes into account the complexity and severity of patients who are then numbered accordingly (Hodge et al., 2013). The full cycle of care must be considered in order to improve patient care with factors such as surgery. A cycle typically entails 6 stages (Cangialosi et al., 2007):

1. Admission: A number is provided to individual patients based on their information.
2. Examination: The patient is admitted to the appropriate department to begin examination and treatment. Here RFID is used for diagnostic purposes and to handle medication side effects using a database for recording medications, which can highlight any concerns. The appropriate medication can then be applied using the patient's number.
3. Patient care: All data is recorded from the patient's assessments.
4. Recovery: Patient care is ongoing after the initial treatment.
5. Discharge: Post-care is arranged following the hospital admission.
6. Billing: Invoices are sent to the appropriate departments (Wijesinghe et al., 2017).

All data is vital and must be recorded accurately throughout all levels of patient care utilising RFID. This can significantly reduce waiting time for patients if RFID encompasses the Hospital Information System (Kuo et al., 2007). This is vital given how much overcrowding has increased and impacted patient care. RFID has the ability to reduce and prevent issues such as medical mistakes (Arkun et al., 2010).

Patients are assigned different streams within their healthcare using the Fast Track Service Delivery Model. This helps relieve pressure on EDs and provide more effective and speedier treatment, thus reducing ward occupancy. This model, alongside triage, has been shown to reap many benefits. RFID allows these benefits to go a step further. Every aspect of ED treatment is accessible in a logical system design for staff to analyse, including medical supplies and care frameworks (de Gruchy et al., 2015).

RFID is utilised from the moment an ambulance is contacted, followed by paramedic assessment and monitoring from then on. The patient is numbered and categorised for triage purposes and an RFID tag is applied (Thapa et al., 2017). The relevant departments then communicate accordingly. As a patient's condition or care changes, the RFID tag is updated. Paramedics are able to access information to determine which departments are best able to assist. This decreases the available treating time through unnecessary screening of departments that do not have the appropriate care. Importantly, ambulance diversion has been reduced owing to RFIDs. A case in point is heart attack patients who can now be taken directly to specialist cardiac units. Furthermore, triage begins with the paramedics and information is immediately put onto RFID tags to enhance efficiency by allowing triage to commence as soon as a patient arrives at the ED, thus reducing nurses' workload. Finally, the patient's treatment starts sooner and is, therefore, more effective (Thapa et al., 2017).

RFIDs need to be updated and accessed through all aspects of treatment including medication. The greater the use of RFIDs, the fewer errors are likely to occur. As patients are better monitored, this can make EDs run smoother and eliminates staffing concerns. Patients wear wristbands that carry all the necessary data and also allows for the correct medication and treatment to be provided. Furthermore, this can be done during a shorter duration and allow staff to estimate timeframes for waiting patients (Thapa et al., 2017). Figure 2.12 depicts patient flow progress with the feasibility of RFID implementation.

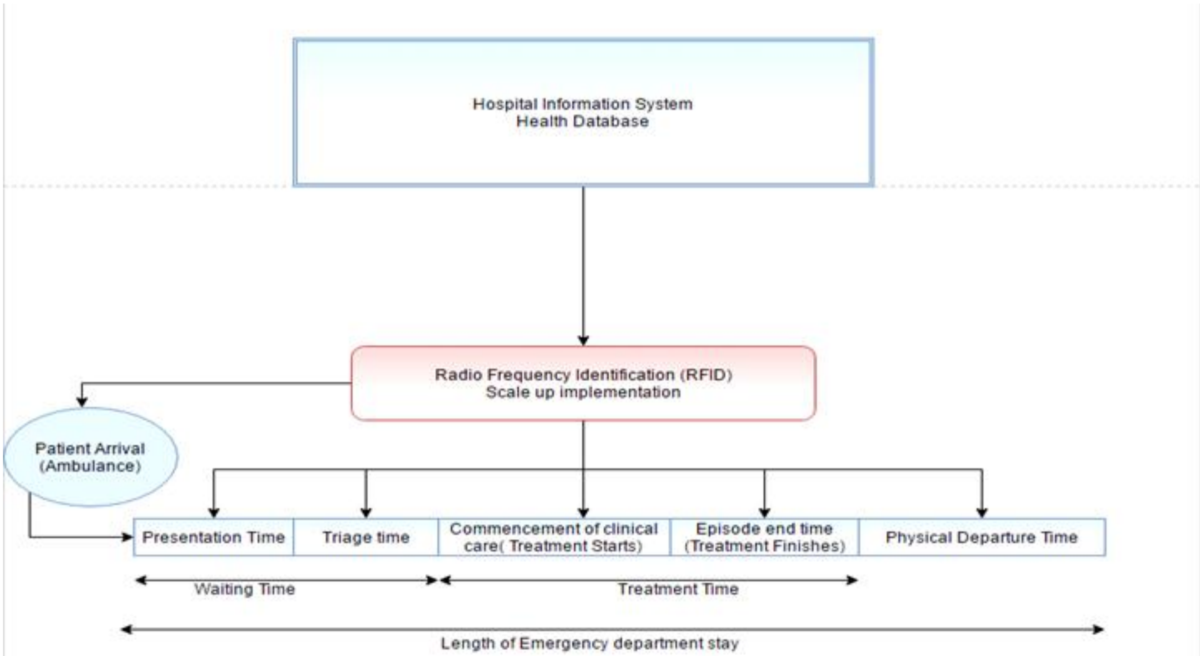


Figure 2.12: Patient Flow progress with feasibility of RFID implementation

RFID also makes repeat patient processes much smoother as all data is at hand. This eliminates the need to wait in an ED as patients' vital information has already been recorded. RFIDs can also be used for alarm purposes for frail patients who are likely to fall. Paramedics are able to access the alarm and reach the patient by scanning RFID signals. This again reduces ED overcrowding by allocating the patient to home care, thus leaving EDs to run more efficiently (Thapa et al., 2017). As shown in Table 2.5 below the analysis of the qualitative benefit of RFID implementation in the emergency department.

Table 2.5: Analysis of RFID Benefit

(Source: Thapa et al, 2017)

Process	Before	After
Pre-Hospital	Emergency ward is unaware of : How many patients will be sent on the way? What time are they due to arrive? What types of injuries do the patients have? It is challenging to deploy the medical supplies and staff such as specialist physicians from various departments.	Emergency medical technician in ambulance assesses the patients on the way to hospital. Medical technician can enter the basic information such as patient ID, basic triage and kinds of injuries into RFID wrist loop. At the same time, data will be transferred to ER via wireless communication. Data receiver will take the information and the relevant care is planned at ER.
Emergency Room	It is challenging to analyse and contrast many patients in a crowded emergency department, which requires the physician to take patients' basic information again. ED will need to upload the information about the patient's health and bed status at the same time.	RFID deployment can support the ER manager by controlling the real situation in locality. Medical staff will have a proper flexible environment to make the right decisions and

	This workload can add to the pressure and create a confused environment in the ER which may lead to errors.	care. Chaotic working pressure and patient waiting times are well balanced for quality care.

Adoption of RFID Technology in the Construction Industry

Radio Frequency Identification (RFID) exists amongst disparate industries and systems, from retail to science and from security to the management of supply chains. While efficiencies have resulted through real-time data and tracking, RFID remains relatively limited in its application (Lu et al., 2011). This may be due to construction companies having not been fully briefed on the possible benefits, which is vital given the characteristics affected by RFID. Yet despite the limited application, there has been significant research in this area. As early as the 1990s, the benefits were discussed in relation to the control of materials, such as processing concrete, labour and equipment (Wang, 2008). More research has followed this such that by Skibniewski and Zavadskas (2013) who initiated a tracking system within construction by combining ultrasound and radio signals; and Goodrum et al. (2006) who specifically created tracking for construction sites. Furthermore, a 3D model was developed using RFID IT and tracking of pipe spools; and other items were investigated by (Dziadak et al., 2009). Moreover, RFID was being utilised to improve construction quality in regards to management and inspection encompassing issues such as preparation and inventory of materials in construction stores and managing the tracking of material between warehouse and company sites. Moreover, since the inspection of the validity date of the material is important (Wang, 2008), RFID and 4D CAD were combined to support management and logistics. However, despite such research and demand, RFID remains quite limited within the construction industry. Project managers may not have been fully aware of the potential uses of RFID in construction. Various technical, financial, or ethical hurdles may also prevent it from being widely adopted in this heterogeneous industry. This has encouraged the researcher to investigate a comprehensive list of potential applications of RFID in construction project management (CPM) by investigating its advantages and hurdles. Yet some companies are beginning to consider the application of RFID. For example, in Hong Kong, the Mass Transit

Railway Corporation (MTRC) has commenced using RFID in storing materials and preparing orders in coordination with suppliers. Moreover, it is encouraged in The Housing Authority (HA) in applications for projects, which commenced with a pilot project. The main potential use of this technology in the construction industry is widespread. The fact that its use is still limited could be attributed to managers being unaware of its potentials and its ways of overcoming barriers such as financial and ethical factors. This has prompted designers to outline possible applications of RFID in CPM by considering the benefits and the barriers (Shin et al., 2011). In addition, the adoption of RFID technology in the construction industry helps to improve the efficiency and effectiveness of on-site data acquisition and information sharing among participants. This data-sharing will assist managers in controlling and monitoring progress in construction supply chains (Wang et al., 2007). RFID has a direct effect on improving the tracking components in construction supply chains (Demiralp et al., 2012). Therefore, this study strives for the adoption of RFID technology in the supply chain to facilitate communication while tracking material at a construction site (Hinkka and Tätilä, 2013). The adoption of RFID in supply chain could improve the process of cost-sharing between suppliers within the construction industry (Lu et al., 2011).

RFID market development

The RFID market has significantly grown in the past decade. Its total worth increased by US$7.33 billion from the period 2006 to 2016 (Nyikes, 2016). According to (Nyikes, 2016), the majority of the market's growth is thanks to RFID applications like Real Time Location Systems (RTLS) or tagging of a large quantity of goods and retail apparel implementations. RFID's market growth from 2014 to 2016 can be seen in Figure 2.13. The growth in the market has shown that RFID technology has a high entrance rate in the trading area (Das, 2017). Developments in the RFID industry have also created advancements in technology, such as eliminating obstacles related to technology; and it helps with the compatibility requirements and works on global standardisation. The educational and promotional efforts regarding UHF RFID have been strengthened through this development and it provides sufficient standards and technology solutions for UHF RFID. Not only has RFID become a functional tool in industries such as retail, logistics and healthcare, but it has also been a crucial part of the Internet of Things (IoT) which is a structure of mechanical devices that have distinctive identifiers and it can connect to the internet on its own (Das, 2017). IoT's evolution from several different technologies enables data analysis which improves an organisation's undertakings. In IoT, RFID is used to identify and link objects to the internet. Even though it is not the only technology used for that purpose, it is emerging as one of the most common standards used in IoT (Das, 2017). To further advance UHF RFID as a crucial part of IoT, some RFID competitors have started collaborating with CC providers and chip manufacturers. An alliance known as RFID alliance was formed back in 2014 by Google, Intel, SMARTRAC and AIM Global to raise understanding in increasing UHF RFID and implementation in applications for businesses and consumers worldwide. IDTechEx has predicted that by 2020 the RFID market will be valued at $13.2 billion. This growth is anticipated to come from RFID technologies and applications.

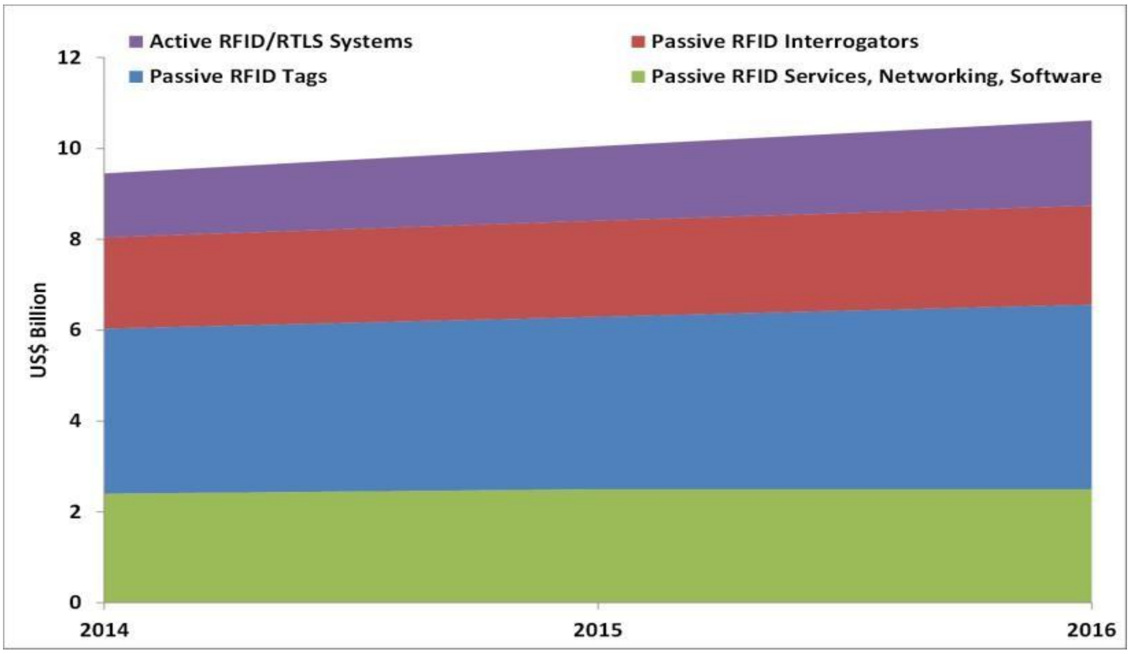


Figure 2.13: RFID's market growth from 2014 to 2016

(Source: IDTechEx 2016)

Industrial applications of RFID technology

To be more competitive and responsive in the business environment, organisations have a goal to attain a closer unification of partners and their working units, minimise costs and, lastly, increase material coordination, data and the economic flow in their logistics network. This has caused organisations to keep on re-examining and improving their logistics processes (Sadlovska and Vishwanata, 2009). The advancement of information technology nowadays has helped these organisations to improve their flexibility, their responsiveness and also to increase their competitiveness. RFID has been appraised to be crucial in helping firms transition from a traditional logistic model to a more unified and efficient one (Bendavid et al., 2009).

RFID encompasses a large variety of services that are available in various industries. According to Sarac et al. (2010b), an RFID publication focuses on diminishing the bullwhip effect, error in inventory and rearranging renewed policies. Nemeth et al. ((2006)) performed a run-through of the evolution of RFID's processes and technologies at the time by looking at the possible advantages and disadvantages of its integration in logistics. Therefore, rather recently, there has been some literature reviews on RFID that focused on how to improve and develop the performance of RFID in various fields. Table 2.6 provides a summary of the content and the outcome of recent literature reviews about RFID performance (Dabo, 2017).

Table 2.6: Literature reviews about RFID performance

(Dabo, 2017).

Reference	Focus of review	Summary
(Wamba et al., 2013)	RFID applications in healthcare settings	RFID is being used in the healthcare department. In this review, RFID publications in the health sector are divided into three parts of applications which are assets, patient, and staff management. Talks about their perception regarding the relevance and usefulness of RFID in managing operations in the healthcare industry which they conclude by pointing out data management, privacy, and security as some research that can be done in the future
(Costa et al., 2013)	RFID literature in the agriculture and food sector	Talks about the developments of RFID in the agriculture-food sector. The applications of RFID in manufacturing and distributing agriculture were identified and evaluated. They also talked about the challenges, both economic and technical, that are holding back the implementation of RFID in the sector.
(Lim et al., 2013)	RFID warehouses	Assesses the advantages, disadvantages, and use of RFID in managing warehouses which gives an understanding of present attempts on integrating RFID into warehouse functions. Also, it points out the strong and crucial bond between RFID's ability to record precise and prompt data and the practical production of the warehouse. This review also

Reference	Focus of review	Summary
		mentions present RFID implementation's status in warehouse purposes and proposes the upcoming challenges in this sector
(Zhou and Piramuthu, 2014)	Focuses on RFID's potential to record precise and prompt data and its part in increasing the clarity of logistics network and product identifiability.	Highlights the advantages, disadvantages and use of RFID in various industries. The use of RFID in managing inventory and improving business processes and supply chain were also brought up in this review. Explored RFID's safety and confidentiality issues in this review and also the trends in RFID are first identified, then suggested.
(Liao et al., 2011)	Regarding RFID publications in SCI and SSCI indexed journals between 2004 and 2008	Distinguishes the relevant SCI-indexed journals along with other less specialised journals about RFID published between 2004 and 2008. Aside from the SCI and SSCI indexed journals, the profiles of the authors and co-authors who wrote the RFID publications are also provided, along with their location and demographic, the topic of research and index citations of their publication.
(Sarac et al., 2010b)	Mainly focuses on the reduction of cost and creation of value that was brought about by RFID to the inventory management	Talks about the use and possible advantages of RFID in managing a logistics network which looks at the use of simulation modelling, logical methods, study cases, and also investigations to analyse the effect RFID has on logistic network activities.
(Ngai et al., 2008a)	RFID publications between 1995 and 2005. A generic review	It is a focussed generic review of the RFID publications that were published from 1995 to 2005 which is grouped into four categories which are technologies, applications, safety and confidentiality issues, and other kinds of publications. Not only does this grouping allow us to see the structure of RFID research conducted throughout 1995 to 2005, but also the managerial and practical perceptions of RFID applications along with its benefits and challenges.
(Chao et al., 2007)	A bibliometric evaluation of RFID current researches and benefactions from 1991 to 2005	Talks about and inspects companies' utilisation of RFID to enhance their organisation change and increase competition. In this review, Chao et al. (2007) also discern RFID's current research trends and talk about future research.

Technology Innovation Adoption

Innovation, which is seen as an enormous challenge in business platforms (Hamel, 2002), is an essential requirement for viability and development (Tidd, 2001). Adopting any innovation involves production and development while it adapts to new concepts in accordance with the specific firm objectives (Damanpour and Schneider, 2006), It is either responding to the environment or controlling the environment. It can change organisational nature completely (Grover, 1993) and through the IS perspective, it involves operational ideas and novel practices as well (Vahtera, 2008, Wang et al., 2011). It has an impact on efficiency and also on the constantly developing technologies (Wang et al., 2011, Oliveira and Martins, 2011, Jasperson et al., 2005, Shiels et al., 2003).

Novel innovations that are implementing, observed and explored on the novelties, that pulls over psychology with sociology (Rogers and Seddon, 2003, Al-Qaisi and Sciences, 2018). The related contests of implementing technologies are reflected in IS and IT innovation and learning (Korpelainen, 2011, Jeyaraj et al., 2006, Willcocks and Kern, 1998).

Adopting innovations is planned at individual stages and also at firm levels; this innovation idea first appeared during the 1950s and then boosted accordingly with communicating techniques later in the 1980s (Zaltman et al., 1973, Van de Ven and Rogers, 1988, Slappendel, 1996).

2.24 Technology Innovation Adoption Barriers

Several internal resistances towards technology alteration might limit forces of change either externally or internally by many influencing innovative practices. Those significant barriers have an impact on organisational technology innovation adoption (Butler and Sellbom, 2002, Joachim et al., 2018).

2.25 Mismanagement in the Innovation process

Oke et al. (2012) identified an obstacle to innovative management—the absence of an effective innovation procedure. The model to be considered on this basis is the command-and-control rational model and it is essential in team functioning issues. Even though the modern, spectacularly multifaceted business atmosphere is changing rapidly and it is seen to be more spontaneous, this model remains absolutely relevant and also prominent. Extremely unsystematic backgrounds could lead to severe issues, but the teams should still stay on alert and confront, and be inspired as required (Ashmos and Nathan, 2002).

2.26 Inability of unlearning

The procedure of replacing standard practices with a novel innovative set of practices by relevant individuals and organisations collectively is undertaken as the unlearning process. Questioning suppositions could be highlighted as an approach of an unlearning system (Baker and Sinkula, 2002).

2.27 The Obsolete Mental Format Model with Theory

The fluctuating situations or modest dealings are no more than accommodating values of entity or firm-wide and to understand it, it is essential to acknowledge the advancement changes of present theories, and the method of implicit information throughout the business. Disruptive innovation progression has been held back due to that. Distinct circumstances and outcasts are stereotypically creating revolutionary technologies, bursting through models of commerce, and also creating disruptive innovations (Baker and Sinkula, 2002).

2.28 Internet connectivity

The challenges of IT/IS adoption are significant and large in number. Technology has to be suitable to a specific business 'temperament', which is one of the factors associated with companies that fail to acknowledge computer facilities. Institutions that declare that the global internet is not compatible with their approaches would not profit from the possible advantages (Parida et al., 2010).

2.29 System Development and Maintenance Costs

It is difficult for an institution to continue with implementation when it is not aided by the business case in which the expected advantages may not exceed the value of the investment. It is often not necessary to foresee future risks and costs, and there might be dependency risks over specific employees (Choi and Krause, 2006).

2.30 Models of IT/IS Adoption

In the study of IT/IS, there are many various theories advocated (Hands et al., 2009). This segment splits the concepts of IT/IS development and implementation in and out of two separate levels: the observations of internal and company levels. An example of major concepts used to examine innovation and adoption of IT/IS at the level of the individual include the Technology Acceptance Model (TAM) (Davis and Davis, 1989); Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003); Theory of Planned Behaviour (TPB) (Ajzen, 1985, Ajzen and processes, 1991, Ajzen and Fishbein, 2000); and Theory of Reasoned Action (TRA) (Fishbein, 1990). Knowledge on crucial concepts used to learn innovation or the adoption at institutional levels may include Diffusion on Innovation (DOI) (Rogers, 1995b); Institutional Theory (Scott, 1995, Scott, 2005); Technology Organisation-Environment Framework (Stoekel and Quirke, Tornatzky et al., 1990).

2.31 Individual Level Theories

Throughout these lines, the researching individual outlined key theories used to analyse the implementation and acceptance of ICT, plus IS innovative concepts at separate levels: TAM (Davis, 1986, Davis et al., 1989); UTAUT (Venkatesh et al., 2011); TPB (Ajzen, 2002); TRA (Fishbein and Ajzen, 1976).

2.31.1 Technology Acceptance Model (TAM)

TAM is one of the most commonly used models in IS/IT determinant enquiries (Davis et al., 1989). TAM originated on TRA that provides an understanding of IT users and user behaviour. This model has been adopted and expanded by several previous studies which have been shown to have high observational reliability (Adams and Searle, 1992, Pituch et al., 2006). TAM speculates that a person's behavioural strategy for accepting a system is influenced by two convictions: supposed worth; and presumed flexibility (Legris et al., 2003).

Perceived worth is the degree by which a person considers the potential to enhance efficiency through the use of a specific program (Davis et al., 1989); while the presumed ease of use is the degree to which a person perceives how simple it would be to use a given tool. Of both of the concepts listed above, perceived ease of use is closely related and has a direct effect on both the use of technology and its supposed worth (Adams and Searle, 1992).

TAM assists in understanding the heterogeneity of behavioural intent in a procurement context, partly as TAM utilises two beliefs that may apply in various circumstances (Gentry et al., 2002). TAM's approach of 'accepting' technology is very popular, but more and more people have questioned TAM's suitability and exhaustiveness. With some critique of the assumption that user adoption of technology is often largely dictated by presumed flexibility and supposed worth (Park et al., 2012), (Silva et al., 2015) argued that more determinants that might affect perceived user-friendliness and usefulness need to be examined, and this has an impact on the model's prediction abilities for accepting innovative technology. TAM is considered to have prediction limitations and is generalised to include build-ups that explain the behavioural intent of implementing IS (Legris et al., 2003, López-Nicolás et al., 2008). TAM's downside is that the TAM theory offers limited assistance on how to impact convention through strategy and execution—and that is a great disadvantage (Taylor and Todd, 1995b, Venkatesh et al., 2003). TAM addresses only suppressed amounts of acting facts and as an executor can consider multiple factors that may distort goals or desires. This theory does not take into account the physical, mental or social aspects of embracing the technology (Bagozzi, 2007).

Unified Theory of Acceptance and Use of Technology (UTAUT)

The UTAUT is a model aimed at providing support for research into IS/IT adoption. Venkatesh et al. (2003) UTAUT emerged after carrying out a relative study of influential forms such as TAM, TRA and TPB used to describe technical actions. UTAUT is among the most frequently used IT theories (Williams et al., 2009, Dwivedi et al., 2009a). Agreeing to Venkatesh et al. (2003), the theory proposes four main constructions: expectation of success, anticipation of exertion, impact on society and facilitation of circumstances (as shown in Figure 2.14).

- ***Performance expectancy*: The number of people who have an opinion that the expectation mechanism will allow them to exhibit better performance at work.
- ***Exertion anticipation*: The limit of when the program can be conveniently used.
- ***Social impact*: To what degree people feel their friends and employers promote the use of the process.
- ***Facilitating conditions*: Where a person believes the system supports the organisational context and the technological infrastructure.

Consumers will have various beliefs and expectations related to technology that will ultimately influence their desire to use technology, which would then have an effect on their willingness to embrace it (Garfield, 2005). UTAUT was originated to explain nearly 70% variability in intended use (Venkatesh et al., 2003). For various studies, this was considered to check the uniformity of the dimension measure used in the UTAUT tool. UTAUT's biggest weakness is its majority of separate changes (Bagozzi, 2007).

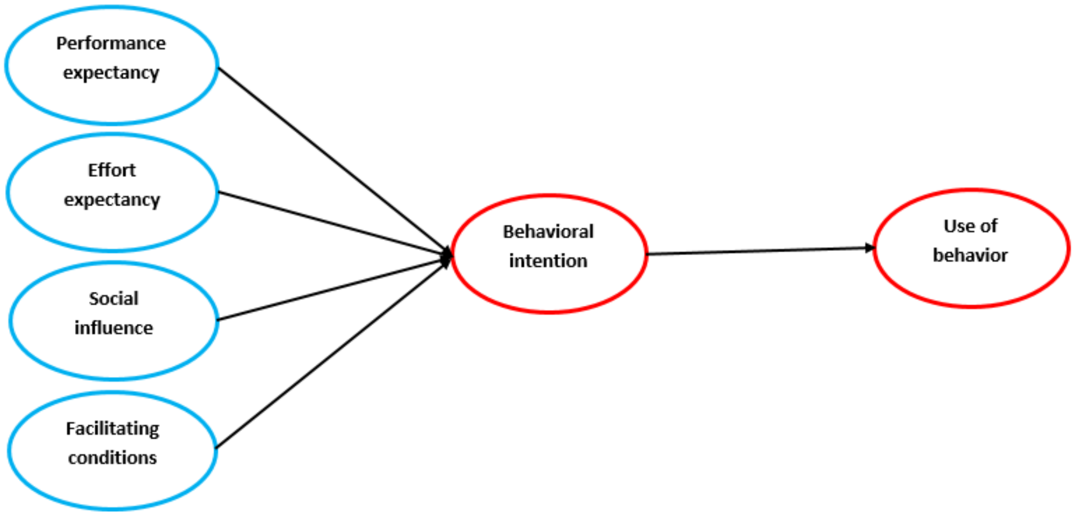


Figure 2.14 Unified Theory of Acceptance and Use of Technology (UTAUT)

(Source: Venkatesh et al., 2003)

Theory of Planned Behaviour (TPB)

TPB is an enhancement on the rational behaviour theory, based on the premise that human beings are generally very reasonable and access the data available to them effectively (Ajzen and Kruglanski, 2019). Many IS studies have used the TPB hypothesis (Brown and Venkatesh, 2005). The theory asserted that individuals evaluate elements before deciding to engage in conduct (factor of intent) or not. The intent adjustment consists of three basic structures, namely, behavioural disposition, social norms, and behavioural management (Taylor and Todd, 1995a) (see Figure 2.9). All these abstracts are discussed here (Ajzen, 1985):

- ***Attitude on a behaviour*:**

  Refers to an individual's pessimistic or optimistic attitude to the actions. It is achieved by exploring the individual's emotions about the behaviour’s effects and determining the advantages of those behaviours.

- ***Subjective norms*:**

  This relates to a person's assumptions the individual would be in favour of performing the action. A focus offered on any particular referent's point of view depends on to what degree the person feels he/she must satisfy the referent's wishes.

- ***Behavioural control***:

This refers to the beliefs of a person as to the degree to which an action can be performed. The amount of control people possess is on a spectrum ranging from activities that are easy to an individual who struggles to act and needs multiple help. The dimension is implemented to resolve uncontrollable variables in the behaviour.

Intentions contribute significantly to behaviour (Webb and Sheeran, 2006). A wide meta-analytic review exists of 37 studies that particularly controlled intention through mediation and evaluated the influence on ensuing behaviour (Webb and Sheeran, 2006).

2.32 Organisation Level Theories

This section summarises the key hypotheses used to research the acceptance at the organisational level of IT/IS innovation: DOI (Rogers, 1995a); Institutional Theory (Scott, 2001); Framework for Technology-Organisation-Environment (Baker, 2012).

DOI the Diffusion - Innovation

DOI examines why novel concepts are created while rapidly propagating at distinct and organisational stages across societies (Rogers, 1995a). It visualises concepts as institutions extend via different networks, in a social task line where individuals at various levels accept innovations. (Rogers, 1995a). It is a successful tool when organisations apply various innovative concepts, as evidenced by various studies (Fichman and Kemerer, 1999, Sharma et al., 2003, Zhu and Kraemer, 2005b). Rogers has proposed five classifications of personal or business preparedness for innovation: early adopters; innovators, laggards; early majority; and late majority; (Rogers, 1995a).

- ***Innovators*** are characterised as decision-makers, introducing a new idea for the development of a part of the company. Must have adequate resources of finance to endure any potential losses resulting from unsuccessful innovation. They are assumed to have a higher level of alertness to perform complex knowledge while being able to work with unpredictable adoption process issues.

- ***Early adopters*** have the highest opinion on leadership in different systems and meet before any proposal is implemented. Transition agents take them as local ambassadors to boost the diffusion process. They have the potential to reduce the degree of innovation uncertainty and ultimately help inspire the masses because they represent creativity

- ***Early majority*:** This category is the predominant adopter category, representing one-third of any participants of the programme. They serve between early and late. Compared with innovators and early adopters, they spend a considerable amount of time making their decision to adopt innovation.

- ***Late majority*:** Influencing factors on adoption decisions are the pressures of some industrial challenges. They have relatively rarer resources, so they need to be certain of the credibility of the invention and be sure of the result early enough to agree to implement the new technology.

- ***Laggards*** are cynical about technologies and keep hiring various managers and have limited understanding of the creativity and expertise which is attributed to their limited adoption. Laggards adopt a new technology only when they are completely certain of its implications.

(Rogers, 1995a) purports that the theory of DOI suggests that innovativeness has relationships with sovereign variables at the organisational level, internal organisational structures, management aspects and/or characteristics—as well as external characteristics of an organisation.

1-Leadership behaviours which are related to change represent individual characteristics

2-Inner characteristics of the organisational framework include elements such as centralisation, complex situations, formalisation, organisational slackness, interconnectivity and organisational scale (Rogers, 1995a):

- ***Centralisation***: The degree that control and power are distributed to relatively fewer individuals.

- ***Complexity:*** The scale that the employees of an organisation have a higher degree of awareness and skill.
- ***Formalisation:*** The level at which a company obliges its employees to comply with procedures.
- ***Organisational slack:*** The degree of allocated resources available.
- ***Interconnectedness:*** The elements of a system are combined via interactive connections;
- ***Organisation Size:*** Employees working in the organisation.

3-An organisation's extraneous features contribute to program transparency. The innovation strategy within companies is considerably complex and requires different staff that can be in support of or against the new concept—thus, all staff play a part in making decisions about innovation.

The adaptation and distribution literature led to the definition of innovative features after an extensive study of adoption to decide the characteristics of different adopter clusters (Rogers, 2003). Differences in creation were not widely considered. Rogers (2003) identified innovation features:

- ***Relative advantage*:** How an invention is considered as more successful than the belief that it succeeds.
- ***Observability*:** To what degree the effects of the invention are apparent to others.
- ***Compatibility*:** The level at which an invention is assumed compatible with present beliefs, previous experiences, and prospective adopters' requirements.

***Complexity*:** To what degree the product is considered comparatively difficult to understand and execute.

Generally, organisations adopt only those innovations with advantages, have no effect on present practices, and are very flexible. Hence, the diffusion rate is positively influenced when there is a high comparative advantage and efficiency in the invention. The challenge is when those measures for innovation might not be the best in all of the possible circumstances. Rogers (2003) proposed that studies using these features allow respondents to obtain a significant innovation feature in determining the measurements in the rate of adoption.

While giving vital assistance to help forecast implementation probability levels, DOI has contributed considerably to current development and distribution practices—which remains one of its primary weaknesses. A critique of Rogers ' research provides no proof of how it becomes an acceptance or rejection(Karahanna et al., 1999).

Studies on multifaceted organisational technologies also challenged the weakness of the characteristics of the DOI theory in light of the implementation behaviour of multifaceted organisational technologies(Prescott and Conger, 1995, Hu et al., 2002). Such features must bring forward the best feature of a new invention to determine features such as those predicting the rate of acceptance (Rogers, 2003). Studies might be required to consider social conditions in order to make this hypothesis more realistic (Dwivedi et al., 2009b). It is recognised that bringing DOI together with new theories may be more effective in further studies to examine the acceptance of novel innovation in industries.

Institutional Theory

Institutional environments are important in assessing the organisational structure and behaviour within institutional theory (Scott, 2005). The theory argues that objective performance expectations do not necessarily inspire organisational decisions; rather, apprehension regarding validity, social and cultural influences also have an effect. Cultures, structures, and procedures form the behaviour of the institutions. In regards to the theory, because of isomorphic forces and the demand for legitimacy, higher levels of similar characteristics between firms are collected (DiMaggio and Powell, 1983). It means companies in the same industry appear to become analogous to each other over time, as rivalry in the market and consumer demand forces them to obey industry leaders. For example, businesses are more likely to embrace and integrate e-commerce because of isomorphic demands from customers, competitors, government and trading partners rather than being solely driven by internal e-commerce decisions(Garud et al., 2002).

Recent studies have followed a systematic approach to distribution and incorporation of e-commerce or electronic data interchange (EDI) (Crook et al., 1998, Li, 2008b, Soares-Aguiar and Palma-dos-Reis, 2008) Mimetic, traditional and institutional services are involved with a setting which affects the attitude of the organisation towards an inter-organisational system based on IT (Teo et al., 2003). If companies follow a competitive strategy or invention, it is known as working under stress (Soares-Aguiar and Palma-dos-Reis, 2008). Coercive pressures describe the powers the outer firms impose on dependent companies (DiMaggio and Powell, 1983). The normative focus occurs because of binary relations to some degree with the exchange of information, laws, and customs. The customs are exchanged between employees of a network through relationship networks; a contract is reached where it would allow blending customs with those related effects on organisational behaviours (Powell and DiMaggio, 2012). In a few experiments, the institutional theory was combined with other theories such as the TOE paradigm (Gibbs and Kraemer, 2004, Soares-Aguiar and Palma-dos-Reis, 2008). In terms of external pressures, the structural theory increases the environmental side of the TOE model, which includes the competition of rivals.

Studies Conducted on DOI theory

The DOI (diffusion of innovation) theory introduced by Everett Rogers is largely taken into use by users from various fields. The studies that have been conducted to date either aim at validating and confirming the validity of this model, or interrogating the same(Rogers, 2010). The variances in the adoption of this theory can be learned from the attributes of the same. The studies where diffusion of innovation theory is used are summarised below. The studies on the diffusion of innovation theory were conducted via telephonic interviews with the random sampling of the APICS (American Production and Inventory Control Society) members in the United States. The findings from these studies put stress upon the significance of the proper positioning of managerial rationality, and although this tends to be a very important factor in explaining DOI, it fails to describe the IOI (or infusion of innovation). It was also learned that the decisions pertaining to the adoption of the innovations are highly influenced by the interests of the political parties. It was also argued that the failure of the model in forecasting the infusion of the MRP system of an organisation was on account of the prevalence of the political forces within the same (Fichman, 2000).

Thong (1999) used Rogers's diffusion of innovation theory for the purpose of developing a new IS adoption model. Thong argued that the decision pertaining to the adoption of a new IS model, as well as the extent of the same, depends upon factors that can be broadly classified into four categories. The four categories of IS adoption are characteristics with respect to the IS, decision-maker/s, environment, and organisation. Not less than 166 small companies took part in the questionnaire survey that was conducted for testing the model. Thong (1999) took use of the discriminant analysis for testing the hypothesis and the findings of his survey reflected that there are various factors that tend to have a positive influence upon IS adoption. These factors are the relative advantage of the innovations, innovativeness, as well as the IS knowledge of the employees and the person/s in charge of making the decisions, compatibility, complexity, size of the business, and so on. The level of extent of the adoption of IS can be evaluated by looking at the organisational characteristics. Thong (1999) in his research also found that the environmental characteristic has zero influence on IS adoption by small organisations.

In 2001, Eder and Igbaria studied intranet diffusion in organisations. The model proposed by (Eder and Igbaria, 2001b)defined factors such as the adoption of IS, organisational size and structure, IS structure, IT infrastructure, and further established that support received from the senior management plays a significant role in infusion, as well as diffusion, of innovations. Eder and Igbaria (2001) ascertained data from the top-level executives of various companies across the U.S. for conducting a cross-sectional survey. Around 1000 companies were asked to fill in the survey for this purpose, out of which only 281 responses were found useful. Eder and Igbaria (2001) analysed the ascertained data by using hierarchical multiple regression. The discriminant, as well as the convergent validity of its terms, was tested by performing a PCA or Principal Component Analysis and the findings of the same reflected that the diffusion of the intranet is closely related with adoption of IS, organisational size and structure, IS structure, IT infrastructure, and support received from the senior management.

Beatty et al. (2001) and his team conducted a study that investigated the adoption of technologies in organisations and, for this purpose, he and his team surveyed around 286 large and medium-size U.S. based organisations that have their own website. The findings of their survey indicated that it is time that plays a significant role in the adoption of technologies for large and medium-sized organisations. Support received from the senior level management, compatibility of the organisation, perceived benefits, complexity, and technical compatibility are the five factors that influence the adoption of technology in large and medium-sized businesses. The researchers in this survey used MANOVA for the purpose of testing the hypotheses of the respondents (IS managers). These respondents were found to be personally involved in the development of websites. Compatibility with the current technology, perceived benefits and the norms of an organisation are the prime factors that have created an influencing impact upon the early adopters. However, in the case of later adopters, the researchers were not able to source findings at all. It was suggested by the authors that strategic necessity could be a possible reason for the late adopters to take up technology adoption. They also found that compatibility with the current technology and perceived benefits are the factors that influence the adoption and regular usage of technology in large and medium-sized U.S. organisations.

Bradford and Florin (2003) also conducted a study using Rogers's DOI theory. Their study investigated the adoption of ERP or Enterprise Resource Planning Systems in U.S. based businesses. Bradford and Florin's model comprised variables that can be divided into three categories: innovative characteristics; environmental characteristics; and organisational characteristics. As per Bradford and Florin's model, implementation success is all about user satisfaction and organisational performance. The survey conducted by them was based upon instruments that already existed and they preferred measuring responses based upon a seven-point Likert type scale. The survey was completed by a total of 51 managers and the data ascertained was analysed by Bradford and Florin using linear regression. The results of this analysis clearly demonstrated that there is a direct relationship between the support and training received from the senior management and user satisfaction. However, it was also found that the complexity of enterprise resource planning systems and competitive pressures have a negative impact on user satisfaction. It was also reflected in the findings that even though competitive pressure has a negative impact on user satisfaction, it is somewhat positively linked to the company's perceived performance. Their findings also reflected that the consensus in the business's objectives is also positively related to the company's perceived performance. Furthermore, they performed a post-hoc analysis and established as per this analysis that user satisfaction also acts as a moderator in between diffusion of innovation and a company's overall performance. In keeping with the overall findings of this study, Bradford and Florin suggested a new and enhanced model of enterprise resource planning implementation systems for future purposes.

Tan et al. (2009), along with a few other researchers, applied DOI model to conduct a study of ICT adoption by small and medium enterprises. Tan and his team suggested a new model by adding some constructs to Rogers's five influential factors. They ascertained essential data by conducting a survey questionnaire of 406 owners or managers of small and medium enterprises operating in the southern region of Malaysia. The findings of their survey signified that digital ICT is basically cost-effective and the best tool of communication for customers. The findings of their survey also stated that security tends to be one of the prime barriers that must be constantly worked upon by SMEs. To sum up, the findings of the questionnaire driven survey conducted by Tan and his team found that compatibility, observability, complexity, relative advantage, and security highly influence digital ICT adoption.

Gollakota and Doshi (2011) used diffusion of innovation theory in their study to investigate the diffusion of rural telecom centres in economies that are in their developing phase. Their research revealed that information (as well as knowledge pertaining to technology and proper infrastructure, ongoing practices and traditions, the essence of perceived complexity, use and advantage of the telecom, centres) has a significant influence upon the diffusion of rural telecom centres in economies that are in their developing phase.

Diffusion of innovation ignores the aspects related to the environment. This calls for the need to make use of a theory that gives importance to the aspects related to the environment as well. Technology Organisation Environment (Stoekel and Quirke, 1992) is another framework that studies all the factors that have a tendency to impact the adoption of the latest technologies. The next segment of this chapter will project detailed information about the TOE framework and will also provide a review of former studies that have utilised this framework.

Studies Conducted on Technology Organisation Environment Framework

Technology Organisation Environment Framework is widely taken into use by eminent researchers of the IS field for the purpose of studying the overall process of adoption of the latest technologies (Sovacool and Hess, 2017). Multiple researchers from the IS field have used this framework for studying the overall process of adoption of new and latest technologies. In most of the studies, this framework is the sole theoretical framework that is implemented for the purpose of investigating the process of adoption and, sometimes, it is also merged with other similar frameworks for the same purpose(Skille, 2008). The first study that was reviewed is one that has investigated the overall process of adoption of an open system. This study considered the uncertainty of the market to act as a segment of external environmental factors (Achrol and Stern, 1988). This study considers factors such as perceived barriers, interoperability, perceived benefits, inter-connectivity and perceived significance of compliance with the standards to act as an essential segment of the technological context of an open system while the organisational factors of the same are the complexity of the information technology infrastructure, formalisation, and management of system development and satisfaction with the ongoing systems (Wouters et al., 2008).

The researchers conducted face-to-face interviews with top-level executives of 89 companies operating in Hong Kong solely for the purpose of attaining relevant data. They used methods such as logistic regression, factor analysis and T-test for analysing the retracted data; and their findings signified that these companies are more concerned about whether they are capable of adopting new technologies rather than focusing on the benefits that they can derive by adopting the same (Leung et al., 2015). It was also found that the companies that have adopted new technologies perceive a higher level of pressure from the government and a lower level of pressure from the industry compared to companies that have not yet adopted new technologies.

Kuan et al. (2001) also conducted research using the TOE framework relating to the adoption of EDI or Electronic Data Interchange systems. The findings of their research regarded perceived pressure (from the government and the industry) as environmental factors; perceived benefits (both direct and indirect) as variables in a technological context; while perceived technical competence and perceived financial costs were identified as organisational factors. Kuan and Chau conducted research by developing and distributing a questionnaire to 575 small firms operating in Hong Kong and used logistic regression and factor analysis for analysing the retracted data. Out of the six factors, they found only five to have a significant influence upon EDI adoption by small businesses. Their findings suggested that the adopter businesses perceive direct benefits to be greater as compared to the non-adopter businesses. Their findings also indicated that the adopter businesses perceive minimal expenses and greater technical competence compared to non-adopter businesses.

Furthermore, Zhu and Kraemer (2002) studied the adoption of e-commerce by companies and in keeping with the conceptual model, they suggested that the factors that tend to influence the adoption of the same are the scope and size of the company, customer readiness, IT infrastructure, competitive pressures, and technical know-how. They ascertained the relevant data by conducting a telephonic interview, and for control variables, they used industry and country effect. The data was sourced from 3100 companies and 7500 customers from the U.K., Germany, France, Ireland, Denmark, Italy, Spain, and Finland. They analysed the retracted data from the companies and customers by performing a CFA or Confirmatory Factor Analysis, logistic regression, CA or cluster analysis and second-order factor modelling. They divided the sample into low and high EB-intensity nations to assess the pattern of adoption.

Zhu and Kraemer (2002) conducted another study that focuses upon the adoption of innovation and other stages of innovation assimilation that include routinisation and initiation adoption. Zhu used this framework for developing a model based on a hypothesis that states the factors that influence e-commerce assimilation in business are the company’s size, managerial obstacles, international scope, the intensity of the competition, and technology readiness. They collected data from 1857 businesses from ten different countries and conducted a questionnaire-based survey through a telephonic interview. The samples received from developed and developing economies were segregated from each other. A covariance-based SEM or Structural Equation Modelling by AMOS 4.0 was used for this study. The findings indicated that competition has a positive influence on the initiation and adoption of innovation but has a negative influence upon routinisation. Their findings also indicated that the large companies enjoy resource benefits at the initiation stage itself, but they must overcome structural inertia in the later stages. They also found that in developing economies, the effect of environment upon innovation assimilation is greater and technology readiness also tends to be a dominant factor, while in the case of developed economies, integration acts as an influential factor.

(Zhu et al., 2002) conducted another study where they applied the TOE framework for investigating the adoption of e-commerce. Regulatory support and competitive pressures acted as environmental factors, while international scope, financial commitment, size and technological factors acted as organisational factors in this study that tends to influence decisions pertaining to the adoption of e-commerce. Zhu and Kraemer added back-end integration and front-end functionality as two constructs to this model. They collected data by conducting telephonic interviews with around 624 firms across 10 nations in the year 2002. For this study, Zhu and Kraemer chose companies from both developed and developing countries and used second-order factor modelling, CFA and SEM for analysing the ascertained data.

TOE framework is also used for studying the deployment of business-to-business e-commerce by companies. For this purpose, the authors performed a field survey of top IT executives from 249 organisations operating in North America. Unresolved legal issues, fear and uncertainty acted as environmental factors; and organisational change, lack of support from the senior management, problems pertaining to the project management and lack of e-business strategy were defined as organisational factors. Moreover, lack of IT infrastructure, unresolved technical issues and lack of interoperability were regarded as technological factors. The authors performed factor analysis, multivariate discriminant analysis, and univariate t-test and found that lack of support from senior management, lack of e-business strategy, unresolved technical issues and the problems faced in cost-benefit assessment acted as key inhibitors in business-to-business development.

Liu (2008) also conducted a study on the adoption of e-business development. The technological factors of this study are human capital and support received from the provider of the technology. Organisational factors of this model included the size of the company and the level of management for information, while the environmental factors of the same are e-business security and user satisfaction. The company's property is considered as a control variable. The authors collected data by conducting an online survey via email and opted for a telephonic interview. They used PLS and factor analysis for analysing the retracted data. As per their findings, it was suggested that user satisfaction, EC security, management, technology foundation and investments in the upcoming technology tend to influence EC development. The findings suggested that the company's property has no effect on EC development—and its size too acted as a non-significant factor.

Pan and Jang (2008) conducted a study concerning the adoption process of enterprise resource planning systems. They conducted face-to-face interviews with 99 companies operating in Taiwan's communications sector. According to these researchers, the company's size, technology readiness, IT infrastructure, perceived barriers, and competitive pressures are factors that act as important determinants in the adoption process of ERP systems. Their model was proved to correctly classify all the decisions that were made about the adoption process of ERP systems.

Lin and Lin (2008b) and others conducted a study on the adoption of electronic procurement in manufacturing companies operating in China. Li collected data by conducting a telephonic interview with 120 managers and data collected was analysed using logistic regression. The findings of their model suggested that the e-procurement option can be determined by support from senior level management, relative advantage, external support, and external pressure.

Lin and Lin conducted another study to investigate the internal integration and external diffusion of e-commerce and its uses. The readiness of the trading partner and competitive pressure are considered environmental constructs. IS expertise and IS infrastructure are regarded as technological constructs; while expected benefits and organisational compatibility are considered as organisational constructs. Lin and Lin gathered data by conducting an email survey in 2006. They surveyed only IS executives of large companies in Taiwan. They also performed CFA and SEM for analysing their data. Their findings suggested that IS expertise and infrastructure and competitive pressures are a few of the factors that have an influence upon the diffusion of e-commerce among large companies.

Oliveira and Martins (2010b) used the TOE framework in order to investigate the adoption of websites by companies. They ascertained data from 637 large and 3155 small Portuguese companies. They analysed the resulting data using MCA (Multiple Correspondence Analysis). In 2009, they also published a new research paper in which they investigated the adoption of e-business and websites and in this study, they focussed on 2626 Portuguese companies. They continued to investigate the adoption of e-commerce and retracted data from around 2459 companies that operated in EU27 nations across two industries. The hypothesis was tested using logistic regression and the analysis stage was completed using factor analysis. The findings of their survey revealed that the decisions pertaining to the adoption of a website and e-commerce are influenced by technology readiness, trading partner collaboration, perceived benefits, and competitive pressures.

TOE framework is also combined with theoretical frameworks such as institutional theory and DOI. In 1999, Thong combined DOI and TOE theories in order to develop a model that could be used as a study into the adoption of IS by small companies. The study considers such companies as adopters that have at least one major software application installed such as sales, inventory control, purchasing, accounting, etc. The number of software applications and PCs were used to determine the extent of usage. The model measures compatibility and complexity of IS, company’s size, the relative advantage of IS, CEO's innovativeness and IS knowledge, information intensity, competition and employees' IS knowledge as independent variables; and all these variables influence the decisions pertaining to the adoption of e-commerce in an organisation but do not have any impact upon the extent of adoption. The extent of adoption is influenced by organisational factors (Thong, 1999).

Zhu et al. (2003) conducted a study on the usage and impact of e-commerce on companies using the DOI and TOI framework. The variables of this study are compatibility, relative advantage, costs, technology competence, security concerns, competitive pressures, size of the organisation and trading partner readiness. The data was ascertained from 1415 firms across Europe by conducting telephonic interviews in the year 2002. The data were analysed using SEM and their findings revealed that compatibility tends to be the strongest driver and that customers these days prefer security over costs (Zhu et al., 2003).

Another study was conducted to examine the adoption of c-commerce (collaborative commerce) (Chong et al., 2013). The constructs of the proposed conceptual model are compatibility, complexity, competitive pressure, relative advantage, trust, information distribution, market trends expectations, senior management support, project champion characteristics, and feasibility. An email survey was conducted for this study and 109 companies were taken as samples. The data were analysed using multiple regression analysis. It was found that organisation readiness, information sharing culture and external environment influence the decisions about the adoption of c-commerce in organisations (Chong et al., 2009b).

Oliveira and Fraga (2011) combined DOI and TOE theories to develop a new model. The constructs of this model are complexity, compatibility, relative advantage, technology competence, competitive and trading partner pressures, senior management support and intensity of the information. They collected data from 133 Taiwanese manufacturing companies via an email survey and subsequently analysed data using logistic regression. The findings of the study determined that complexity, compatibility, relative advantage, technology competence, competitive and trading partner pressures, senior management support and intensity of the information tend to influence decisions pertaining to the adoption of RFID (Radio-frequency identification) in manufacturing companies (Wang et al., 2010b).

Combining two different theories often helps users in understanding technology adoption. Two totally different theories are combined in this research for proposing a new conceptual model. The next chapter focuses on describing the research model in detail (Dwivedi et al., 2019).

When it comes to the adoption of innovations, it is found that there are two theories that are predominately implemented by numerous researchers. Complexity, compatibility and relative advantage are factors that influence adoption-related decisions; and trialability acts as an important factor in cloud computing. Environmental and organisational factors often tend to influence decisions pertaining to the adoption of innovations (Choi et al., 2020). The adoption-related decisions are significantly influenced by competitive pressures. External support is a significant factor when it comes to cloud computing. The resistance against change is minimised with the employees' knowledge pertaining to innovation and, therefore, this factor must not be ignored (El-Haddadeh, 2020). All these aforesaid factors are clubbed together in this research model. The following chapters fully detail this model, its constructs and related hypotheses.

Research Gap

The following outlines the existing gaps in this particular research.

To the researcher's knowledge, there are few studies that have been conducted to assess the adoption of RFID technology in SMEs construction companies with reference to Australia (Sepasgozar and Davis, 2014). Most of the empirical studies have focused only on the advantages and associated risks of RFID technology and failed to address the factors affecting its adoption in SMEs construction companies (Lu et al., 2011).

Since the problem statement has been defined, it is important to frame the main research question from which the investigation will be carried out further; and, subsequently, the obtained results on analysis will provide the required answers to the research.

CHAPTER THREE: RESEARCH MODEL DEVELOPMENT

Previously, the literature review of the ICT adoption, in particular RFID technology, the Australian context and its related issues, SCS and the benefits of using RFID technology on SCS performance have been discussed. This research is a hypotheses-driven study since it follows a quantitative research design. In this chapter, the research model development is discussed by the discussion of the three theories underpinnings this model which include Diffusion of Innovation (DOI), Technology-Organization-Environment Framework and Actor Network Theory (ANT) followed by hypotheses development.

3 Conceptual Research Model

In this research, the key theories of Diffusion on Innovation (DOI), the Technology-Organisation-Environment (Stoekel and Quirke) framework (Tornatzky and Fleischer, 1990), and Actor Network Theory (ANT), will be combined to develop a comprehensive model for further investigation. This combining of models is justified because it provides a better understanding of the IT/IS adoption phenomenon (Wang et al., 2010a, Chong et al., 2009a). The combination of models is justified for two reasons. The first reason is that the TOE framework includes a focus on the environmental context of technology adoption, which is not included in the DOI theory, and that TOE is better able to explain intra-firm innovation adoption (Oliveira and Martins, 2010a). The second reason is that the empirical support and theoretical basis are the main advantages of the TOE framework and DOI theory. Reference RUI (2007) notes that "Compared to other theories, the TOE framework overcomes the domination of the technical perspective and provides a useful analytical tool". A review of previous studies found that, typically, studies about IT/IS adoption at the firm level is derived from using TOE, DOI or other similar models (Oliveira and Martins, 2010a, Lin and Lin, 2008a). In addition, ANT's main feature is its focus on entities and their effect on social processes. An actor is thus defined as the "source of an action regardless of its status as a human or non-human"(Berg, 1999, Chiasson et al., 2007). Therefore, this research chooses to use ANT theory in this study because this research will focus on humans and on non-humans and their interactions with technology adoption. This approach is very useful in gaining an understanding of how social effects are generated as a result of associations between different actors in a network (Cresswell et al., 2010).

Most studies that use theories of technology adoption at the organisational level utilise the DOI model, the TOE framework and ANT (Oliveira and Martins, 2010a). Some researchers have analysed the adoption of technology based on the TOE framework (Lin and Lin, 2008a, Lee et al., 2009, Martins and Oliveira, 2009, Zhu and Kraemer, 2005a), others have chosen to study it through the DOI model (Cooper and Zmud, 1990, Eder and Igbaria, 2001a, Hsu et al., 2006, Li, 2008a), whilst others have suggested studying the adoption of technology based on the two models together (Melville and Ramirez, 2008, Chong et al., 2009a, Eder and Igbaria, 2001a, Wang et al., 2010a). While TOE framework, DOI theory have been individually applied successfully to numerous studies on the adoption of innovation at an organisation level, both models have been successfully combined in numerous studies relating to the adoption of innovation at the organisation level. Also, ANT theory, approached in many studies, makes no distinction in approach between the social, natural and technological aspects (Linderoth, 2010).

This combined model has not been applied to the adoption of RFID technology.

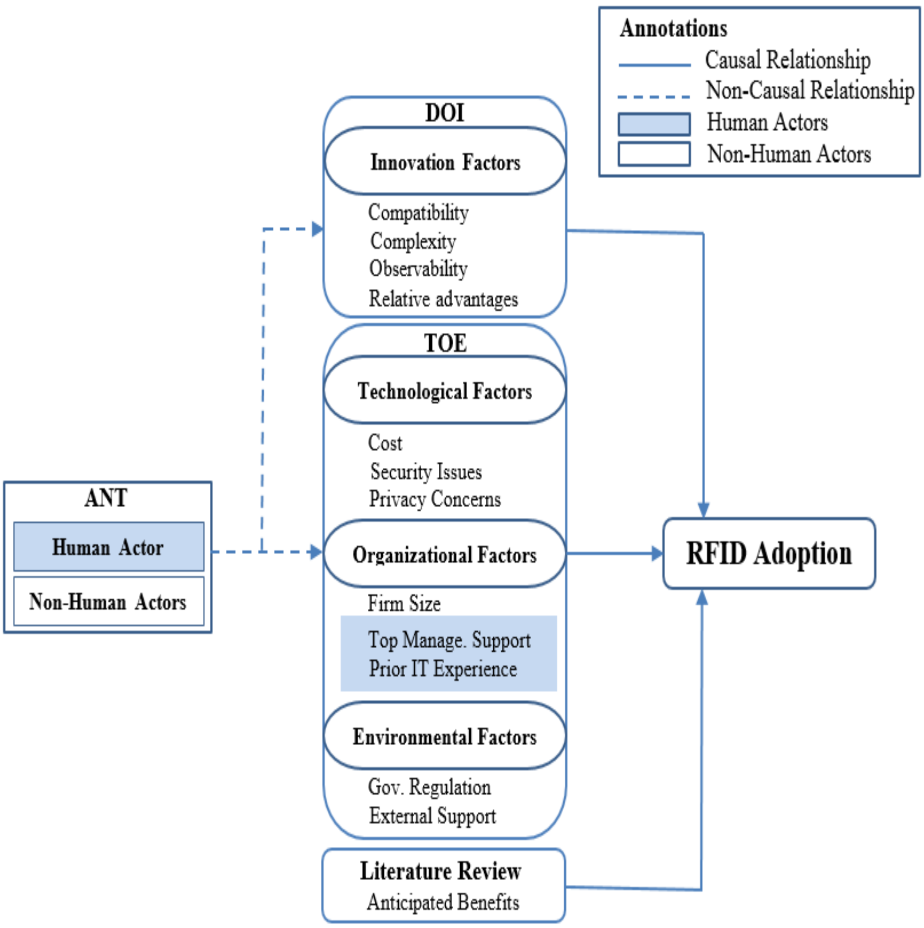


Figure 3.1 Conceptual Research Model

In this research, a multi-perspective research model will be developed to provide a framework for investigating the adoption of RFID in SCCA. As SMEs construction companies are the context of this study, organisational-level theories in the adoption of innovation will be considered. In particular, three related theories, namely, Diffusion of Innovation (DOI) theory, Technology-Organisation-Environment framework, and Actor Network Theory (ANT), will be adopted for constructing the multi-perspective research model (Stoekel and Quirke, 1992).

Innovation is one of the best ways by which to face challenges between significant businesses (Hamel, 2002). Innovation is very important and plays a significant role in development and viability in the business market because companies which have adopted new innovations are always desirable to customers (Tidd, 2001). This entails a new plan and study of the diffusion by implementation and adoption of new innovations (Rogers, 2003). Research needs to delve further into the verification of factors that have direct effects on SMEs construction companies. In addition, to identify and overcome obstacles, it is important to use technology adoption theory to reach clear and accurate results. This research will choose two theories to assist in data collection and to conduct an accurate analysis. Two models will be considered in the study. The first one is the DOI theory which includes how, why and what. It is an important tool to provide more knowledge on how companies adapt to different technological innovations as indicated by many studies (Bharati and Chaudhury, 2006). The adoption of technology innovation in SMEs construction companies in Australia is a very important factor necessary to increase the level of performance and for these companies to operate successfully in the labour market, and a necessary aspect to consider in this study.

3.1 Diffusion of Innovation (DOI)

The theory of how, why and at what rate new thoughts and innovations spread through societies, and working at the individual and at the firm level is called the DOI (Greenhalgh et al., 2004b). This theory includes the innovations being evolved as they go through different criteria as time goes on through a time span and in a social framework (Rogers, 2002). It has been observed that people are always ready for modern innovations, but they also take their time to adjust to these changes (Rogers, 1995a).

There are five classifications (from oldest to newest adopters) of individual or corporate preparedness for innovation: innovators; early adopters; early majority; late majority; and laggards (ibid). Each of these will now be explored. Within an organisation, five factors determine the adoption of innovation (Rogers, 2003). Firstly, (1) *relative advantage* relates to how comparable the innovation is with post models. Secondly, (2) *compatibility* refers to how far a particular innovation can be implemented into company visions and procedures. Thirdly, (3) *complexity* pertains to the amount of effort required to comprehend the innovation. Fourthly, (Das) *observability* considers others perceptions of the innovation. Lastly, (Das) *trialability* looks at the simplicity of testing the innovation. As such, DOI entails user insight and technical components and has been seen in vast applications regarding innovation adoption and diffusion research.

3.2 Technology-Organisation-Environment (Stoekel and Quirke) Framework

Innovation in firms can be signified through its technological perspective, which includes accessibility, unpredictability, and similarity, which are the three factors that can produce innovative changes (Eldridge et al., 2011). The technological perspective includes all the factors, external or internal, that can influence the organisation in any way (Doolin and Troshani, 2007). For example, testing the technology organisation-environment schema, both internally and externally. Furthermore, an inter-organisational connection may be fundamental as a result of the free variables demonstrating interior reception and might be unique in relation to the individuals demonstrating inter-organisational adoption (Henderson et al., 2012). Moving on to the second context that affects the innovations of a company is the organisational context, which refers to the perspectives of the organisation. They include size, level of intricacy in managerial structure, level of formalisation, employee assets, the measure of slack assets, and linkages around representatives (Koh and DiPietro, 2011). Lastly, there is the environmental perspective which influences the framework of the industry, contenders, and governments' regulations and strategies (Depietro et al., 1990). All these abovementioned factors and the links of companies with their business partners, contenders, government, pressures of associates, and industry group may influence the modern changes that are made in a company (Embry and Biglan, 2008). For example, to make use of favourable situations, if the competition is very strong, then the company is under more pressure to adapt to modern changes (Doolin and Troshani, 2007). The innovations can be made relatively easily if the TOE framework is being used since it helps in highlighting the pros and cons of various technological changes that can be made due to a number of studies conducted in this area (Angeles, 2012).

To analyse Purdue's encounters, Tornatzky et al. (1990) TOE framework was utilised. The model is divided into three parts which are environmental, organisational and technological conditions. Actors and plots surrounding an industry that it belongs to are contained in environmental conditions. Meanwhile, relevant features such as the organisation's size, its management structure complication and the available internal slack resources are all part of the organisational condition. Last but not least, the technological condition contains the inner and outer technologies that can be utilised by an organisation.

To understand how organisations take on technological revolutions, we can adopt a TOE framework which has been used several times in undergoing research between 1990 to 2010. The three factors of the TOE framework are addressed in the study by Daim et al. (2010) regarding the dispersal of IT based on the assessment of certain characters that vary in importance by using a spreadsheet-driven implementation and Enterprise Resource Planning structure (Dwivedi et al., 2019). Differences in the firm's characters are being taken care of by differences of sector, culture and function. On the other hand, the technology's freedom, user interface and its success in achieving its goal are all factors related to the technological condition. The distinctions between the three factors affects the adoption of the other two. TOE can be used to describe elements elaborated in adopting RFID in Taiwan's logistic industry (Lin and Ho, 2009). It was also used to derive a technology distribution point of view about adopting e-business in several countries by utilising the information from 1857 firms (Zhu et al., 2006).

A total of 83 motor carrier firms tried out models for Electronic Data Interchange (EDI) usage which leads to the organisation's execution being measured by functional and retail performance in the end (Ramamurthy and Premkumar, 1995). Aspects of the TOE framework were utilised by Thong (1999) to construct a model which has dependent variables as the adoption's primary influence which were then evaluated using information from 166 small firms. There are seven aspects that inform a firms' open adoption structure (Chau and Tam, 1997) and these aspects enclose three crucial conditions based on TOE. The first one is the external environment. The second factor of open systems technology. Lastly, the organisational technology. There are three crucial aspects that affect a small organisation's usage of EDI, namely: environmental, technological and organisational aspects, as examined by Iacovou et al. (1995) through the use of seven case studies. Customer-based Inter-Organisational Systems (CIOS) adoption was evaluated in 1993 by Grover who used four aspects that are derived from the TOE framework, namely organisational, environmental, inter-organisational and supporting factors which comes from data of 226 senior executives.

A three-stage alteration assimilation procedure model uses TOE's three factors as its main precursor. The TOE framework was used by Hackney and Tassabehji (2016) to evaluate web facilities adoption in UK firms by utilising case studies.

Sharma and Citurs (2005) used a part of the TOE framework as a predecessor to defining RFID usage based on interviews and secondary source information from 16 firms. Electronic Data Interchange (EDI) usage components were looked into by Kuan et al. (2001) by using the TOE framework in 575 Hong Kong firms. Ryan and Deci (2000) defined knowledge organisation technologies usage by using TOE framework aspects and utilising analysed data samples from several countries.

3.3 Actor Network Theory (ANT)

ANT considers the correlations between organisations, people and things, which are referred to as acts (Law, 1992). Heterogeneous networks involving both technical and social components can see this theory applied effectively, which is a great advantage of the theory (Law, 2009). ANT seeks to describe and analyse contexts from various perspectives encompassing socio-technical contexts (Geels, 2010). All human and non-human acts are equally valid in the analysis; this may include, for example, supervisors and customers, and extend to hardware and software (Fenwick and Edwards, 2010). The different acts have equal salience in interpreting disparate contexts (Kennan et al., 2010). Fourteen elements were identified regarding the influence of decisions surrounding RFID and categorised into three groups (as per the research model in Figure 1): technological factors, organisational factors, and environmental factors. Human and non-human acts, considered as outer groups, do not relate to the three categorised factors—although they can be applied in order to gain clearer comprehension of the context. (Mustonen-Ollila and Lyytinen, 2003), when examining DOI, refer to relative advantage, complexity and compatibility, a view supported by (Tornatzky and Klein, 1982) who also point out that organisational factors link to company characteristics, for example, employee comprehension. Environmental aspects consider external elements which drive organisations, while human factors relate to those staff members who make decisions. SMEs decision-makers play vital roles in innovative decisions (Thong and Yap, 1995).

Factors from original theories have been selected that relate to the specific research aspects. TOE framework is used in research because it investigates the adoption of any new technology from different aspects such as technological, organisational, and environmental; whereas in ANT, acts go through the process of identifying and categorizing as human and non-human. This is so that a correlation between all constructs and theories can be drawn so as to understand the challenges and motivations of RFID. ANT acts are seen as more versatile in certain environments and in the role of actor or the property of such, thus having no resemblance to ANT (Tatnall and Burgess, 2002).

Actor Network Theory (ANT) can describe social contacts that are linked with the use of technology. Hanseth et al. (2004) stated that this theory can reveal concepts that are stronger and can help with recognising the connection between used technology and their remains. Human beings as actors coincide in a network in which they try to impose their own ideas, values and expectations on other people who also fight to have their claims accepted (Faraj et al., 2004). According to Sarker et al. (2006), if these actors' interests are not conforming to the main actors' interests (which for this paper are the SMEs,) it will be harder for them to use ICT. If the interests of the main actors and the other actors are in check with the technology, the network will become more powerful and secure. Meanwhile, the network will be weaker if there is a disagreement between the actors either regarding the evolution of technology or even the current application of technology (Bijker and Values, 1993). At this stage, if an actor still does not fulfil the requirements of the main actor, they will be asked to depart from the network while the others will be taken in. Through ANT, the common and unbalanced interaction between the actors are acknowledged and it also shows how the actors accept or reject the components which create ICT adoption at different levels (Faraj et al., 2004). According to Andrade et al. (2010), ANT accepts both social and technological actors seeing that they all alter a situation. In conclusion, ANT is a crucial part since it is capable of aiding more variety of techniques of ICT management and implementation in enterprises, work out the aspects which affect the adoption and lastly to accommodate academics which helps expand views on the use of technology (Eze et al., 2019). Provost and Fawcett (2013) mentioned that big data's significance is shown by continuous developments that caused big data analytics to be more economical and applicable. Every year there has been an increase in literature, studies and meetings regarding data analytics and data mining (Sadovskyi et al., 2014) which increases people's interest in big data and also increases the use of big data in enterprise models (Manyika et al., 2011).

According to Sadovskyi et al. (2014), there are a number of academic and technical improvements which aims at developing internal operations. In order for the companies to maximise the external operations, there have to be some modifications that have to be executed by the logistic network partners so both parties have the same shared information. New technologies, such as RFID and sensor networks which permits quicker tracking and goods identification (Brundtland et al., 2012), can help with the data trading among business partners. Aside from that, cloud computing can help with data acquisition and big data applications will help with concurrent optimisation of areas like organizing transportations (Tariq et al., 2019). ANT is used as the academic foundation because the delivery requires a minimum of two logistic network partners and also instruments. With ANT, different aspects can be created even if they have no similarity. As stated by Walsham (1997), ANT's main principle is that systems and their components, which needs to be seen as diverse even though in social and practical aspects it is not probable most of the time, have a complicated socio-technical nature. As an example, delivery becomes more complex when it comes to the customers who likely change locations, so solving this with only a human or technical approach will not be worthwhile. ANT is a satisfactory theory for creating and evaluating last-mile delivery services because it can estimate the socio-technical relations that arise from interactions between buyer, courier or even their mode of transportation. It can also be used to notify Design Science proposal. Aside from all that, ANT is also useful in comprehending ICT acquisition since it sees both social and technical aspects. Because of that, ANT does not prioritise the major actors over minor actors in the system development(Callon et al., 1981). Latour (2005) mentioned that the stimulating part about equal social and technical actors is that both parties can modify situations (Andrade et al., 2010).

The adoption of ICT is complicated and more ingrained in the public(Hanseth et al., 2004). Things thagt previously were hard to give to social or non-social beings are now more interrelated. According to Andrade et al. (2010), social and practical entities exist in the world together and they cannot be separated. ANT's basic principle is acknowledging the socio-technical relationship and comprehending how interrelated they are. It also emphasises that social and technical aspects should be inspected as a group and their contact is what helps actors perceive the worth and the prospect of a particular technology. It has been asserted that a theory that splits up technology from the public will not highlight social facilities and goals. According to Cordella and Shaikh (2006), ANT was utilised since it assists in comprehending activities and interrelation of the actors and those whose settlement can give a positive impact on the acquisition. Aside from that, ANT authorises researchers to study the use of the latest technologies and steadily shift to the time when it becomes a success (Akrich et al., 2002). Schwarz et al. (2014) stated that acquiring technology applications that are evolving is never-ending since new technologies may arise and be welcomed.

Factors affecting RFID were studied from an ANT perspective and, in doing so, aspects that limit or aid activities were considered. Looking at technology and people, the connection between the two was established. Actor-networks and the related processes are analysed using sociological translation; the contexts and relationships are the structure of actor-networks, and the processes are referred to as translations. For analysis, four aspects of translation were defined. These are problematisation, interessement, enrolment and mobilisation.

Problematisation; Actors describe an aspect in their own words in order to identify authority shifts. The customary Obligatory Passage Point must exist so that all areas outlined to them from the key actor are satisfied(Unnithan et al., 2013).

Interessement; This entails motivating people to accept a resolution provided by the key actor with the actors involved in the course of OPP(Rivera, 2013).

Enrolment; Negotiations are established and positions of self are accepted within the network (Iyamu and Tatnall, 2010).

Mobilisation; the key actor has spokespeople and the group gains representation. This new network then adopts the suggested resolution thus making the network stronger. Competing translations can then be challenged from this newly strengthened actor-network (Unnithan et al., 2013).

From the start, actors are established, as are their positions and interests. These are outlined as the socio-technical aspects owing to people and technology within one piece of research. The people in the study are represented in documents and by actors. RFID is considered from an ANT perspective within minor construction businesses and the interplay from the actors is then analysed.

3.4 Research Hypotheses

3.4.1 Analysis of Hypotheses:

This approach considers adopting measures that were discussed previously, Approximately 13 hypotheses were developed and tested to analyse the theoretical research model which consists in determining the answers to the research questions.

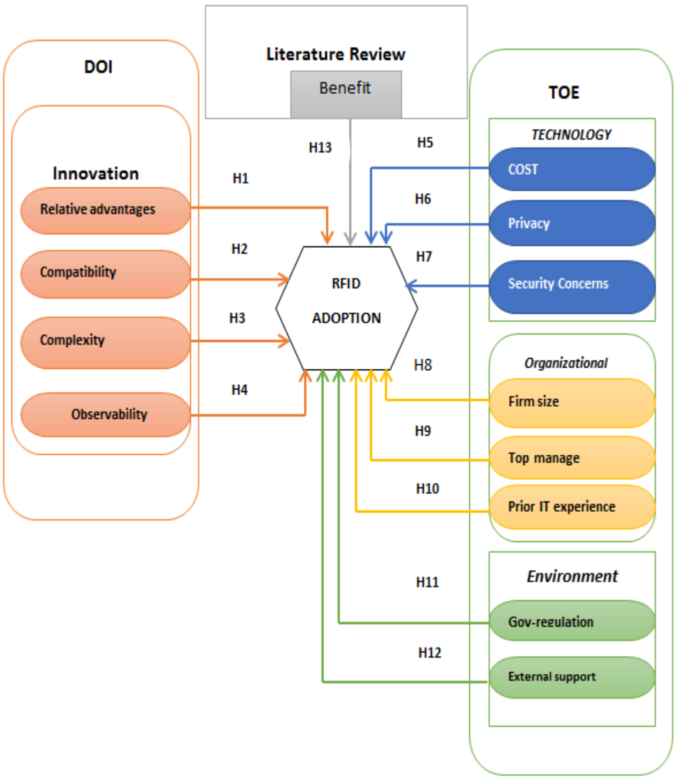


Figure3.2: Research hypotheses

3.4.2 Hypothesis One (H1): Relative advantage

Relative advantage refers to the perceived benefits of a particular innovation in comparison to the existing technology (Wang et al., 2010a). Relative advantage refers back to the degree to which an innovation is perceived as imparting more benefits than its predecessor. These benefits include efficiency, economy, and popularity, as well as the cost of adopting the innovation (Tsai et al., 2010). Relative advantage resulted in accelerated efficiency, monetary gains and enhanced status. Past studies have determined that the relative advantage of han innovation is undoubtedly associated with the cost of adoption, therefore, when the user believes that overall the innovation provides a greater relative advantage than the existing technology, the innovation is usually adopted (Tsai et al., 2010, Wang et al., 2010a). Research suggests that when the user perceives the relative gain or usefulness of a new generation innovation over a vintage one, they tend to adopt it. Therefore; it is hypothesised that when customers perceive enhanced benefits provided with the aid of RFID, they are much more likely to adopt it. It is therefore hypothesised that when customers believe RFID provides a high relative advantage, they will prove far more likely to adopt it.

H1 The relative advantage of an RFID system positively affects the attitude of RFID adoption in construction companies.

3.4.3 Hypothesis Two (H2): Compatibility

The compatibility factor works as an influencer in adopting the DOI concept. Drawn from DOI theory, this factor significantly influences the rate, location and intensity of implementation of an innovation (Lertwongsatien and Wongpinunwatana, 2003, Ching and Ellis, 2004).

Based on previous studies and research, compatibility acts as a hurdle that notably affects the implementation price of innovation. Research has investigated the distribution process of improvements and observed compatibility to be a considerable factor. It is a theory that shows that RFID's compatibility with the work surroundings has a tremendous influence on whether to adopt RFID.

In summary, the compatibility of RFID with the work context greatly influences the likelihood of its adoption (Bradford and Florin, 2003, Tsai et al., 2010).

H2 The high level of RFID's compatibility with an existing organisation's technologies will lead to a positive influence on RFID adoption

3.4.4 Hypothesis Three (H3): Complexity

Complexity is the second most important influencer which becomes tailored for the change of the theory of DOI according to this research. Innovation complexity is taken into consideration and plays a role of hindrance in adjusting to the new brand. A new generation innovation consists of traits of problems in information, and utilisation is complex. Higher complexity can lead to problems around information availability and innovation usage. If it means considerably more time is required to summarise or to perform general functions by the user, that time taken is considered to be composite. Additionally, the time taken to utilise the innovation's interface forms part of the cost of adoption (Shi and Yan, 2016, Harindranath et al., 2008). Furthermore, the time taken to utilise the innovation's interface forms a further cost of adoption (Shi & Yan, 2016; Harindranath et al., 2008). New technologies are more easily adopted when they are simple—or at least simple to interact with (Bradford et al., 2014). In reducing the cost and complexity of adoption, technologies need to have the crucial function of person-friendliness. Complexity is proved to be a key component in the selection for adoption. Thus, it is important to note that during the various phases of RFID, there is an effective effect on the decision to adopt RFID when there is a low degree of complexity. It is hypothesised that the perceived low complexity of RFID will enhance its rate of adoption (Wang et al., 2012, Tsai et al., 2010).

H3 ***The perceived low complexity level in the adoption and use of RFID technology will significantly lead to a positive influence on the adoption process.***

3.4.5 Hypothesis Four (H4): Observability

This is the extent to which the innovation's outcomes can be perceived to be beneficial (Agarwal and Prasad, 1997, Ali and Soar, 2018). Observability of innovation shows the degree to which innovation of a public device is shown to individuals and the positive advantages of low difficulty and transferability. Observability can be separated into two categories: visibility and demonstrability. In regards to RFID, observability is an important frame of analysis because this is a key strength of its design: it can facilitate visibility across regions, reduce delays in observation time, and increase accessibility. Also, observability should be explained because the capacity to have the facility in any region at any time with fewer numbers in queues and delays, seeing the impact of RFID transactions immediately, and transmission of accessibility advantages to others results in the observability of RFID being hypothesised to improve the facility upon its adoption (Low et al., 2011, Chong and Chan, 2012).

The perceived high level of observability in the adoption of RFID technology will significantly lead to a positive influence on the adoption process.

3.4.6 Hypothesis Five (H5): Cost

Cost depends on the efficiency of operational processes. Cost-reducing innovations are typically more easily adopted (Ghobakhloo et al., 2011, Ali and Soar, 2018). The cost-efficiency factor is one aimed at reducing cost—which is one of the capabilities of RFID. RFID adoption can substantially reduce the IS cost within an organisation (Thiesse et al., 2011, Yang and Chen, 2020).

RFID service vendors assert that their offerings can substantially reduce the entire IS budget of a business enterprise, including ongoing expenses, with a preliminary investment. The low pricing cost enhances the opportunity of accomplishing RFID implementation. Cost has been used in many previous studies as a significant factor to investigate the adoption of various technologies (Ghobakhloo et al., 2011, Thiesse et al., 2011). In this context of RFID, the following hypothesis is built:

H5: RFID's perceived capacity to reduce costs, compared to other innovations, will increase its rate and likelihood of adoption.

3.4.7 Hypothesis Six (H6): Privacy

This is a related topic to security issues. Privacy and confidentiality of data are important to organisations, and it is one of the security measures that users put in force to improve their privacy and security and, as a data-handling system, this is, therefore, a key issue in the adoption of RFID (Wang et al., 2010). Furthermore, Wang et al. (2010) claim that several solutions have been proposed worldwide to improve authentication inside the RFID. It is obvious that safety and privacy are nevertheless the primary challenges in RFID—as indicated by Wang et al. (2010). This characteristic is a critical factor in RFID adoption.

RFID systems can improve their privacy by adding security elements such as mutual authentication, key establishment, and data confidentiality in internet data storage (Das et al., 2020, Paquette et al., 2010). In this context, the following hypothesis is built:

H6: RFID technology is more likely to be adopted when it demonstrates increased data privacy than existing technological models.

3.4.8 Hypothesis Seven (H7): Security concerns

Security in the context of RFID refers to the security of data. Extant literature has shown that security concerns impact the adoption of innovations (Nkhoma et al., 2013, Lin and Lin, 2008a). Rieback et al. (2005) recommend a device, known as an "RFID Guardian". The RFID Guardian is a platform that offers centralised RFID protection and privacy control for personnel. It is integrated with four separate safety rules: auditing, green key management, access controls and the ability to act as a mediator among RFID readers and RFID tags such as RFID firewall. In phrases of RFID, protection is the extent to which RFID is taken into consideration as being more secure in comparison to other models (Kaufman and Privacy, 2009). Therefore, it can shield the information of corporations. Concerning security, and based on these studies, it is clear that the safety of services is paramount. This feature takes into account the confidentiality of the company's data. Higher tiers of security are a significant factor in a decision to undertake RFID (Paquette et al., 2010, Subashini et al., 2011). Consequently, in the RFID research framework, the following speculation is hypothesised.

H7 RFID technology is more likely to be adopted when it is more secure than existing technological models.

3.4.9 Hypothesis Eight (H8): Size of organisation

One of the most significant elements associated with IT innovation is the scale of the enterprise; and moreover, the enterprise within the organisation is a key element in the uptake of new IT technology (Hong et al., 2006, Wang et al., 2010a). Some experiential research has established that an effective correlation exists between size and adoption of new era technology in a business enterprise It is proposed that organisations of smaller size are undoubtedly less predisposed and have less flexibility when it comes to adopting new innovations. Others have continually discovered that, due to their extra litheness and capability for risk-taking, larger establishments are more willing to adopt new innovations (Jambekar and Pelc, 2007). Larger firms, by contrast, have more capacity to absorb risk and more resources to devote to technological pivots, making them far more likely and willing to adopt innovations (Zhu et al., 2008). The apparent tactical significance of RFID in modern technological improvement is stricken by the essential issue of the size of the corporation. Firms' size has been investigated in many previous technology adoption studies (Nkhoma et al., 2013, Thiesse et al., 2011). Thus, the following hypothesis is formulated:

H8 Size of firms is positively linked with the intention to adopt and use RFID technology.

3.4.10 Hypothesis Nine (H9): Top management support

Research has shown this to be the mechanism by which organisational culture impacts IT adoption (Jeyaraj et al., 2006). Other studies have shown that a lack of top management support for technology adoption reduces the tendency of organisations to adopt new innovations (El-Kassar et al., 2019, Cresswell and Sheikh, 2013).

A revision of the predictors and biases in IT revealed that guidance through the initial phase is the key to character and organisational ICT innovation adoption. These consequences are consistent with the findings of Low et al. (2011), who determined that establishments have a lesser tendency to undertake new technology without the assistance of top control. In the context of top management support, the leadership of an organisation has a large impact on the adoption of innovative technology within firms and it can guide the effect on the adoption of recent technology innovation (Damanpour and Schneider, 2006). The impact of top management support in the adoption of new technology has been investigated in many previous studies (Nkhoma et al., 2013, Thiesse et al., 2011). In the context of the goal to undertake RFID, the following theory has been advanced:

H9 Firms that have high support from top management are more likely to adopt and use RFID technology.

3.4.11 Hypothesis Ten (H10): Prior similar IT experience

The experience of the workforce of an organisation with IT, along with their ability to work creatively and collaboratively together in their development of systems using IT, increases the organisational likelihood of adopting innovative technology. Furthermore, the prior experience can stimulate creativity by improving the capacity of every team member to create a product and/or via enhancing the capability of the workforce to proportion and integrate personal contributions to create a collective product (Forman and Practice, 2014). By gaining first-hand experience, teams can more readily recognise the mission requirements, analyse their errors and learn how to better coordinate their activities. These factors help teams understand the tasks necessary for successful adoption, and improve their systems in dealing with the technology (Cresswell and Sheikh, 2013). Direct satisfaction with the mission allows individuals to broaden their skills with a transactive reminiscence machine. Further, transactive reminiscence systems switch from one mission to an associated one. Several studies have shown the positive links between prior IT experience and the adoption of new technologies (Low et al., 2011, Eggers and Kaplan, 2013).

H10: A higher level of the employees' prior experience related to RFID technology is positively linked to an increased level of adoption.

3.4.12 Hypothesis Eleven (H11): Government regulation

Governments can encourage or discourage the adoption of new technologies in general, or a specific new technology, through their regulatory frameworks for industry. Regulatory authority hints may also be prescribed because the aid is given via the administration with the motive of encouraging the magnification of organisations (Ali et al., 2020). Innovation potential is the coverage settings that organisations have and cutting-edge legal guidelines and rules may be evaluated at some stage in this procedure. Industries take these regulations, rules and guidelines into account when assessing whether to adopt a new technology (Baldwin et al., 2012). By formulating regulations aimed at shielding agencies in the usage of RFID technology, governments can sell the adoption of RFID. The subsequent speculation associated with this regulation has, therefore, been considered by numerous previous studies in this area (Zhu and Kraemer, 2005b).

H11 In places where regulations are more favourable to RFID technology, the technology will be more rapidly and frequently adopted.

3.4.13 Hypothesis Twelve (H12): External Support

This characteristic is described as the provision of help for imposing and the usage of an information system. For some technologies, external help is available to facilitate firms introducing and using an IS often in the form of technical support (Brown and Russell, 2007). It discusses how external help which includes schooling, customer service, and technical support can be presented through RFID companies and how it can influence growing the RFID services adoption in SMEs. This can lead to an increase in the adoption of RFID (Aboelmaged and Hashem, 2018). Hence, in the environmental context, this research predicts that:

H12 There will be a positive correlation between the availability of external support and the implementation of RFID technology.

3.4.14 Hypothesis Thirteen (H13): Expected Benefit

The decision made by a firm to adopt RFID is crucially connected to that firm's perception of the benefits which may be drawn from the integration of RFID. Studies show the possible financial benefits from RFID in created models and give the impression that this is a significant motive for an enterprise in adopting RFID (Wang et al., 2010a, Reyes et al., 2016). Depending on the firm's needs and current strengths and growth areas, they may regard different elements of RFID as most beneficial and value-specific. Potential benefits can be outlined as: notably lower preliminary expenses, increased standardisation of services and convenience, all of which results in RFID being adopted in a number of sectors (Reyes et al., 2016). Potential benefits may include reduced cost (Saeed et al., 2011), or improved standardisation of service. One other benefit of RFID is that there might be a minimum obligation for the provision of sources and protection after the implementation and the enterprise can concentrate more on its essential business activities (Ustundag et al., 2009). Many studies have regarded anticipated benefit as a key element in understanding the adoption of technological innovation, (Roh et al., 2009, Ramdani et al., 2013).

H13An increases in the anticipated benefits of using RFID are positively related to the intention to adopt RFID technology.

3.5 Summary

The study version and techniques utilised in this research are very unique and the questions, variables and concepts are explained in the hypotheses study. Accordingly, it highlights and provides the information of the study method to be used for building and expanding on the research facts and, ultimately presents solutions to the research aims described in the thesis.

Chapter 4: RESEARCH METHODOLOGY

4.1 Overview

Previously, we discussed the structure of the thesis from publications that contain conceptual and factual studies of the elements, and which indicate the research design relating to the research question. In this chapter, the methods used to gather and evaluate data to answer the hypotheses will be discussed. The chapter is divided into four parts which, respectively, discusses the research philosophies, paradigm, design and, lastly, the methodology.

4.2 Research Philosophy

Research philosophy is linked to the evolution and character of knowledge (Mkansi and Acheampong, 2012, Crossan, 2003, Guba and Lincoln, 1994b). According to (Crossan, 2003, Proctor, 1998, Yadav et al., 2016), a researcher's goal is to promote understanding in a certain area by adopting an analytical approach that is based on discussions. A deep understanding of the knowledge of research acts as a guide in selecting the most suitable method for the research. Easterby-Smith et al. (2012) stated that research philosophy can help researchers be more creative and analytical. Research philosophies help to identify and support the techniques that are to be used (Crossan, 2003). The experience regarding the study will be discussed, along with the evidence needed to be gathered and analysed to provide answers for the research questions (Easterby-Smith, 1997).

4.3 Research Paradigm

Deshpande (1983b) stated that a paradigm is a structure that contains mutually acquired knowledge regarding a topic, research direction and how research should be conducted. A paradigm is a set of theories conveyed by scientists examining the world (Rao et al., 2007, Deshpande, 1983b, Lincoln and Denzin, 2003). It has three aspects: ontology, epistemology and methodology (Rao et al., 2007, Healy and Perry, 2000). All these three aspects are used to explain positivism, realism, critical theory and, lastly, methodology.

Table 4.1: Comparison of different approaches

Item	Positivism	Realism	Critical theory	Constructivism
Ontology	Positivism: a naïve realism which is a reality that is distinguishable	Critical realism which is a reality that is only distinguishable defectively and selectively	Historic realism which is a virtual reality that has been built up over time.	Relativism which is a locally specified reality that is built up.
Epistemology	As a dual objectivist in which the findings are true from one point of view	Modified dual objectivist where the conventional critical findings are true based on 'open window' concept	Transactionally subjectivist in which the findings are revolutionary cognitive.	Acknowledged as subjective findings created by participants.
Methodology	The methods in which positivism is put as a chiefly quantitative method which requires verified thesis, test and investigation.	As the part where the technical issues such as focused interviews are conducted for the research.	The action of the research	The interviews are conducted and require participant monitoring
Causality	Has a cause-effect association	Causal inclinations or generative mechanism	Limited relationship between variables within boundaries	Relationship between variables within boundaries
Sample size	Large	Small	Very small	Very small
Type of data gathered	Replicable, discrete elements, statistical	Gather rich non-statistical data	Sample specific, non-statistical	Sample specific, non-statistical
Type of data analysis	Uses statistic methods that are objective and free of value	Uses triangulation method which is value aware	Uses an established and moderated method which is dependent on value	Uses value-dependent consensus which is revisable.

Source: (Perry et al., 1997, Orlikowski and Baroudi, 1991, Deshpande, 1983a, Ali, 2016)

4.4 Ontology

The study of the status of actuality along with its types and their relationships is called ontology (Corley et al., 2006, Sale et al., 2002). Parkhe (1993) stated that it is a premise created based on features of real-life that clarifies what exists and what does not. Ontology can also be explained as reality's anatomy, status and recognition (Healy and Perry, 2000, Rao et al., 2007, Guba and Lincoln, 1994a). It can be applied to the four paradigms.

First, positivism puts forward the knowledge that reality's character can be recorded through an unbiased study of theories or models; it can also be made general to the public (Healy and Perry, 2000, Guba and Lincoln, 1994a).

Next, realism is the paradigm that sees real life as something distinguishable with flaws (Outhwaite et al., 1983, Guba and Lincoln, 1994a). Realism also states that the world should be liberated, and science's primary duty is to look for the world's factual knowledge and this knowledge needs to be critically examined. According to Hunt (1991), the knowledge should be inspected to test its stability as a symbol of the world.

Third, critical theory proposes that reality's character is created internally as time passes. It is the paradigm that has an impact from a variety of aspects and it happens inside a person's mind. This paradigm is what assists reality's alteration—which has a fresh social and intellectual form. Critical theory is also known as virtual reality (Perry et al., 1997, Guba and Lincoln, 1994a).

Lastly, constructivism states that reality's attributes are expected to be in the form of numerous internal cognitive formations either all at once or based on experience (Guba and Lincoln, 1994a). Those attributes are dependent on their formations and the individual and group elements assisting the establishment (Healy and Perry, 2000, Guba and Lincoln, 1994a). Healy and Perry (2000) also state that constructivism's character can be modified when the assembler becomes well-informed.

4.5 Epistemology

Epistemology talks about the significance of knowledge, how to gain it and to what extent is it relevant to every subject (Krauss, 2005, Cousins and Management, 2002). It also explains how one can learn about a particular area of study (Krauss, 2005, Shah and Corley, 2006). As mentioned by (Perry Jr, 1999, Guba and Lincoln, 1994a), the connection between the learner and the knowledge is epistemology. It is also applicable to the four paradigms which are positivism, realism, critical theory and constructivism.

Positivism expresses researchers and real-life to be ‘dualist and objectivist’ (Healy and Perry, 2000, Guba and Lincoln, 1994a). It shows that researchers will not be influenced by emerging discoveries in their field. The result is expected to be an actual depiction of reality which can be explained with an open mind (Hunt, 1991, Parkhe, 1993).

Second, realism expresses researchers and reality’s connection as an adjustable ‘dualist and objectivist’ (Perry et al., 1997). It uses unbiased techniques to seek discoveries that aim to contribute towards a clearer picture of real life. The researcher can also contribute in the field as a spectator (Godfrey and Hill, 1995, Carson et al., 1996).

Next, critical theory suggests that researchers’ and reality’s relationship should be biased. The purpose of the research and the research itself is linked to the researcher’s concept which affects the investigation (Guba and Lincoln, 1994b). It is also mentioned that the understanding is based on social and ancient practices, even though the premises were biased and the results were based on value (Riege and Nair, 1996, Guba and Lincoln, 1994b) interpret researchers as ‘transformative intellectuals’.

Fourth, constructivism is biased where there is a notion that the purpose of research and researcher are synergetically linked so that the outcome emerges in the learning process (Stokes and Perry, 2007). Constructivism puts the gaps of ontology and epistemology together to demonstrate how a researcher becomes a participant in critical theory (Guba and Lincoln, 1994a).

4.6 Research Methodology

A methodology is the structured and conceptual assessment of the techniques used in research (Venkatesh et al., 2013, Johnson et al., 2007). It is the steps followed to develop the research (Perry Jr, 1999). The methodology used in every research varies, depending on the significance or the value, or both (Johnson et al., 2007). Quantitative is for exploring theories instead of creating them (Parkhe, 1993). Quantitative methodology is mainly used for commerce-related research (Hanson and Grimmer, 2005). It is an applied methodology since in surveys organised questions are posed. There normally are a great number of participants to gain a generalised and significant result (Munhall and Chenail, 2008). This methodology is also known as the 'data analysis technique', which is what surveys are called, or data accumulation strategy, which are statistics or graphs that are used to manifest an already existent theory (Patton, 1987).

Given the above, the targeted relevant body in this study will consist of between 20 to 25 SME construction companies in Australia; and an RFID provider will apply the irregular (probability) tests system which the example decided to choose in light of the areas which include cities, rural areas and SMEs in towns in Australia with labourers who work in SME construction companies Mertens (2014). It involves an explanatory design, beginning with an analysis of quantitative data and then applying a quantitative approach to develop greater insight. Confirmatory factor analysis (Greenhalgh et al., 2004a) and structural equation modelling (Gündüz et al. 2013) can be used to determine the relationship between all variables in the quantitative stage. For the second objective, a quantitative study using a survey that includes RFID providers and IT staff in SCC (phase two), will be used to test the measurement model and the structural model of the conceptual framework. The adoption of this approach is not new: IS researchers have used this approach for similar purposes (Irma Becerra-Fernandez, 2001); (Ho et al., 2003) (Grimsley and Meehan, 2007). In the following sections, the unit of analysis and sampling technique constructs measures, data collection methods, and data analysis tools will be described.

4.7 Research Design

Research design lays out a structure that helps researchers sum up their research (Cooper and Emory, 1995). It acts as a means for data gathering, evaluating and clarifying (Zikmund et al., 2013, Loo and Thorpe, 2002).

This research examines the possibility of gaining value from using RFID in SMEs. Writings about this adoption of RFID technology in construction companies seem to be somewhat limited and the matters in this research are not discussed in detail. The method used in this research is a quantitative methodology. The design in this research has four aspects to it which are: methods of gathering data, evaluating the unit, selecting sample size, and contacting the ones being interviewed via a survey.

4.8 Research Data Collection Stages

Data quality is associated with the data-gathering technique. Primary and secondary data gathering techniques are the two main methods of gathering data. Hox and Boeije (2005) purported that the two most common methods for gathering primary data are interviews and surveys; while the literature, such as journals or books, are normally used to gather secondary data.

Data collection can entail "unstructured or semi-structured observations and interviews, documents, and visual materials, as well as establishing the protocol for recording information" (Creswell, 2014b). The selection of a method type can be considered by posing the following questions (Kumar and Sivalingam, 2010):

What is the underlying viewpoint guiding this investigation?

Was the data collection rigid or did the structure allow for flexibility?

Were the answers provided narratively or more systematically through charts or structured questions?

What was the method of analysis? Did it entail statistics, categories or description?

Questionnaires have been chosen due to their ability to obtain answers from closed and structured questions, allowing for quantitative patterns in the data (Duan et al., 2011). This study will focus on using a quantitative method approach to trialled standardised surveys.

4.9 Quantitative Data Collection Method

In order to reduce bias from the practitioner and acquire an objective benchmark (Cavana et al., 2001), the survey will be selected as the data collection method of this research. In the survey, the collection of data can be conducted through different techniques such as face-to-face surveys, mailed surveys, and online surveys. All of these types of data collection techniques are different and no superiority lies in any one technique. Consequently, the technique is selected according to the research type. Conversely, the wrong selection of survey can lead to unanswered research questions (Cavana et al., 2001).

Online surveys are simple tools to use, are easy to complete and analyse, and are cost-effective (Zikmund et al., 2013). These days, with simple access to online survey development firms, online surveys are directly placed in the database, and afterwards arranged and examined in a composed, coordinated way that enormously decreases costs (Frankfort-Nachmias and Nachmias, 2007). In this research, all IT staff at SMEs, ACC and staff at RFID providers have email addresses; and all of them are connected to the Internet. Due to the low cost of conveying e-mails and the effortlessness of doing so with online survey tools, the researcher can increase the response toward the survey by sending email-based reminders. Based on that, online surveys will be selected as the best technique for the data collection in this research.

A pre-test is carried out considering one site to examine all the processes and instruments in order to recognise the required improvement in the research survey (Wholey, 2004). This identification of necessary improvements is possible only by conducting the pre-test (Waters and Psychologist, 2011). In this research, the pre-test will be organised through USQ academic staff, and a PhD candidate majoring in IT. This is in line with the recommendations of Saunders et al. (2009) that obtaining expert advice enhances the validity of the survey and helps in making required changes before the actual survey.

An important step for improving the effectiveness of the survey is to conduct a pilot study (Shaughnessy et al., 2012). A pilot study includes actually running the survey with a similar sample of respondents, under the same conditions as those anticipated in the final running of the survey (Shaughnessy et al., 2012). Running a pilot study before the final one is the best way to explore and identify issues and improve the design of the research survey (Waters and Psychologist, 2011). It is very important to conduct a pilot study for testing the survey questions. The weaknesses in the survey and its techniques can be explored and identified by the use of a survey pilot study (Kothari, 2008).

4.10 Literature Review (Preparation Stage)

To assess the first step, it is important to explain the issue of the research, create a hypothesis, and select the methods. This holds up the recognition of hypothesis regarding IT/IS research application and aiding the initial conceptual structure design. In this stage, more publications such as journal articles, conference papers, books or government reports were considered to gain a deeper insight into the research problem (Walsham, 2006).

The goal of this research is to analyse the use of RFID in SME construction companies and to identify the elements that are likely affecting all Australian SME construction companies in their adoption of RFID. No results were found regarding the usage of RFID in Australian SMEs during the literature review that was carried out in Chapter 2. The development of conceptual structure, and also differences in literature, are led by this research.

In order to gain precise and complete data, a computerised search is needed (Golder et al., 2014, Brettle and Long, 2001); and the research used an accepted way of searching the literature review. The strategy has five steps. First, selecting keywords relating to the topic (Higgins et al., 2011). Second, top-level data quality relies on search planning of all the databases in which each plan needs to have at least two electronic databases to increase responsiveness—and a manual search of the references should also be undertaken (Shea et al., 2007). Third, in order to acquire top-level information, all available methods are used to manage the results so it is in line with what is required (Golder et al., 2014, Ali et al., 2012). Fourth, inspect the articles' abstract and title (Pucher et al., 2013, Golder et al., 2014). Lastly, investigate whole articles to acquire top-level information (Pucher et al., 2013, Ali, 2012). Each of these stages is explained in detail next.

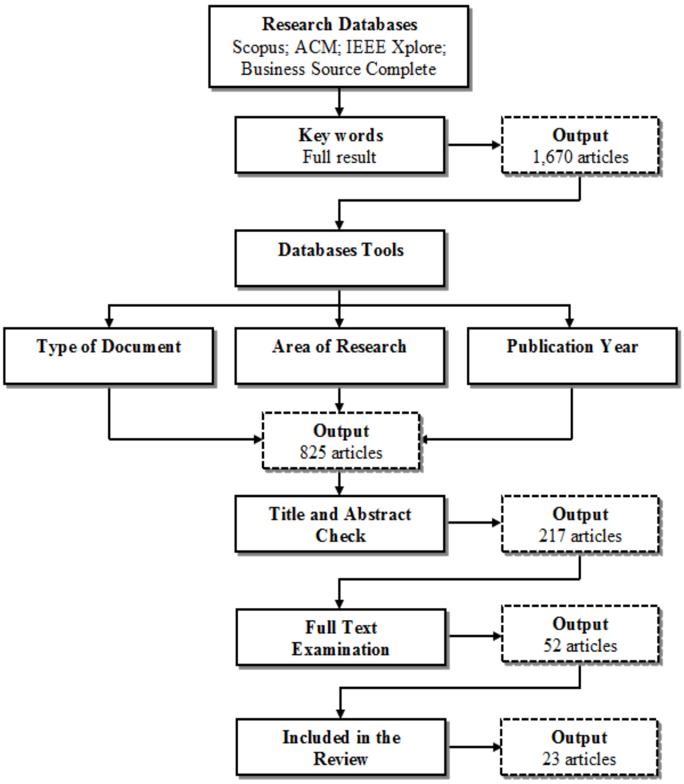


Figure 4.1; Preparation stage of Literature Review

From August 2, 2016, to April 26, 2017, a computerised article search was conducted for this research. Five approaches were used. First, selecting keywords that relate to the topic. AND, OR, NOT and * should be utilised in Web of Science search (Higgins et al., 2011, Golder et al., 2014). Examples of keywords used are “challenges and issues” AND “adoption level” OR “factors affecting” and improve OR performance. The keywords can either be researched individually, or combined with others.

In the second, databases that were used were Business Source Complete, ACM Digital Library, Scopus, IEEE Xplore Digital Library and government websites. The operation started with electronic sources: in this case databases that provided a large number of research papers regarding RFID technology and its acquisition.

The area of research needs to be restricted to the primary topic to show the databases used in the search. Minor changes in the keywords result in a group of sources that were filtered through the search option.

For the third strategy, database tools were used to minimise the number of articles according to their publication year, area of research and the variety of documents.

In the fourth strategy, other articles were taken out after screening the titles and abstracts according to their relationship to the research question.

The articles were examined carefully in the fifth strategy through an in-depth study of the contents and those that contained data suitable for the research were selected.

4.11 Online Survey (Confirmation stage)

To gather data for the next stage of the research, a survey was carried out. Zikmund et al. (2013) stated that surveys give systematic and somewhat accurate information which involves collecting data from a group of people to categorise their responses (Mackenzie and Knipe, 2006, De Villiers, 2005). Robson (2002) mentioned that participants' characteristics, understanding, and motivation have an impact on the survey.

According to Zikmund et al. (2013), a survey is a compliant tool. Surveys can be done in various ways, either through an email attachment, an emailed survey URL, a site in a browser (Jankowicz, 2005, Evans and Mathur, 2005) or using an online survey in which researchers give participants the time to complete the survey. Surveys are also more private and comfortable since it is done individually (Evans and Mathur, 2005).

4.12 Survey data collection technique

Surveys were the chosen technique since they are more unbiased and the preparation of the implementation affects data collection (Cavana et al., 2001). Surveys can be done in person, through email or online. Depending on the type of research, and even though all three methods are non-identical, they are all equal. Selecting the wrong technique can result in unresolved questions.

Online surveys are straightforward, effortless and more affordable (Evans and Mathur, 2005, Zikmund et al., 2013) and because of that can be entered into the database to be evaluated in an organised way that reduces cost (Frankfort-Nachmias and Nachmias, 2007). All the IT employees at SME construction companies in Australia have emails that are linked to the internet, meaning that an online survey was the best choice for this research. To minimise cost, the researcher gains more responses by reminding staff via email to participate in the survey.

4.13 Survey population

Hair et al. (2006a) and Sarantakos (1998) said that a population's features should be reflected by a quantitative research illustration in which the results are applicable to the entire population. The more symbolic the samples are, the better the research standard is since it becomes more generalised. One of the techniques used to gain generalisation is probability testing (Zikmund et al., 2013), which is the accommodation between the time taken to do research and the precision of the results. With a larger sample size, there will also be fewer mistakes (Sarantakos, 1998).

The decision-makers in SMEs in all states are the ones who mainly provide services to their companies and they are all reliant on technology to provide the services to their companies (LGAQ, 2013). These decision-makers and their IT departments are the main focus of the research since they are the targeted group of people.

4.13.1 The Unit of Analysis

Gronn (2002) mentioned that unit of analysis is one of the most crucial factors in research since it is the subject of the research. For this research, the unit of analysis is the IT employees and anyone related to the IT department, since they are the experts who know how to use IT in SME construction companies.

4.13.2 Survey development process

This issue talks about the evolution and creation of the survey. The goal is to create a survey with contents relating to the aim of the research. The contents and layout were carefully selected and then testing was conducted to analyse the quality of the collected information.

According to Shaughnessy et al. (2012), this research is reliant on the model that is constructed and the functional illustration is used to explain it. An analytical procedure is where questions regarding research goals are represented by a point called operationalisation (Cohen and Hersh, 2005).

Constructs that were already approved from the preceding studies were used to create the survey. To improve the construct's calculation, each item will be considered and then operationalised. All the measures of the constructs are based on publications related to the matter. All research construct questions come from information gathered through previous studies. The measurements utilised come from high-ranking and approved papers that have been reviewed.

The constructs are also engaged using approved objects from preceding studies. The measurements and sources of the constructs are shown in Table 4.2.

Table 4.2: Constructs measures, their source and subject field

Constructs	Sources	Subject field
Relative advantage	Beatty et al. (2001)	Information Systems
Compatibility	Cooper and Zmud (1990)	IS
Complexity	Thompson et al. (1991)	IS
Observability	Cooper and Zmud (1990)	IS
Cost	Premkumar and Roberts (1999)	IS
Security concern	Soliman and Janz (2004)	IS
Privacy	Soliman and Janz (2004)	IS
Top management support	Premkumar and Roberts (1999)	IS
Firm size	Premkumar and Roberts (1999)	IS
Prior similar IT experience	Kuan and Chau (2001)	IS
Government regulation	Kuan and Chau (2001)	IS
External support	Chau and Tam (1997)	IS
Anticipated benefits	Beatty et al. (2001)	IS
RFID adoption	Beatty et al. (2001)	IS

Greater survey responses can be obtained from the participants' data sheet that (Sarantakos, 1998) used to talk about the topic and motivate respondents. Participants' data sheets contain security statements and an assurance that the collected information is used only for research. To make it more legitimate, the researcher's contacts were also provided.

The interface is always the problem with online surveys. It has to be easy to operate and have an interface that would motivate participants to complete the survey. Internet data gathering can be assisted by software or survey host websites (Zikmund et al., 2013).

USQ's Sustainable Business Management and Improvement (SBMI) team assisted in creating the survey interface to avoid any potential problems. SBMI is a group of expert developers, programmers and survey interface designers. To help with the data gathering and to ensure it is safe, USQ Custom Survey System was used.

The survey's opening and ending sections need to be contemplated to gain more reactions (De Leeuw et al., 2008). Understandable and neutral titles were used to attract respondents, along with the use of a simple logo.

To ensure that a survey has a high level of response, it is important to pose specific questions. The survey's growth needs specific organising, analysing and fixing. Researchers also need to contemplate how long the survey is; and check the conclusion's clarity, since extended surveys tend to have the worst response rate (Fayers et al., 2005).

In a survey, the researcher should avoid identical questions, using scientific terms, questions that are long and not simplified enough, and make sure all the outcomes are presumably justifiable and in line with the underlying principle when it comes to multiple choices (De Vaus, 2002). Adopting these guidelines help to create questions that are basic and clear (Churchill and Iacobucci, 2009). Close-ended queries were utilised in this research (Zikmund et al., 2013). Foddy and Foddy (1994) argued that these questions have advantages such as generating fast answers which are easily evaluated, not discriminating against respondents who are not open and providing recognitive tasks based on memories.

4.13.3 Measurement scale development

The Likert scale is a popular scale used for IS studies (Bhattacherjee, 2012). It is a psychometric scale to rate statements based on participants' consensus or dispute. It typically uses a five or seven-point scale (Cavana et al., 2001, Premkumar and Roberts, 1999) and is one suggested by numerous researchers (Misra et al., 2011, Premkumar and Roberts, 1999). In this research, a five-point scale was used to obtain more precise data (Lian et al., 2014, Finstad, 2010); and it is more equitable since its responses are sufficient for the purposes of the research (Sauro and Lewis, 2011).

The scale ranged from 1 for "Highly Likely" to 5 for "Slightly Important". This response scale provides a wider variety of results and increases alternatives for the researcher's analytical evaluation (Zhu and Kraemer, 2005b, Misra et al., 2011, Pallant, 2007).

4.14 Preparing the instrument

The survey comprised questions regarding the results from the investigative level which impact the SME construction companies in Australia using RFID.

Underlying data of the respondents were gathered in the survey's first section. It asked for their population and character data. This section is divided into four. The first one is the role of the respondents in IT, which was grouped based on different classes. The second one is their understanding of RFID, which was grouped into five levels. The last one is their years of practice in dealing with RFID, which was classified into six groups. The participants' data items are listed in Table 4.3.

Table 4.3: Participants background items

Respondents' demographics characteristics
Item
How would you describe your Information Technology/ System (IT) role in your company?
How many years of experience do you have in IT? ?
How many years of experience do you have in the construction industry?
How many years of experience do you have in RFID technology?

In the second section, data from respondents in SME construction companies were gathered and the organisation's population character was identified. This section contains five items. The first is about the size of the company and their staff, which was grouped into four groups. The next item is about what type of construction the company is mainly engaged in which was differentiated into Building, which includes houses, schools and building structures, Road construction maintenance, Bridges building services and ‘other’. The third item seeks to determine how frequently site materials are delivered to work locations on time and was divided into five groups.

The fourth item asks what computer systems/applications does the company use during time work, and incorporates seven items. The next item concerns the type of communication system the company uses during the delivery process of site materials, where respondents can also choose multiple types presented in the question. Table 4.4 shows questions about participants’ company information.

Table 4.4: Information about participants’ company items

Firms’ demographics characteristics
Item
What is the size of your company in terms of total number of staff?
What type of construction is your company mainly engaged in?
Which of the following computer systems/applications does your company use? (tick all that apply)
In your company, how frequently are site materials delivered to work locations on time?
What communication system does your company use during the delivery process of site materials? (Tick all that apply)

The goal of the third section is to evaluate the most crucial elements needed for RFID adoption and this corresponds to the first objective. Responses were evaluated using a five-point Likert scale which spans from “Highly likely” to “Slightly Important”. There were 13 elements evaluated, as shown in Table 4.5.

Table 4.5: Factors adopted from previous studies phase

Factors to be considered for RFID adoption performance	
Code	Item
Factor 1	Improved inventory control
Factor 2	Improved efficiency of store operation
Factor 3	Data accuracy
Factor 4	Tag cost at item level
Factor 5	System automation
Factor 6	Security
Factor 7	Data back-up
Factor 8	Business activity monitoring
Factor 9	Provider dependability
Factor 10	Data backup
Factor 11	Provider dependability
Factor 12	Transportability
Factor 13	Improved connection with suppliers

Section four seeks to establish the threats and problems that will probably be faced when using RFID adoption on company performance—and it responds to the second objective. Again, a five-point Likert scale is used with the same range as detailed above. There were 10 threats and problems evaluated, as shown in Table 4.6.

Table 4.6: Challenges and issues adopted from previous studies phase

Challenges and Issues	
Code	Item
Challenges and risks 1	Effective network
Challenges and risks 2	Data storage location
Challenges and risks 3	Cost
Challenges and risks 4	Loss of control over data application
Challenges and risks 5	Privacy
Challenges and risks 6	Trust
Challenges and risks 7	Integration
Challenges and risks 8	Policy maker
Challenges and risks 9	Lack of real understanding of cloud
Challenges and risks 10	Business transformation

Construct items in the research prototype are provided in section five and it clearly responds to the fourth, fifth and sixth objectives.

4.15 Pretesting of the survey instrument

A pre-test was used to evaluate the procedures and tools during the process to see what survey changes needed to be made (Wholey, 2004); and these required changes can only be known by executing a pre-test (Waters and Psychologist, 2011).

The USQ academic personnel, IT PhD candidates and several USQ IT employees were the ones who dealt with the pre-test. It was done in accordance with the statement made by Saunders et al. (2009) stating that obtaining guidance from professionals makes the survey more legitimate and assists in making any necessary changes before the final run. There were 50 people who were asked to provide feedback about the survey. Emond et al. (2005) suggested that respondents be asked to comment on the survey's problems, its duration, the clarity of instructions and questions and, lastly, if they have any feedback.

Pre-test results assisted in identifying the problems regarding the survey. Changes made to the survey included the rephrasing of some questions. Some feedback advised the survey to be shorter and more captivating. The pre-test results contributed to the need of having a majority of questions that are close-ended. It took approximately 8-12 minutes for the survey to be completed.

4.16 Pilot study of the survey instrument

A pilot study is an essential step to increase the survey's success and it involves conducting a survey to an identical group of people (Shaughnessy et al., 2012). It is the most effective way to study and determine the problems of the survey, as well as improving its layout (Waters, 2011). Kothari (2008) also stated that this is a significant way to test surveys by exploring and identifying their fragility and methods. Through this, the authenticity and accuracy of a survey are increased (Cohen and Hersh, 2005). This study ensured that the instructions and questions were understandable and assured the possible setting of the process (Cozby and Bates, 2001).

A pilot study for this research can improve the precision of the survey tool and alert the researcher to any potential problems before the survey is distributed. The population used in this study are similar to that of the one in the final survey, who are the IT staff of SME construction companies in Australia. In this case, the participants were 30 IT managers of Australian SME construction companies.

4.16.1 Pilot Study Sample

Researchers are still struggling to settle on the correct sample size since the exact size depends on the population and environment of the research (Cohen and Hersh, 2005). Hunt et al. (Tornatzky and Klein) suggest a population size of 12-30 for a pilot study. In this study, 19 out of 21 surveys were submitted, resulting in a 90% response rate.

4.16.2 Pilot Study Demographic Analysis

Table 4.7 illustrates the pilot study demographic analysis.

Variable	Valid	Frequency	Percent
Describe role of IT in your company.	Management	12	63.15%
	Systems development/ Analyst/ Programmer	5	26.31%
	Operations/ Systems administrator/User support	2	10.52%
	Other	0	0.00%
Years' experience of IT.	No experience	0	0.00%
	Less than 2 year	0	0.00%
	Between 2 and 5 years	2	10.52%
	Between 5 and 10 years	6	31.57%
	Between 10 and 15 years	2	10.52%
	More than 15 years	9	47.36%
Years' experience of construction industry.	No experience	0	0.00%
	Less than 2 year	0	00.00%
	Between 2 and 5 years	4	21.00%
	Between 5 and 10 years	2	10.52%
	Between 10 and 15 years	10	52.63%
	More than 15 years	3	15.78%
Years' of RFID experience	No experience	0	0.00%
	Less than 2 year	1	5.26%
	Between 2 and 5 years	5	26.31%
	Between 5 and 10 years	7	36.84%
	Between 10 and 15 years	4	21.00%
	More than 15 years	2	10.00%

From Table 4.7, it can be seen that 63.15% of the respondents were IT managers, 26.31% of them were system developers/analysts/programmers, and

10.42% of the respondents were systems administrators. About half of them (47.36%) had more than 15 years of experience in IT and 52.63% have many years of construction industry experience. Of the respondents, 21.00% have between 2 to 5 years of company experience; and none of the respondents had any understanding about it. Furthermore, 36.48% of those respondents have 5-10 years of RFID experience, 26.31% of them have 2-5 years and the rest 21.00% of them have 10-15 years.

4.16.3 Pilot Study Reliability Results

A measurement's dependability is specified by its stability (Shaughnessy et al., 2012) which is often examined by the test-retest stability method and through the build-up of indistinguishable objects on a measure the validity can be increased. Items that are not stable enough will then be removed. According to (Cozby and Bates, 2001), Cronbach's alpha is widely used as a stability pointer because it supplies the standard of practical split-half stability co-efficient and it is used to examine research tools' stability (Field et al., 2009). A tool is acceptable according to Cronbach's alpha if its value is in the 0.7 to 0.8 range (Stafford and Turan, 2011, Field, 2009, Helms et al., 2006)— 0.9 and above, being the highest value, is excellent; and 0.5 and lower, being the lowest, is unacceptable. The Alpha Cronbach values for survey instruments are shown in Table 4.8.

Table 4.8: Reliability coefficients of the scale items (Cronbach Alpha)

Constructs	Alpha Cronbach Stage One	No. of items	Alpha Cronbach Stage Two	No. of items
Relative advantage	0.752	6 items	0.806	4 items
Compatibility	0.618	12 items	0.712	12 items
Complexity	0.589	7 items	0.689	5 items
Observability	0.906	6 items	0.923	5 items
Cost	0.922	5 items	0.906	4 items
Privacy	0.568	9 items	0.687	7 items
Security concern	0.698	6 items	0.760	5 items
Top management support	0.848	7 items	0.848	7 items
Firm size	0.725	4 items	0.725	4 items
Prior similar IT experience	0.912	6 items	0.912	5 items
Government regulation	0.783	5 items	0.842	4 items
External support	0.567	13 items	0.638	12 items
Anticipated benefit	0.832	9 items	0.832	7 items
RFID adoption	0.915	9 items	0.915	9 items
Total	######	104 items	######	90 items

4.17 Validity and reliability of the quantitative stage

Data gathering from various sources is among the main purposes of this research. Legitimacy and accuracy of the information are checked because it is the underlying concept to determine its standard (Lancaster, 2005, Cozby and Bates, 2001).

4.17.1 Internal Validity

Exploratory design framework and research methods are established in order to examine the cause and effect of factual confirmations (Cohen and Hersh, 2005). Bhattacherjee (2012) stated that authentication is the apparatus of what shall be considered in the method of research. Research's character is what influences the authenticity since there are not any validity scales, so in this case validation from the respondents will be valid enough.

Experts' input should be prioritised since they have a great understanding of the subject being studied (Hair et al., 2006b). Bryman (2004) mentioned that a great number of researchers have indicated how important ideas are in examining data. Content authentication is done by reviewing the literature that has been selected in the development of the survey. Measurement tools are limited to those that have been used in preceding research and were created to fit the research requirements, pre-tests and seminars.

A professional in the field of IS and RFID was chosen to do a trial run of the survey. To ensure that it is strongly valid, IS/IT PhD candidates were also chosen. A total of 44 people completed the survey; 25 of them were academics and included the research team's supervisor. Furthermore, 19 of the participants were IT experts, several were from SME construction companies from different areas in Australia, and 13 of them held a PhD. A total of 31 of those participants returned the data, along with feedback. A meeting was conducted involving IT experts and USQ academic personnel who examined the survey questions. This meeting aimed to elicit academics' and employees' points of view. An open group discussion was held, which resulted in an effective summary of the survey instrument and content authentication.

4.17.2 External Validity

This issue concerns evaluating the outcomes according to generalisations and to establish if there are other likely appointments (Golafshani, 2003, Ghauri and Grønhaug, 2005). The absence of this leads to an analytical disadvantage in IS/IT research. Just like previous studies by (Lee, 2004, Grandon et al., 2004) and Lee (2004), this research does not have any assertion on considering external authentication.

4.18 Reliability

Compatible responses are the focus of reliability and the fixed results shall be essentially repetitive (Field et al., 2009, Gill and Johnson, 2002). The outcomes should be compatible and precise based on reliability: if it is then the respondents are considered as dependable. Instruments are considered to be stable if research results are consistent after multiple testings and the reliability is the precise results for the population (Golafshani, 2003).

Every item was evaluated rigorously in this research. The reliability test was conducted during the pilot study to predict the inner stability of the measurement which was evaluated by Cronbach's alpha. To show the reliability of the inner stability, IBM SPSS Statistics 22 was used to calculate Cronbach's alpha (Conner and Norman, 2015). According to researchers (Stafford and Turan, 2011, Helms et al., 2006) 0.7 is a tolerated value; and to improve the co-efficiency, several items were taken away. Table 4.8 shows the details of Alpha Cronbach.

4.19 Survey administration and data collection

Online surveys were selected for this research due to the participants' ease of accessing the internet. An online provider was used to provide the link from February 15, 2019, to October 18, 2019, so that it could be accessed at any time. Participants were given the link to the survey and their IPs to avoid multiple completions. All SME construction companies in Australia were asked to send the link to their employees.

The survey was sent out through USQ's Custom Survey System. IT managers and staff of 342 small and medium Australian construction companies completed the survey, resulting in a 90% response rate. Moreover, 308 companies fully responded to the survey and 34 companies did not respond. Of this number, 7 stated that they could not do it since they were under company regulations not to provide any data; 19 did not participate since there were not any IT employees, and the remaining 8 did not respond at all. The details are listed in Table 4.9.

Table 4.9: Survey details

Survey Details		
Survey participant	No. of Companies	Percent
Survey received	308 companies	90%
Survey not replied	34 companies	10%
Total	342 companies	100%
Not Respondents Companies Details		
No. of companies	Percent	Reasons
7 Companies	2%	Because of government regulations
19 Companies	5%	Because their IT were outsourcing
8 Companies	2%	Because they did not reply to the survey

4.20 Quantitative data analysis techniques

Using smart and authentic systems to manage the collected data is also known as data analysis. Presenting an illustrative statistic is the first step in quantitative data analysis which shows population statistics to gain the background of participants. The next step is to assess the authenticity and stability of the instrument, which hopefully has a high level of response since it is aided by LGAQ. The data will then be analysed through SEM.

SEM is meant to simultaneously work with a variety of linked equations which gives different approving conditions and presents a structure for linear modelling. Extensive adjustments of the identification of equations are allowed by SEM and the development of it as a statistic system coexisted with the evolution of suggestive visual language (McArdle et al., 1984). Complicated links can be displayed to those not familiar with SEM with the help of these languages.

4.21 Ethical Considerations

A researcher must follow particular ethics and qualities in their area and research will only be approved if it follows all ethical qualities (Cooper and Emory, 1995, Cavana et al., 2001). Participants' dignity and security shall be maintained along with those who might be affected by the research. Privacy violation such as the display of a participant's data is also considered an ethical inference because it makes them feel violated by the research. Participants shall also not be pressured to respond to the research since that is ethically unacceptable (Patton, 2002, Lincoln, 2005).

Ethical standards on carrying out research that involves people are stated in the National Statement on Ethical Conduct in Human Research (2007) for Australians. It provides a complete mechanism so that ethical problems are avoided whether during or after the research. Australian institutions are required by law to ethically review the process for research that involves people. All research that includes people needs consent from the Human Research Ethics Committees (HREC), which is a legal requirement. The committees make sure that laws regarding participant confidentiality in research are followed in research proposals.

To avoid possible ethical problems, HREC provides a comprehensive guide for all researchers. In our research, ethical obligations were followed, along with the HREC guidelines at USQ. Ethics rules are applied to every document. HREC then provides feedback on the issuing of consent forms and participation data sheets after they review the applications. They also give feedback regarding the pilot study, location of stored information and audio recordings which may be part of the research method. The researchers need to make changes based on HREC's feedback to gain their approval. HREC will review the changes made, and the research subsequently approved with the approval number H14REA079.

After being approved by USQ's HREC, invitations and participant datasheets for the research were distributed to the 308 SME Australian construction companies with the purpose of outlining the details and aims of this research. Participation in the survey is optional and participants can opt-out at any time. If they have any queries, they need to contact the researchers and supervisors (Patton, 2002, Lincoln and Guba, 1985). Data gathering, evaluation and issues are all included in the research stages (Burton, 2000). Participants will be provided with a consent form to give their consent and intention of participating. Before starting the research and gathering the data, the consent form needs to be completed. The participants were allowed to read about the research before participating and they were also informed about surveys being a part of this research.

4.22 Summary

The methodology used to collect and evaluate data to solve the research problem was discussed in this chapter. It is split into four parts: first, it explains the research philosophy, and the second part discussed the research approach. The third section talks about the research design and, lastly, an explanation is provided about the gathering of data and its evaluation.

CHAPTER FIVE: QUANTITATIVE DATA ANALYSIS

5.1 Overview

The previous chapter provided an overview of the methodology adopted in this research study, as well as describing the development of the research proposed model and hypothesis. This chapter outlines the results of the quantitative data analysis. The chapter commences by presenting an overview in section 4.1; then, it presents data analysis techniques including preparing data for analysis, descriptive data analysis, and measurement scale validation in section 4.2. Section 4.3 explains the measurement development of the research proposed model in relation to Confirmatory Factor Analysis (CFA) and validity and reliability statistical techniques. This is followed by Structural Equation Modelling (Gündüz et al., 2013) testing; section 4.4 examines the hypotheses results; section 5.5 assesses the relationships; and, finally, a chapter summary is provided in section 5.6.

5.2 Data analysis

The data set obtained from the survey is used in subsequent analyses and was implemented in two stages using SPSS 25 and AMOS version 25. In the first stage, the data set served the purpose of data management and data cleaning using SPSS. Then, descriptive statistics were used for all the questionnaire content. For the second stage, the data set from the first stage was analysed via AMOS, applying CFA and SEM. CFA, using one of the multivariate analysis packages, was utilised to test how well the measurement items represented the constructs. It was also used to ensure that the measurement items (questions) were valid and reliable (unidimensional) for the constructs (Li and Leal, 2008, Lin et al., 2011b, Lin et al., 2011a, Li, 2008a). SEM was used in terms of finding the most appropriate observed variables (measurement items) pertaining to each latent variable (i.e. measurement dimensions), as well as testing the relationship between exogenous variables (independent variables) and endogenous variables (dependent variables) and testing the hypotheses. Each of the methodological techniques is explained below:

5.2.1 Data preparation technique

Before carrying out any statistical analysis, a preparation stage was applied after collecting the questionnaire data from participants, and prior to the data that is collected being properly examined (Field, 2013, Elliott et al., 2006). This is a crucial step in identifying data entry errors and missing data (Hair et al., 2006c, Field, 2009, Tabashnick and Fidell, 2007).

Pallant (2013) stated that preparing data has a direct effect on the analysis results because errors in data and missing data can have a harmful effect on the statistical analysis and lead to incorrect findings. Hence, data editing, coding, entry into a database, data cleaning, and data screening to find any missing responses are the main steps in data preparation to ensure the accuracy and validity of the data analysis (Fink, 2015, Leavy, 2017b, Saunders et al., 2011a, Phakiti, 2015, Bazeley, 2013). Accordingly, this study adopted a series of steps to conduct the data preparation, including the following:

- Checking raw data to ensure it is accurately arranged, uniformly entered and complete (Wilson, 2014, Saunders et al., 2016)
- Ensuring data accuracy and quality before data entry into SPSS includes, for instance, looking for illegitimate codes, illogical relations and checking the basics in filter questions (Saunders et al., 2016, Tharenou et al., 2007)
- Numbering the responses and checking their validity based on participant eligibility, amount of missing data, and the way that the questions were answered (Phakiti, 2010, Watkins and Gioia, 2015, Bernard and Bernard, 2013).
- Coding data to classify data into a limited number of categories (Creswell, 2014a, Zikmund et al., 2013, Malhotra et al., 2006).
- The numerical data collected were entered into the computer by converting a Microsoft Excel spreadsheet to SPSS software.

5.3 Descriptive Data Analysis

Descriptive statistics is a critical base for any quantitative data analysis in terms of describing and summarising the data (O'Dwyer and Bernauer, 2013, Leavy, 2017a). It is an initial test conducted on numerical data to examine data properties, analysis techniques, and to obtain sample description and data (Tharenou et al., 2007). In this study, descriptive statistics were utilised to describe the demographic characteristics of the study sample (Chen et al., 2020, Chen et al., 2017, Leavy, 2017a).

5.3.1 Respondents' demographic characteristics

The survey was distributed to a number of construction companies. Participants from trustees, company, and IT staff responded to the survey which represented a response rate of 91 per cent. The participating construction companies had around 324 personnel who were invited to participate, and 297 responded.

The respondents' demographics data in this research included: roles in IT, experience in IT, years of experience in the construction industry, experience in RFID, company size, type of construction that participant companies mainly engaged in, operating systems and applications that participant companies mainly used, how often they delivered materials to work locations, how each of the participant companies related to knowledge about RFID, and how likely these companies would adopt RFID. Each of these respondent's demographic data will be addressed next.

- ***Role in Information Technology***

Table 5.1 represents the participants' role in IT. The table shows that the highest proportion (46.5%) of participants (138) worked as system development/analyst/programmer; while 84 of the respondents (28.3%) were working in a management role; followed by 73 of the respondents (24.6%) working in a role of operation/systems administration/user support. The remaining 2 of the respondents (0.7%) worked in other different roles. These results indicate that most of the respondents have an IT position in the participant construction companies.

Table 5.1: Information Technology Roles

	Frequency	Percent	Valid Percent	Cumulative Percent
Management	84	28.3	28.3	28.3
Systems development/ Analyst/ Programmer	138	46.5	46.5	74.7
Operation/ Systems administrator/ User support	73	24.6	24.6	99.3
Other	2	.7	.7	100.0
Total	297	100.0	100.0	

- ***Experience within IT***

Table 5.2 represents the participants' years of experience with IT. The table shows that 97 of the respondents (32.7%) had 10 to 15 years of IT experience, whereas 61 of the respondents (20.5%) had more than 15 years, and another 61 of the respondents (20.5%) had 2 to 5 years of IT experience. Furthermore, 51 of the respondents (17.2%) had 5 to 10 years of IT experience, followed by 26 of the respondents (8.8%) having 1 to 2 years of IT experience. Only 1 participant had less than one year of IT experience. These results indicate that most of the research respondents have IT experience.

Table 5.2: Years of experience with IT

	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 1 year	1	.3	.3	.3
1 year to 2 year	26	8.8	8.8	9.1
Between 2 and 5 years	61	20.5	20.5	29.6
Between 5 and 10 years	51	17.2	17.2	46.8
Between 10 and 15 years	97	32.7	32.7	79.5
More than 15 years	61	20.5	20.5	100.0
Total	297	100.0	100.0	

- ***Experience in the construction industry***

Table 5.3 represents the participants' years of experience in the construction industry. The table shows that the highest proportion of the 104 participants (35%) had experience of between 2 to 5 years in the construction industry; while 77 of the respondents (25.9%) had experience of between 1 to 2 years in the construction industry. Of the 62 participants, 20.9 per cent had experience of between 5 to 10 years in the construction industry. Another 39 of the participants (13.1%) had experience of between 10 to 15 years in the construction industry. The lowest percentage (2%) showed that 6 participants had experience of more than 15 years in the construction industry. These results indicate that most of the respondents have considerable experience in their particular companies and they are familiar with the operational processes of these companies.

Table 5.3: Years of experience in the construction industry

	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 1 year	9	3.0	3.0	3.0
1 year to 2 year	77	25.9	25.9	29.0
Between 2 and 5 years	104	35.0	35.0	64.0
Between 5 and 10 years	62	20.9	20.9	84.8
Between 10 and 15 years	39	13.1	13.1	98.0
More than 15 years	6	2.0	2.0	100.0
Total	297	100.0	100.0	

- ***Experience in RFID technology***

Table 5.4 represents the participants' years of experience in RFID technology. The table shows that the highest proportion (39.4%) of 117 participants had experience of between 1 to 2 years; while 68 of the respondents (22.9%) had experience of between 2 to 5 years related to RFID technology. Of the respondents, 58 (19.5%) had less than 1 year of experience related to RFID technology, whereas 44 of the respondents (14.8%) had experience of between 5 to 10 years related to RFID technology. A further 10 of the respondents (3.4%) had experience of between 10 to 15 years related to RFID technology. These results indicate that the respondents have the necessary knowledge and experience to participate in this research study.

Table 5.4: Years of experience in RFID technology

	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 1 year	58	19.5	19.5	19.5
1 year to 2 year	117	39.4	39.4	58.9
Between 2 and 5 years	68	22.9	22.9	81.8
Between 5 and 10 years	44	14.8	14.8	96.6
Between 10 and 15 years	10	3.4	3.4	100.0
Total	297	100.0	100.0	

- ***Company size***

Table 5.5 represents the size of construction companies in the research study. The table indicates that 115 of the respondents (38.7%) were from a company that had between (100-150) employees, and 92 of the respondents (31.0%) were from a company that had more than 150 employees. Furthermore, 64 of the respondents (21.5) were from a company with 5-10) employees, followed by 26 of the respondents 8.8%) being from a company with less than 50 employees. These results indicate that more than 60 per cent of the respondents are from large construction companies.

Table 5.5: Size of your company in terms of total number of staff

	Frequency	Percent	Valid Percent	Cumulative Percent
Less than 50	26	8.8	8.8	8.8
Between 5-100	64	21.5	21.5	30.3
Between 100--150	115	38.7	38.7	69.0
More than 150	92	31.0	31.0	100.0
Total	297	100.0	100.0	

- ***Type of construction your company is mainly engaged in***

Table 5.6 represents the type of construction that the participating companies are mainly engaged in. The table indicates that 159 of the participating companies (53.5%) engaged in the building of houses, schools, and public structures. The data indicates that 84 of the participating companies (28.3%) are engaged in road construction maintenance. The remaining 54 companies (18.2%) are engaged in bridge-building services. These results indicate that all of the participating companies are engaged in construction services—which signifies that they are eligible to participate in this research project.

Table 5.6: Type of construction your company is mainly engaged in

	Frequency	Percent	Valid Percent	Cumulative Percent
Building (Houses, schools, building of public structures)	159	53.5	53.5	53.5
Road construction maintenance	84	28.3	28.3	81.8
Bridges building services	54	18.2	18.2	100.0
Total	297	100.0	100.0	

- ***Computer systems and applications***

Table 5.7 represents the current computer systems and applications that the responding companies used. The table indicates that the majority of participants (115/38.7%) reported that the current computer systems and applications that they use are basic internet services such as email and web, whereas 90 of the respondents (30.3%) reported that the current computer systems and applications that they use are web-based advanced e-commerce functions. Another 42 of the respondents (14.1%) reported that the current computer systems and applications that they use are transaction processing systems such as payroll and order tracking. Furthermore, 40 of the respondents (13.5%) reported that the current computer systems and applications that they use are management information systems such as sales management and inventory control. Finally, 9 of the respondents (3.0%) reported that the current computer systems and applications that they use are for enterprise resource planning; and the other one participant (0.3%) reported that the current computer systems and applications they use are the supply chain management system. These results show the common computer systems and applications that the participating companies use in their systems.

Table 5.7: Computer systems and applications

	Frequency	Percent	Valid Percent	Cumulative Percent
Basic Internet services (email and web)	115	38.7	38.7	38.7
Web site with advanced ecommerce functions	90	30.3	30.3	69.0
Transaction Processing Systems such as: Payroll, Order Tracking	42	14.1	14.1	83.2
Management Information Systems such as: Sales management, inventory control	40	13.5	13.5	96.6
Enterprise Resource Planning (Dwivedi et al.)	9	3.0	3.0	99.7
Supply Chain Management Systems	1	.3	.3	100.0
Total	297	100.0	100.0	

Figure 5.1 illustrates the current computer systems and applications that companies use in their systems. This range—shown in the figure—indicates that the majority of the construction companies employ basic internet services such as email, and websites with advanced e-commerce functions.

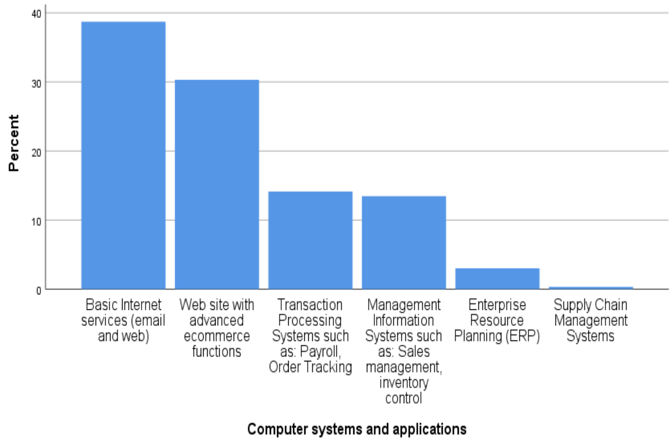


Figure 5.1: Computer systems and applications

- ***Communication system used during the delivery process***

Table 5.8 represents the current communication systems that the participating companies use during the delivery process. The table indicates that the highest communication system used by companies during the delivery process is email (171 or 57.6% of participants), followed by telephone service/VoIP with 111 (37.4). The lowest communication system used during the delivery process is SMS/text messaging with only one indicating this mode (2.0%). This result clarifies the common types of communication systems that the participant companies used during the delivery process.

Table 5.8: Communication system used during the delivery process

	Frequency	Percent	Valid Percent	Cumulative Percent
Email	171	57.6	57.6	57.6
Telephone service/VoIP	111	37.4	37.5	94.9
Website hosting	8	2.7	2.7	97.6
SMS/text messaging	1	.3	.3	98.0
Social networking/Web 2.0	6	2.0	2.0	100.0
Total	297	100.0	100.0	

Figure 5.2 illustrates the frequency of current communication systems that the participant companies used during the delivery process. This range shown in the figure indicates that the majority of the construction companies used email to communicate during the delivery process.

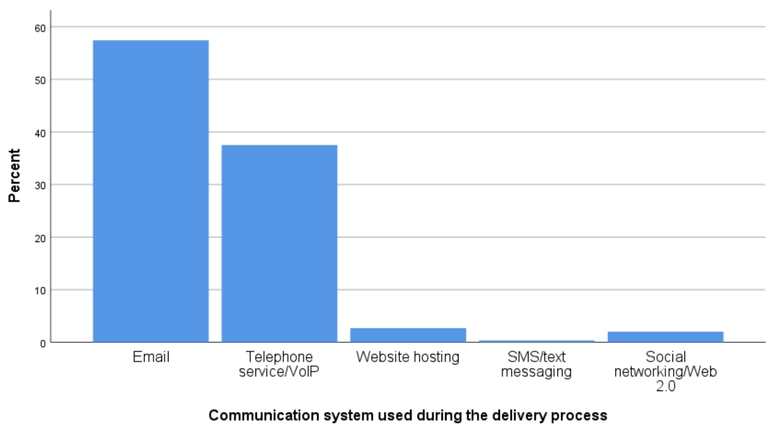


Figure 5.2: Communication system used during the delivery process

- ***Which best describes your company's knowledge of RFID?***

Table 5.9 demonstrates the best description of company knowledge related to RFID technology. The table shows that the majority of the 130 participants (43.8%) understand most of the concepts related to RFID technology, followed by 102 participants (34.3%) who were fully conversant with all aspects related to this technology. Furthermore, 34 of the research participants (11.4) had little knowledge related to RFID technology, followed by 31 (10.4%) who understood the principles of RFID. These results illustrate that most of the research participants demonstrated a good knowledge of RFID technology.

Table 5.9: Which best describes your company's knowledge of RFID?

	Frequency	Percent	Valid Percent	Cumulative Percent
Fully conversant with all aspects of RFID	102	34.3	34.3	34.3
Understand most of the concepts of RFID	130	43.8	43.8	78.1
Understand the principles of RFID	31	10.4	10.4	88.6
Little knowledge of RFID principles	34	11.4	11.4	100.0
Total	297	100.0	100.0	

Figure 5.3 illustrates the frequency of current RFID knowledge within the participating construction companies. This range, shown in the figure, indicates that the majority of the construction companies had an understanding of most of the concepts related to RFID technology. Also, other companies described themselves as full conversant with all aspects of RFID technology.

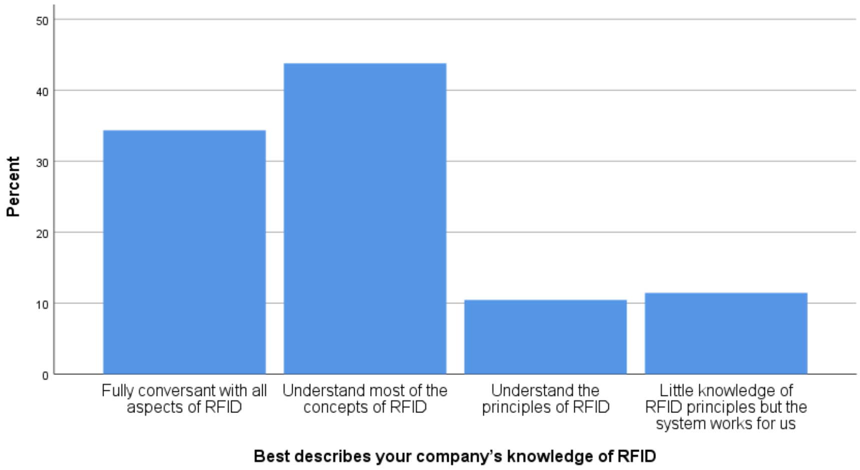


Figure 5.3: Company knowledge related to RFID

- ***How likely will your company be to adopt RFID?***

Table 5.10 shows the likelihood of a company adopting RFID technology. The result illustrates that the majority of the 138 participating companies (46.5%) are likely to adopt this type of technology, followed by 126 (42.4%) who are certain to adopt this technology. Moreover, 31 of the companies (10.4%) are equally likely to adopt, where only one company (0.3%) is unlikely or finds it impossible to adopt this type of technology. This result indicates that most of the companies have the ability to adopt RFID technology within their systems.

Table 5.10: How likely is it that your company would adopt RFID?

	Frequency	Percent	Valid Percent	Cumulative Percent
Certain	126	42.4	42.4	42.4
Likely	138	46.5	46.5	88.9
Equally likely	31	10.4	10.4	99.3
Unlikely	1	.3	.3	99.7
Impossible	1	.3	.3	100.0
Total	297	100.0	100.0	

5.4 Benefits from implementing RFID technology

Figure 5.4 demonstrates the research findings related to the benefits of adopting RFID technology in the construction companies, which include improved connection with the supplier, transportability, improved inventory control, improved efficiency of store operation, data accuracy, provider dependability, business activity monitoring, data back-up, security, system automation, and tag cost at item level.

This suggests that construction companies are seen as improving their inventory control by 56 per cent, followed by transportability at 48 per cent. Thereafter, improvement in the connection with the supplier was rated by nearly 47 per cent of respondents; and system automation at 45 per cent. In other words, participants rated improved efficiency of store operation as having a high likelihood, with nearly 30 per cent of respondents sharing this view. For more details, see Figure 5.4.

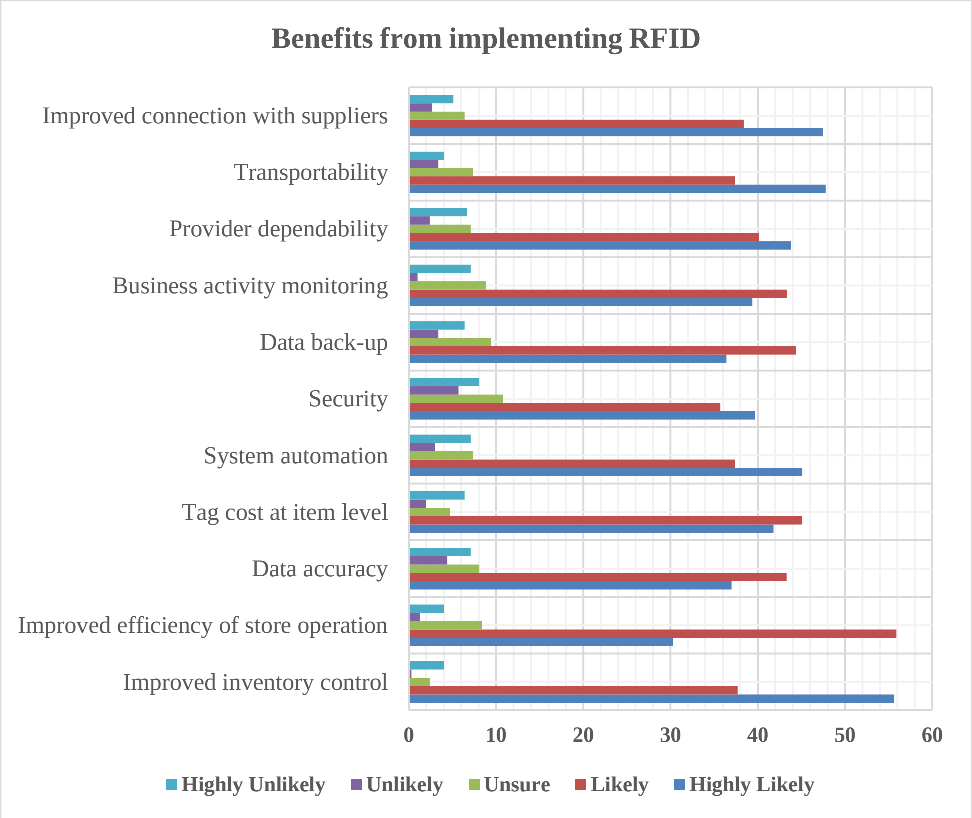


Figure 5.4: Benefits from implementing RFID

5.5 Challenges of implementing RFID technology

Figure 5.5 demonstrates the research findings related to the challenges in adopting RFID technology within the construction companies, which include cost, privacy, trust, integration, business transformation, and lack of real understanding of RFID. This result suggests that the cost to adopt this technology is seen as the highest challenge by nearly 52 per cent of respondents, followed by trust at 42 per cent and integration of the RFID technology with exciting technologies at nearly 40 per cent. For more details about these challenges see Figure 5.5.

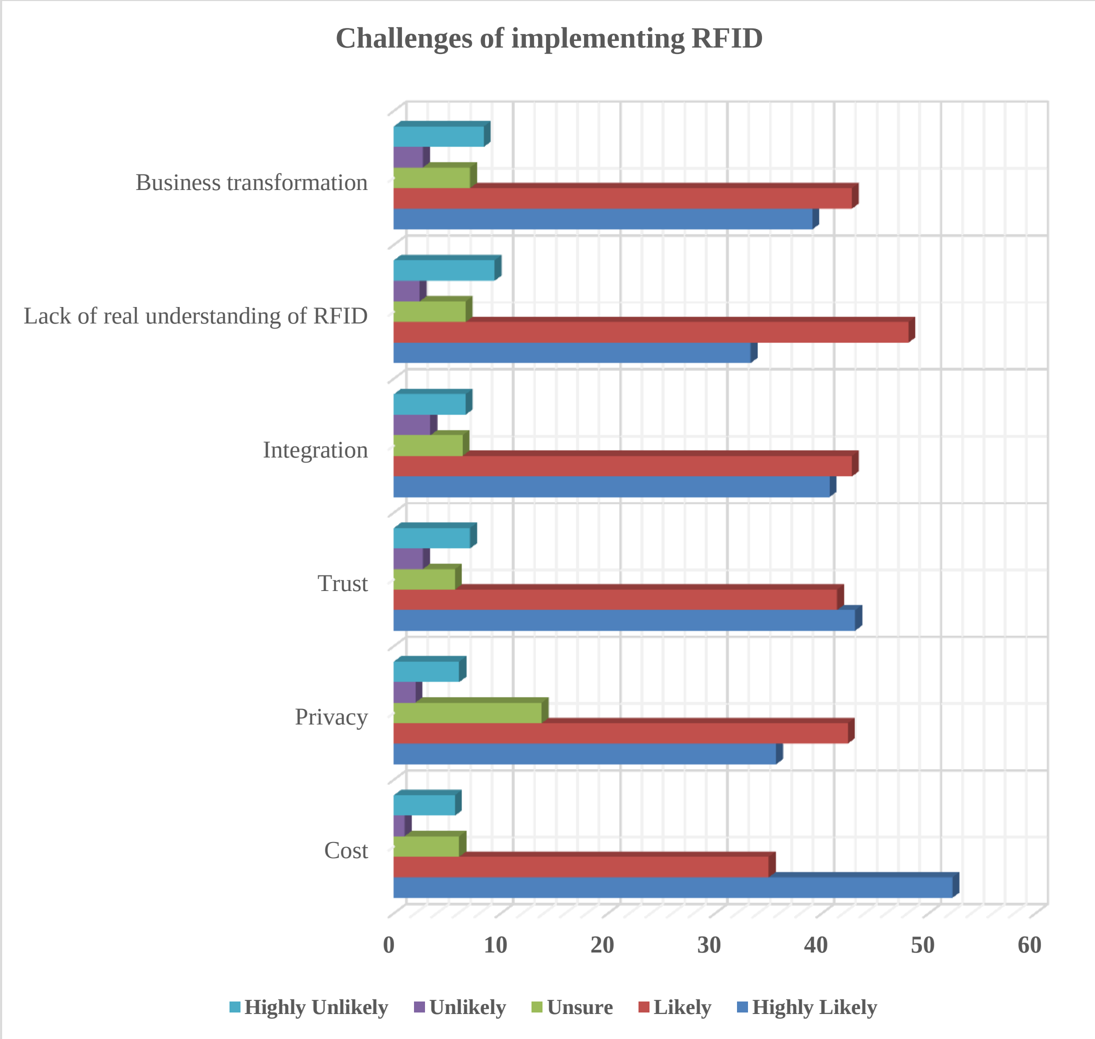


Figure 5.5: Challenges of implementing RFID

5.5.1 **Measurement scale validation**

The aim of this section is to check the procedures that have been implemented to validate the measurement scale used in this study. Reliability coefficients were obtained for all the factors. IBM SPSS Statistics 25 was employed to conduct this test, which is explained in the following section.

5.5.2 Reliability of the scale

Reliability is an assessment of the degree of consistency between multiple measurements of a variable (Hair et al., 2010b). It is an indication of the stability and consistency with which the instrument measures the concept and helps to assess the goodness of a measure (Sakrana et al., 2017). The reliability of a scale is determined by the consistency of the items on the scale. This is commonly determined in terms of the internal consistency of the scales based on how well the items of the scale correlate (Hair et al., 2006b). The aim of this test is to reduce measurement errors and prevent further errors from occurring in data analysis. However, this study is primarily concerned with the internal consistency of the scales as determined in terms of the reliability coefficient. The most widely used reliability coefficient measure is Cronbach's alpha (Hair et al., 2006b). Pallant et al. (2015) and Hair et al. (2006b) stated that the lower limit of Cronbach's Alpha value should be above 0.7 to be reliable. Thus, all measurement items must be reliable and consistent in order to produce accurate results (Hair et al., 2010b). Therefore, the following section presents the steps followed to assess the reliability of the scale and, subsequently, presents the results.

- ***Internal consistency***

It is the homogeneity of the items in the measure that tap a construct (Bajpai et al., 2014). Internal consistency reliability is the degree to which responses are consistent across the items within a measure. (Kline, 2011). Internal consistency involves correlating the responses to each question in the questionnaire with others in the questionnaire (Zikmund et al., 2013). It therefore measures the consistency of responses across either all the questions or a sub-group of the questions from the questionnaire (Krause et al., 2011, Saunders et al., 2011b). There are a variety of methods for calculating internal consistency and one of the most frequently used is Cronbach's alpha (Churchill Jr, 1979, Mitchell, 1996, Field, 2005, Hair et al., 2014a, Christensen et al., 2011, Field et al., 2018). The internal consistency for a set of items is considered excellent if the value of Cronbach's alpha is around 0.9; very good if it is around 0.8; and adequate if it is around 0.7—which is suggested to be an accepted cut-off (Hair et al., 2006b). Table 5.11 shows the value of Cronbach's alpha for each scale. All the values of the alpha coefficient were greater than 0.7 between (0.790 - 0.960). Therefore, no item was deleted in this stage.

Table 5.11: Cronbach's alphas for the measurement scales

Scales	**No. of Items**	**Cronbach Alpha**
Relative advantage	9	.730
Compatibility	4	.924
Complexity	5	.908
Observability	4	.933
Cost	7	.920
Privacy	5	.908
Security concern	5	.874

Scales	No. of Items	Cronbach Alpha
Top management support	5	.909
Firm size	5	.923
Prior similar IT experience	4	.726
Competitive pressure	6	.811
Government regulation	7	.840
External support	5	.887
Anticipated benefits	16	.930
RFID adoption	5	.810
Total	**92**	**.13033**

5.6 Measurement Development of the Research Proposed Model

To measure the fit of the proposed research model, there are different statistical techniques that are used to analyse the data. The first statistical technique is a factor analysis (FA) test which is used to check the scales' validity and establish the loading for each item within the same construct. This technique contains CFA. The second statistical technique is used to test the reliability and validity of the scales and to find the most appropriate observed variables pertaining to each latent variable.

5.6.1 The First Statistical Technique

This technique is used to exam the scales' validity through a FA test. According to Williams et al. (2010), FA is a significant instrument that is employed in improvement, assessment of tests, and scales. This technique comprises CFA. This statistical technique will be explored next.

5.6.2 Confirmatory Factor Analysis (CFA)

CFA is a method of testing how well measured variables represent a smaller number of constructs (Hair et al., 2014a, Jeon et al., 2015). It is a powerful statistical tool for examining the nature of and relationships among latent constructs (Jackson et al., 2009). CFA explicitly tests a priori hypotheses about relationships between observed variables and latent variables or factors (Schreiber et al., 2006a, Brown and Moore, 2012). It is often the analytic tool of choice for developing and refining measurement instruments, assessing construct validity, identifying method effects, assessing the quality of the measurement model and evaluating factor invariance across time and groups (DiStefano and Hess, 2005, Brown and Moore, 2012, Jackson et al., 2009). CFA is considered a part of SEM (Swisher et al., 2004). Consequently, this research study has used AMOS software to conduct CFA and SEM analysis.

CFA is used to provide a confirmatory test of measurement theory (Hair et al., 2014b). CFA is applied to test the extent to which a researcher's a priori theoretical pattern of factor loadings on pre-specified constructs (variables loading on specific constructs) represents the actual data (Hair et al., 2010b). Thus, CFA statistics tell us how well our theoretical specification of the factors matches reality. CFA is a tool that enables researchers to either "confirm" or "reject" their preconceived theory (Hair et al., 2014a). Therefore, this study employed CFA to confirm that the measurement items are measuring the construct extracted from previous studies, using the AMOS software.

The study applied the following criteria to determine which items should be retained in the factors of the research model:

- The items should load on the same factor subsequent to the confirmatory analysis (Mulaik & Millsap, 2000).
- The item loadings should exceed 0.5 as an accepted level (Hair et al., 2014a).
- Each factor is required to have at least three measurement items to enable the development of congeneric factors (Byrne, 2008, Hair et al., 2014b).
- It is required in determining the goodness of model fit criteria for CFA and SEM (Byrne, 2001, Schreiber et al., 2006b, Cunningham, 2008, Jackson et al., 2009, Holmes-Smith, 2011).

The following sections present the Goodness-Of-Fit (GOF) index that the current study adopts for the CFA and SEM analysis.

5.6.3 Measure of Model Fit

The Goodness of Fit (GOF) of the structural model can be assessed by interpreting GOF index (Schumacker and Lomax, 2004). CFA was used to assess the measurement model for this study (Hair et al., 2006b, Musil et al., 1998). CFA as a specific case of SEM provides a comprehensive picture of how well the measured items represent the variables (Hair et al., 2010a, Jeon et al., 2015). The measurement of fitness of the model for CFA and structural model can be justified by three main types of indices, namely: incremental fit indices, absolute fit indices and parsimony fit indices (Schumacker and Lomax, 2004, Hopper et al., 2008). *An absolute fit measure technique* is employed to measure the overall fit of the measurement and the structural model (Hair et al., 2010a). *An incremental fit measure* assesses GOF by comparing the standard hypothesised model with the hypothesised model (Byrne, 2009). *Parsimony fit indices* approach is used to identify the hypothesised model that represents the best fit, when compared to other competing hypothesised models. Typically, a more complex model would appear to be a better fit (Hair et al., 2010a).

However, it is important to note that for suitability, there are various fit indices and several rules of thumb regarding the minimum range of value in these types of measurement (Byrne, 2001). It is not necessary to include every index in the software output (Hooper et al., 2008). In this research, Normed Chi-square (CMIN/DF), Root Mean Square Residual (RMR), Goodness-of-Fit Index (GFI), Adjusted Goodness of Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), Incremental-Fit-Index (IFI), Tucker Lewis Fit Index (TLI) and Comparative Fit Index (CFI) are taken into account for this analysis because these indices are employed frequently and are mentioned in the literature (Hulland et al., 1996, Byrne, 1998, Byrne, 2001, Kline, 2005, Hair et al., 2006b, Schreiber et al., 2006b, Cunningham, 2008, Hooper et al., 2008). Accordingly, to ensure the measurement model's quality, the indices reported in this study are illustrated in Table 5.12.

Table 5.12: Goodness of Fit Indices

Goodness of Fit Indices					
Name of category	**Name of index**	**Abbreviation**	**Acceptable Level**	**Fit Measures' Indications**	**Sources**
Absolute fit	Root Mean Square Error of Approximation (RMSEA)	**RMSEA**	**≤ .08**	A value should not be greater than 0.1.	Steiger (1990); Browne and Cudeck (1993); Hu and Bentler (1998); Schumacker and Lomax (2004); Holmes-Smith et al. (2006); Hair et al. (2006); Steiger (2007); Byrne (2010); Holmes-Smith (2011); Bagozzi and Yi (2012)
	Goodness-of-Fit (GFI)	**GFI**	**≥.90**	A value close to 0 indicates a poor fit, while a value close to 1 indicates a perfect fit.	Byrne (1989); Hair et al. (1998); Shevlin and Miles (1998); Chau and Hu (2001); Hair et al. (2006); Shah and Goldstein (2006); Hooper et al. (2008); Byrne (2010); Tu et al. (2012); Bagozzi and Yi (2012)
	Root Mean Square Residual (RMR)	**RMR**	**<.06**	A value less than .06 indicates a perfect fit.	Joreskog and Sorbom (1989); Brown and cudeck (1993); Hu and Bentler (1995); Gefen et al. (2000); Byrne (2001); Hair et al. (2006); Hooper et al. (2008); Byrne (2010); Holmes-Smith (2011; Kline (2011)
	Normed Chi Square (CMIN)	**CMIN/DF**	**≤ 5.0**	Lower limit is 1.0, upper limit is 3.0 or as high as 5.0.	Wheaton et al. (1977); Carmines and McIver (1981); Marsh and Hocevar (1985); Bollen (1989); Hair et al. (1998); Tabachnick and Fidell (2001); Bredahl (2001); Stank et al. (2003); Schumacker and Lomax (2004); Hooper et al. (2008); Holmes-Smith (2011); Kline (2011)
Increm ental fit	Comparative Fit Index (CFI)	**CFI**	**≥.90**	A value close to 1 indicates a good fit.	Bagozzi and Yi (1988); Bentler (1992); Hair et al. (1998); Hu and Bentler (1998); Hu and Bentler (1999); Byrne (2001); Stank et al. (2003); Hair et al. (2006); Byrne (2009); Bagozzi and Yi (2012).

Goodness of Fit Indices					
Name of category	**Name of index**	**Abbreviation**	**Acceptable Level**	**Fit Measures' Indications**	**Sources**
	Tucker-Lewis Index (TLI)	**TLI**	**≥.90**	A value close to 1 indicates a good fit.	Bentler and Bonett (1980); Marsh et al. (1988); Finch and West (1997); Hair et al. (1998); Hu and Bentler (1998); Byrne (2001); Hair et al. (2006); Tabachnick and Fidell (2007); Holmes-Smith (2011)
	Incremental Index of Fit (IFI)	**IFI**	**≥.90**	A value close to 1 indicates a good fit.	(Bagozzi and Yi (1988); Bollen (1989); Byrne (2001); Byrne (2016)
Par simonious fit	Adjusted Goodness-of-Fit (AGFI)	**AGFI**	**≥.80**	4A value close to 0 indicates a poor fit, while value close to 1 indicates a perfect fit.	Marsh et al. (1988); Hair et al. (1998); Byrne (2009); Hair et al. (2010)

The basic objective of these fit indices is to evaluate the initial measurement models and the final structural model outlined in the next sections. However, for this study, two stages were employed to assess the measurement model: (1) CFA for the single-composite variable measurement model; and (2) CFA for the overall measurement model (Taha and Sciences, 2018, Alsabawy et al., 2013).

- ***First stage: Initial measurement and modification of CFA for the single-composite variable measurement model***

This stage of the analysis confirms the major findings related to the initial measurement fit with CFA. CFA in this stage was used to evaluate uni-dimensionality composite variables through alteration, simplification and any essential modification in the measurement model (Byrne, 2001, Cunningham et al., 2006). CFA was also used to validate the model fit through examining modification goodness indices which include variance, covariance, and regression weight and standardised loadings in AMOS output, even though model identification is a pre-requisite of the CFA. However, these indices determine the direction of the model modification.

The one-factor congeneric measurement model was undertaken with each construct separately using CFA. In this study, the CFA procedures for each composite variable in the measurement model were calculated to obtain load factors. Regression weights between a particular composite variable and its items were calculated by this stage. During this stage, the data set being used consisted of 92 items that measured fourteen composite variables, namely, (1) relative advantage; (2) compatibility; (3) complexity; (Das) cost; (Das) security concern; (Das) privacy; (7) top management support; (8) anticipated benefit; (9) competitive pressure; (10) external support; (11) prior similar IT experience; (12) government regulation; (13) Observability; and (14) RFID adoption. The initial measurement models for each construct measure are discussed next.

- ***Relative Advantage: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were nine items used to measure relative advantage. The CFA initial results of the relative advantage model fit revealed that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.13). The CFA initial findings presented in Table 5.13 demonstrate that the relative advantage model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.13: Relative advantage CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	C.R. (t)
RA1	Using the RFID technology improves the quality of operation for the organisation	**-.03**	Removed	
RA2	Using the RFID technology provides better services	**.20**	Removed	
RA3	Using the RFID technology allows for improved inventory management	**.54**	**.60**	**9.450**
RA4	Using the RFID technology reduces the level of risk	**.62**	**.50**	**7.859**
RA5	Using the RFID technology improves disaster recovery	**.26**	Removed	
RA6	Using the RFID technology leads to cost reduction	**.76**	**.80**	**11.463**
RA7	Using the RFID technology provides improved security against theft and counterfeiting	**.58**	Removed	
RA8	Using the RFID technology improves productivity	**.46**	Removed	
RA9	Using the RFID technology increases efficiency	**.78**	**.82**	

Fit Indices

	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	**16.564**	**.699**	**.498**	**.122**	**.536**	**.375**	**.531**	**.229**
CFA Final Findings	**1.195**	**.996**	**.979**	**.009**	**.999**	**.996**	**.999**	**.026**

The researcher found that the main reason for the poor fit of the relative advantage model is the items loading. The first iteration involved examining the items loading which indicated that the regression weight of RA1, RA2, RA5, RA7, and RA8 were the lowest among the other items with RA1 (-.03), RA2 (20), RA5 (26), RA7 (58), and RA8 (Das). Based on that, RA1, RA2, RA5, RA7, and RA8 were eliminated (Hair et al., 2010a). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.13, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

CFA Initial Diagram	CFA Final Diagram

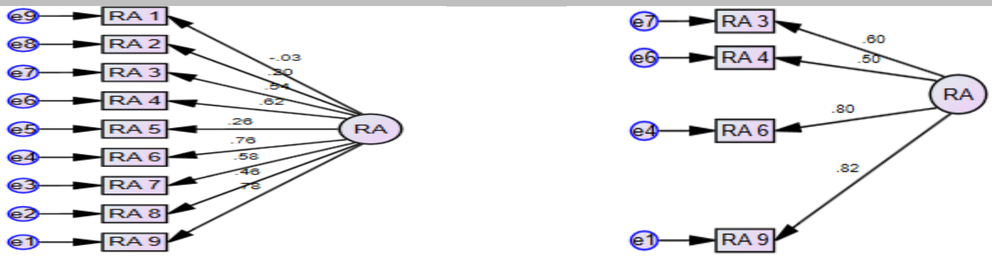


Figure 5.6: Congeneric model of relative advantage

- ***Compatibility: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were four items used to measure strategic leadership. The CFA initial results of the compatibility model fit revealed that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.14). The CFA initial findings presented in Table 5.14 demonstrate that the compatibility model does not fit and needs some modification to reach an acceptable level of fit.

Table 5.14: Compatibility CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	C.R. (t)
Compa 1	RFID technology is easily connected with the existing IT infrastructure of my organisation	.89	.90	20.991
Compa 2	Using RFID technology is compatible with all aspects of my company	.87	.84	18.558
Compa 3	RFID is compatible with my company's values and beliefs	.86	.84	18.317
Compa 4	RFID compatibility is not an issue for my company	.87	.88	

Fit Indices	CMIN/DF	FI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	6.276	.979	.897	.006	.989	.966	.989	.134
CFA Final Findings	3.267	.995	.945	.003	.998	.985	.998	.080

The researcher found that the main reason for the poor fit of the compatibility model is the high standardised residual covariance between Compa2 *'using RFID technology is compatible with all aspects of my company'* and Compa3 *'RFID is compatible with my company's values and beliefs'* (between *e3* and *e2*) was 5.440. According to (Byrne, 2001, Cunningham et al., 2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (Compa2 and Compa3) (for more details see Figure 5.7). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.14, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

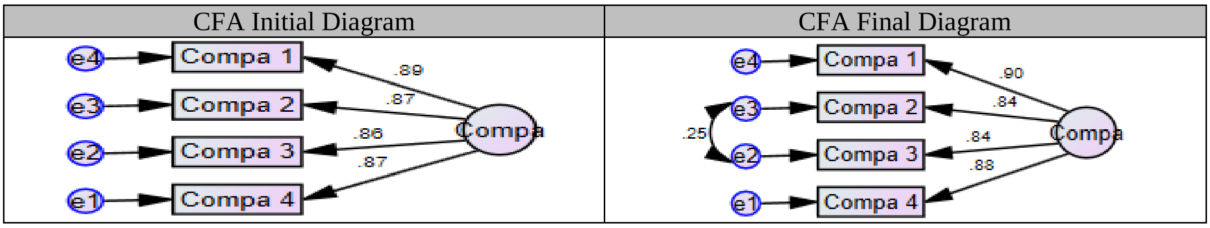


Figure 5.7: Congeneric model of compatibility

- ***Complexity: CFA Initial Findings***

At the first iteration of conducting a one-factor congeneric measurement, there were five items used to measure complexity. The CFA initial results of the complexity model fit established that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.15). The CFA initial findings presented in Table 5.15 demonstrate that the complexity model does not fit and needs some modification to reach an acceptable level of fit.

Table 5.15: Complexity CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
Comex 1	Using RFID technology is not seen as complex for business operations in my company	.83	.85	19.334
Comex 2	The skills needed to adopt RFID are not seen as complex for employees in my company	.72	.64	15.958
Comex 3	Compared to other types of technologies RFID is less complex	.90	.92	22.258
Comex 4	Integration of RFID with the existing IT system presents no problems for my company	.73	.75	15.832
Comex 5	Massive amounts of data generated by RFID is not difficult to manage	.92	.88	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	14.633	.901	.703	.041	.938	.875	.937	.215
CFA Final Findings	1.481	.992	.969	.013	.998	.996	.998	.040

The researcher found that the main reason for the poor fit of the complexity model is the high standardised residual covariance between Comex2 *'the skills needed to adopt RFID are not seen as complex for employees in my company'* and Comex5 *'massive amounts of data* *generated by RFID is not difficult to manage'* (between *e4* and *e1*) was 54.464. According to Byrne (2001), correlating the error covariance approach can be justified both statistically and substantively. As a result of that, the researcher made covering error variance terms of both items (Comex2 and Compex5) (for more details see Figure 5.8). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.15, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

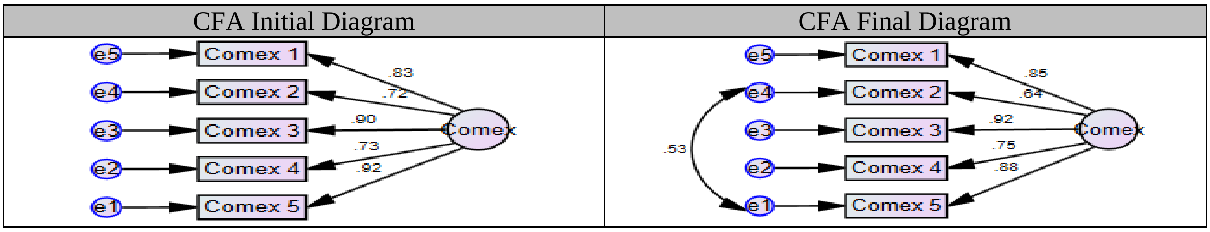


Figure 5.8: Congeneric model of Complexity

- ***Observability: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were four items used to measure observability. The CFA initial results of the observability model fit established that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.16). The CFA initial findings presented in Table 5.16 demonstrate that the observability model does not fit and needs some modification to reach an acceptable level of fit.

Table 5.16: Observability CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
Observ 1	Adoption of RFID is important in developing innovation in your company	.68	.64	14.117
Observ 2	Using RFID is important to improve the performance of your company	.80	.78	14.514
Observ 3	Using RFID could enhance confidence with customers and increase the competitiveness of your company in the marketplace	.97	1.01	15.933
Observ 4	Adoption of RFID could increase the supplier's ability to control the time	.79	.75	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	13.441	.955	.777	.018	.966	.896	.965	.205
CFA Final Findings	.008	1.000	1.000	.000	1.001	1.008	1.000	.000

The researcher found that the main reason for the poor fit of the observability model is the high standardised residual covariance between Observ1 *'adoption of RFID is important in developing innovation in your company'* and Observ4 *''Adoption of RFID could increase the supplier's ability to control the time''* (Between *e4* and *e1*) was 21.968. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result of that, the researcher made covering error variance terms of both items (Observ1 and Observ4) (for more details see Figure 5.9). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.16, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

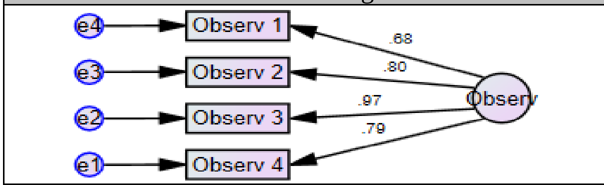
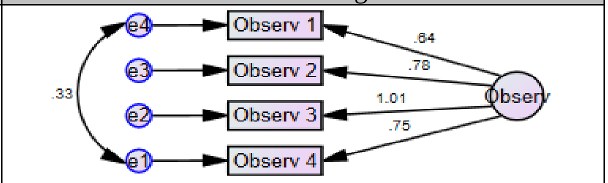
CFA Initial Diagram	CFA Final Diagram
	

Figure 5.9: Congeneric model of Complexity

- ***Cost: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were seven items used to measure cost. The CFA initial results of the cost model fit revealed the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.17). The CFA initial findings presented in Table 5.17 demonstrate that the cost model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.17: Cost CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
Cost 1	Maintenance costs of the RFID technology are very low	.73	.71	14.821
Cost 2	Energy and environmental costs of the RFID technology are very low	.74	.65	13.033
Cost 3	RFID has low training costs	.89	.83	19.088
Cost 4	RFID decreases the investment cost in new IT infrastructure	.84	.89	20.404
Cost 5	RFID reduces the costs of system upgrades	.67	.69	14.039
Cost 6	RFID is cost effective compared with the other IS technologies	.82	.88	20.172
Cost 7	RFID reduces the total cost of operational processes	.86	.87	

Fit Indices

	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	11.901	.872	.745	.023	.901	.850	.900	.192
CFA Final Findings	3.444	.964	.916	.012	.981	.966	.981	.53

To improve the model fit, two iterations have been made: the first iteration involved examining the residual covariance with other different items, which indicated that the Cost2 *'energy and environmental costs of the RFID technology are very low'* had a high residual covariance with Cost3 '*RFID has low training costs*.' The value of the residual covariance for Cost2 and Cost3 (*e5* and *e6*) was 68.836. According to Byrne (2001) and (Holmes-Smith, 2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (Cost2 and Cost3). The results of the first iteration still showed that the Cost model did not achieve a good fit. The second iteration found that Cost4 '*RFID decreases the investment cost in new IT infrastructure'* had a high residual covariance with other different items, and especially with Cost6 '*RFID is cost-effective compared with the other IS technologies*'. The value of the residual covariance for TD4 and TD5 (*e2* and *e4*) was 27.610. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (Cot4 and Cost6) (for more details see Figure 5.10). The results of the second iteration confirmed that the model was a good fit. As shown in Table 5.17, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

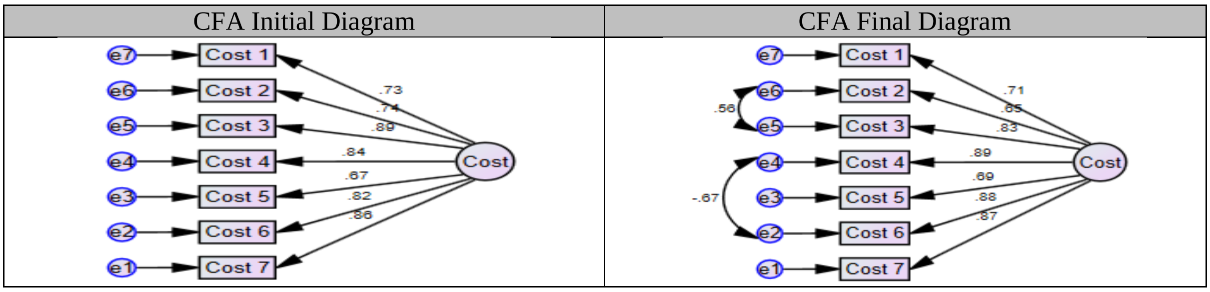


Figure 5.10: Congeneric model of cost

- ***Privacy: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were five items used to measure privacy. The CFA initial results of the privacy model fit revealed that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.18). The CFA initial findings presented in Table 5.18 demonstrate that the privacy model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.18: Privacy CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
Priv 1	My company can provide strong support to maintain privacy with the adoption of RFID	.83	.85	19.334
Priv 2	My company can maintain the personal privacy when adopting RFID	.72	.64	15.958
Priv 3	My company can maintain the location privacy when adopting RFID	.90	.92	22.258
Priv 4	My company can maintain the forward privacy* when adopting RFID **Forward privacy:* *pushing forward the privacy protections in advance to prevent the competitor from tracing back the data stored in RFID tag and associate it with the current output*	.73	.75	15.832
Priv 5	My company has the capacity to follow the measures within the protocols to maintain location privacy when adopting RFID	.92	.88	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	14.633	.901	.703	.041	.938	.875	.937	.215
CFA Final Findings	1.481	.992	.969	.013	.998	.996	.998	.040

To improve the model fit, one iteration has been made: this iteration involved examining the residual covariance with other different items, which indicated that the Priv2 *'my company* *can maintain the personal privacy when adopting RFID'* had a high residual covariance with Priv5 '*My company has the capacity to follow the measures within the protocols to maintain location privacy when adopting RFID*. The value of the residual covariance for Priv2 and Priv5 (Tashakkori and Teddlie, 1998) was 54.464. According to (Byrne, 2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (Priv2 and Priv5). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.18, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

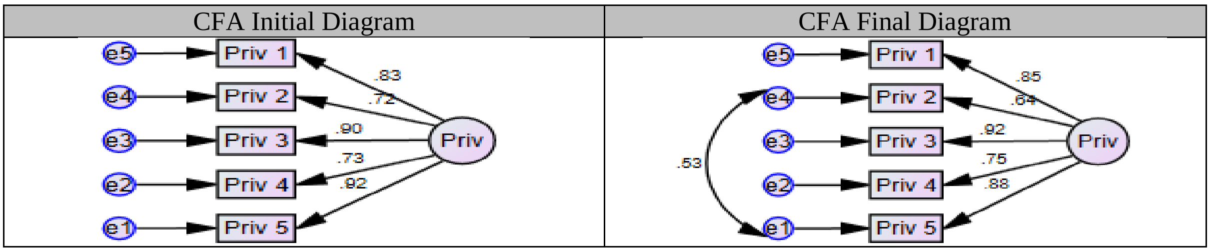


Figure 5.11: Congeneric model of privacy

- ***Security Concern: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were five items used to measure security concerns. The CFA initial results of the security concern model fit showed that the model was a poor fit to the data because the cut-off ranges of several fit indices were not at acceptable levels (for more details see Table 5.19). The CFA initial findings presented in Table 5.19 demonstrate that the security concern model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.19: Security concern CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	C.R. (t)
SecC 1	RFID provides a sufficient security transfer channel during the process of mass data interchange	.66	.82	10.594
SecC 2	Using RFID technology solutions is trustworthy	.91	.77	13.329
SecC 3	RFID provides a secure service	.85	.69	12.090
SecC 4	RFID tags can provide more authentication by preventing unauthorised duplication	.65	.71	12.164
SecC 5	Security concerns are not an issue with RFID	.73	.88	

Fit Indices							
	CMIN/DF	**GFI**	**AGFI**	**RMR**	**IFI**	**TLI**	**CFI**	**RMSEA**
CFA Initial Findings	28.006	.887	.662	.027	.848	.695	.847	.302
CFA Final Findings	.576	.998	.988	.003	1.001	1.005	1.000	.000

To improve the model fit, two iterations have been made: the first iteration involved examining the residual covariance with other different items, which indicated that the SecC1 *'RFID provides a sufficient security transfer channel during the process of mass data interchange'* had a high residual covariance with SecC5 '*Security concerns are not an issue with RFID*'. The value of the residual covariance for SecC1 and SecC5 (*e1* and *e5*) was 39.558. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (SecC1 and SecC5). The results of the first iteration still showed that the security concern model did not achieve a good fit. The second iteration found that SecC2 '*Using RFID technology solutions is trustworthy'* had a high residual covariance with other different items, and especially with SecC3 '*RFID provides a secure service*'. The value of the residual covariance for SecC3 and SecC4 (*e4* and *e3*) was 44.166. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (SecC2 and SecC3) (for more details see Figure 5.12). The results of the second iteration confirmed that the model was a good fit. As shown in Table 5.19, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

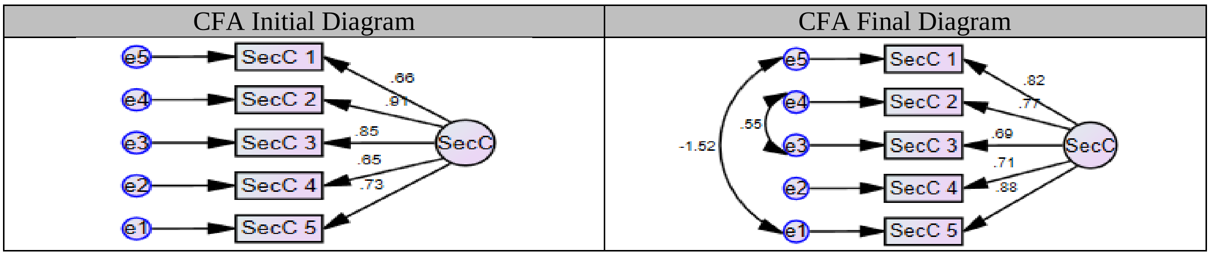


Figure 5.12: Congeneric model of security concern

- ***Top Management Support: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were five items used to measure top management support. The CFA initial results of the top management support model fit established that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.20). The CFA initial findings presented in Table 5.20 demonstrate that the top management support model is not a good fit and needs some modification to reach an acceptable level of fit.

Table 5.20: Top management support CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
TMS1	Top management is willing to take the risks (financial and organisational) involved in adopting RFID technology	.83	.78	14.846
TMS2	Top management is seriously considering the adoption of an appropriate RFID technology in my company	.87	.88	17.059
TMS3	Top management understands the benefits of RFID technology	.77	**Removed**	
TMS4	Top management provides resources to support the adoption of RFID technology	.86	.89	15.639
TMS5	RFID technology adoption is a top management decision	.80	.84	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	17.798	.905	.716	.019	.923	.845	.922	.234
CFA Final Findings	2.213	.996	.963	.005	.998	.991	.998	.064

The researcher found that one of the main reasons for the poor fit of the top management support model is the items loading. The first iteration involved examining the items loading which indicated that the regression weight of TMS3 was the lowest among the other items with 0.77. Based on that, TMS3 was eliminated (Hair et al., 2010a). The other main reason for the poor fit of the competitive pressure model is the high standardised residual covariance between TMS4 ‘*top management provides resources to support the adoption of RFID technology*’ and TMS5 *‘RFID technology adoption is a top management decision*’ (between *e1* and *e2*) was 9.886. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result of that, the researcher made covering error variance terms of both items (TMS4 and TMS5) (for more details see Figure 5.13). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.20, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

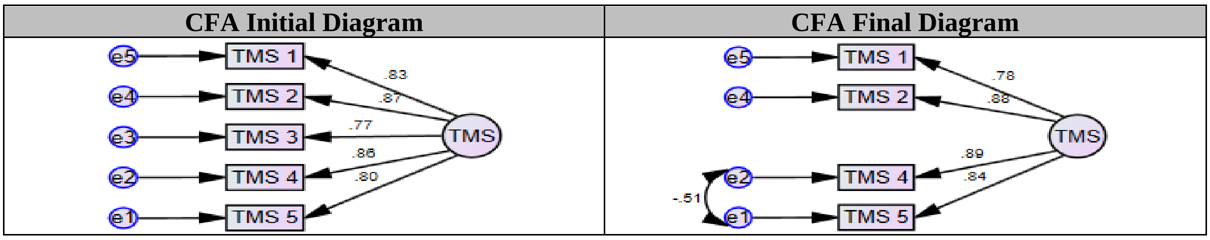


Figure 5.13: Congeneric model of top management support

- ***Firm Size: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were five items used to measure firm size. The CFA initial results of the firm size model fit revealed that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.21). The CFA initial findings presented in Table 5.21 demonstrate that the firm size model is not a good fit and needs some modification to reach an acceptable level of fit.

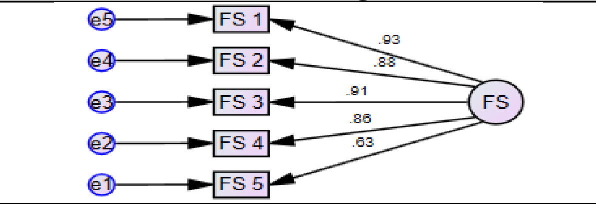
Table 5.21: Firm size CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
FS 1	The number of employees in my company is high compared to others in the industry	.93	.94	12.920
FS 2	The revenue of my company is high compared to others in the industry	.88	.88	12.959
FS 3	Small & medium companies are more flexible in adopting RFID technology	.91	.90	14.146
FS 4	Bigger company with larger resources can easily move to adopt RFID technology	.86	.85	13.475
FS 5	The size of an company impacts its adoption of RFID technology	.63	.71	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	10.415	.937	.811	.025	.962	.924	.962	.178
CFA Final Findings	3.062	.989	.943	.008	.995	.983	.995	.079

To improve the model fit two iterations have been made: the first iteration was examining the residual covariance with other different items which indicated that the FS1 '*the number of employees in my company is high compared to others in the industry'* had a high residual covariance with FS5 *'the size of a company impacts its adoption of RFID technology.'* The value of the residual covariance for FS1 and FS5 (between *e5* and *e1*) was 24.301. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (FS1 and FS5), (for more details see Figure 5.14). The results of the first iteration still showed that the Geographic proximity model did not achieve a good fit. The second iteration found that FS2 '*the revenue of my company is high compared to others in the industry'* had a high residual covariance with other different items, and especially with FS5 *'the size of a company impacts its adoption of RFID technology.'* The value of the residual covariance for FS2 and FS5 (between *e4* and *e1*) was 6.780. The results of the second iteration confirmed that the model was a good fit. As shown in Table 5.21, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

CFA Initial Diagram



CFA Final Diagram

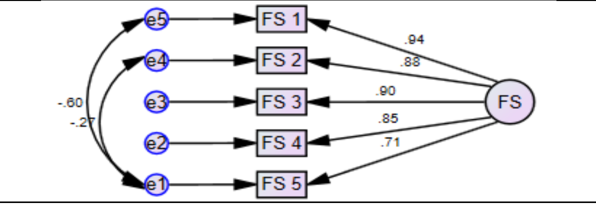


Figure 5.14: Congeneric model of firm size

- ***Prior Similar IT Experience: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were four items used to measure prior similar IT experience. The CFA initial results of the prior similar IT experience model fit showed that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.22). The CFA initial findings presented in Table 5.22 demonstrate that the prior similar IT experience model is not a good fit and needs some modification to reach an acceptable level of fit.

Table 5.22: Prior similar IT experience CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
PSITE 1	IT staff in my company have the ability to support RFID technology development	.84	.85	17.134
PSITE 2	IT staff in my company have previous IT development experience	.91	.94	18.605
PSITE 3	Overall, our firm has extensive technical knowledge about technologies similar to RFID	.85	.80	19.890
PSITE 4	RFID is a familiar type of technology	.86	.81	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	12.301	.957	.786	.010	.975	.924	.975	.195
CFA Final Findings	.283	1.000	.995	.001	1.001	1.005	1.000	.000

The researcher found that the main reason for the poor fit of the prior similar IT experience model is the high standardised residual covariance between PSITE3 *'overall, our firm has extensive technical knowledge about technologies similar to RFID'* and PSITE4 *'RFID is a familiar type of technology'* (between *e2* and *e1*)—which was 15.597. According to (Byrne, 2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (PSITE3 and PSITE4) (for more details see Figure 5.15). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.22, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

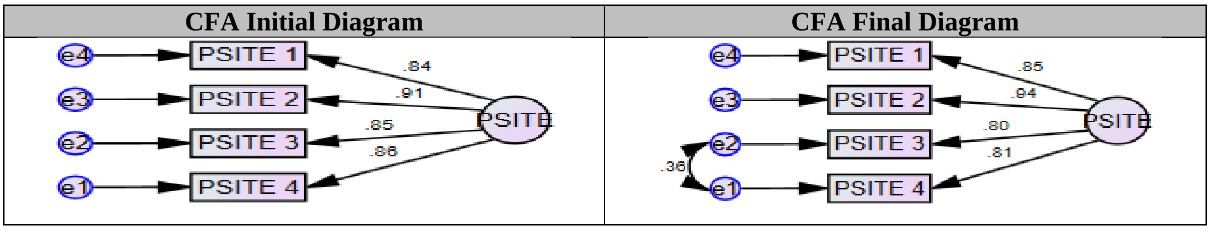


Figure 5.15: Congeneric model of prior similar IT experience

- ***Competitive Pressure: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were six items used to measure competitive pressure. The CFA initial results of the competitive pressure model fit determined that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.23). The CFA initial findings presented in Table 5.23 demonstrate that the competitive pressure model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.23: Competitive pressure CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
CP 1	My company would experience a competitive advantage if it adopts RFID technology	.34	Removed	
CP 2	Adoption of RFID technology by the competitors put pressure on my company to adopt it	.88	.86	22.901
CP 3	It is a strategic necessity for my company to use RFID to compete in marketplace	.89	.87	23.528
CP 4	My company may lose its customers to competitors if it does not adopt RFID technology	.95	.96	30.819
CP 5	The rivalry among companies in the industry which my company is operating in is very intense	.92	.92	
CP 6	RFID can offer both competitive advantages based on cost and differentiation	.12	**Removed**	

Fit Indices

	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	2.803	.970	.929	.011	.987	.979	.987	.078
CFA Final Findings	.225	1.000	.996	.001	1.001	1.004	1.000	000

The researcher found that one of the main reasons for the poor fit of the competitive pressure model is the items loading. The first iteration involved examining the items loading which indicated that the regression weight of CP6 was the lowest among the other items at 0.12.

Based on that, CP1was eliminated (Hair et al., 2010a). The other main reason for the poor fit of the competitive pressure model is the high standardised residual covariance between CP2 ‘*adoption of RFID technology by the competitors put pressure on my company to adopt it*’ and CP3 *‘it is a strategic necessity for my company to use RFID to compete in the marketplace*’ (between *e4* and *e5*) was 11.380. According to Byrne (2001) and Hair et al. (2010a), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (CP2 and CP3) (for more details see Figure 5.16). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.23, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

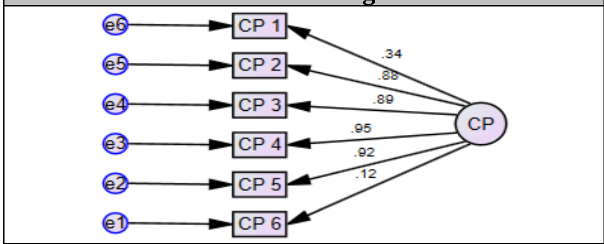
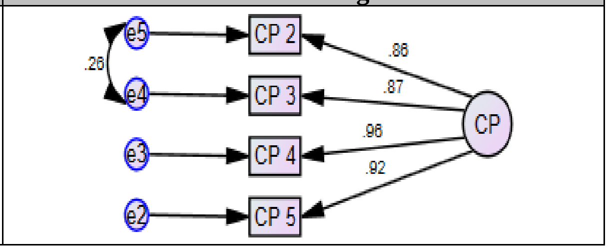
CFA Initial Diagram	CFA Final Diagram
	

Figure 5.16: Congeneric model of competitive pressure

- ***Government Regulation: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were seven items used to measure government regulation. The CFA initial results of government regulation model fit showed that the model was a poor fit to the data because the cut-off range of several fit indices was not at acceptable levels (for more details see Table 5.24). The CFA initial findings presented in Table 5.24 demonstrate that the government regulation model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.24: Government regulation CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
GR 1	Government effectively promotes RFID technology adoption	.74	.76	8.516
GR 2	The data protection policies are regulated by government regulation	.88	.86	8.934
GR 3	Government regulation can provide a better process for adopting RFID technology	.70	.69	8.144
GR 4	Current government regulation is focused on privacy	.87	.84	8.860
GR 5	Current government regulation is focused on security	.64	.57	7.210
GR 6	Current government regulation is focused on all of the risk factors	.35	**Removed**	
GR 7	There is no specific government regulation on adoption of RFID technology	.52	.51	

Fit Indices

	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	4.731	.939	.879	.053	.939	.908	.939	.112
CFA Final Findings	1.951	.983	.956	.021	.991	.982	.990	.057

The researcher found that one of the main reasons for the poor fit of the government regulation model is the items loading. The first iteration involved examining the items loading which indicated that the regression weight of GR6 was the lowest among the other items with 0.35. Based on that, GR6 was eliminated (Hair et al., 2010a). The other main reason for the poor fit of the competitive pressure model is the high standardised residual covariance between GR4 '*current government regulation is focused on privacy*' and GR5 '*current government regulation is focused on security*' (between *e4* and *e3*) was 17.635. According to (Byrne, 2001) and Hair et al. (2006b), correlating the error covariance approach can be justified both statistically and substantively. As a result of that, the researcher made covering error variance terms of both items (GR4 and GR5), (for more details see Figure 5.17). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.24, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

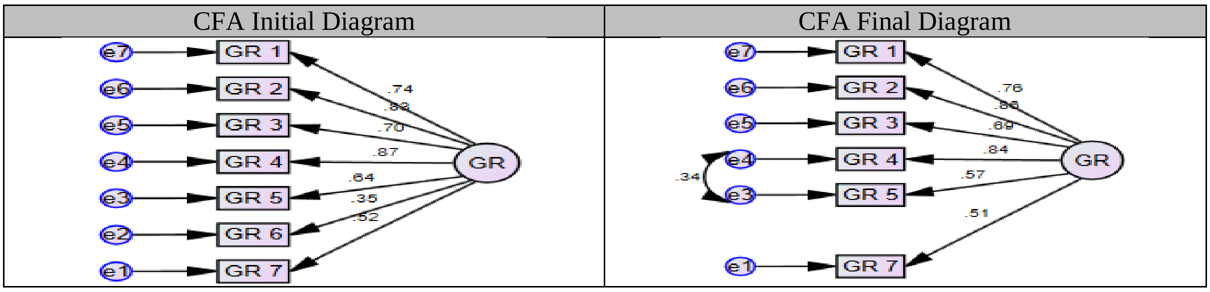


Figure 5.17: Congeneric model of government regulation

External Support: CFA Initial Findings

At the first iteration of conducting a one-factor congeneric measurement, there were five items used to measure external support. The CFA initial results of the external support model fit established that the model was a poor fit to the data because the cut-off range of several fit indices was at unacceptable levels (for more details see Table 5.25). The CFA initial findings presented in Table 5.25 demonstrate that the external support model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.25: External support CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
ES 1	Technology vendors promote RFID technology by offering free training sessions	.87	.89	8.942
ES 2	Technology vendors actively market RFID technology by providing incentives for adoption	.87	.86	8.911
ES 3	It is necessary to have adequate technical support before RFID adoption	.85	.84	8.856
ES 4	It is necessary to have adequate technical support after RFID services adoption.	.84	.86	8.813
ES 5	It is necessary that a good relationship with other parties will be crucial	.50	.49	

Fit Indices

	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	2.829	.981	.944	.007	.990	.980	.990	.079
CFA Final Findings	1.629	.992	.969	.006	.997	.993	.997	.046

The researcher found that the main reason for the poor fit of the external support model is the high standardised residual covariance between ES1 *'technology vendors promote RFID technology by offering free training sessions'* and ES4 *'it is necessary to have adequate technical support after RFID services adoption'* (between *e5* and *e2*)—which was 4.091. According to Byrne (2001) and Hair et al. (2010a), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (ES1 and ES4) (for more details see Figure 5.18). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.70, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

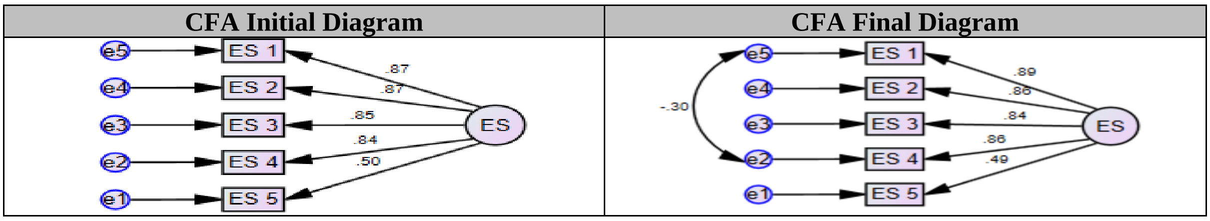


Figure 5.18: Congeneric model of external support

- ***Anticipated Benefit: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were sixteen items used to measure anticipated benefit. The CFA initial results of the anticipated benefit model fit established that the model was a poor fit to the data because the cut-off range of several fit indices was not at an acceptable level (for more details see Table 5.26). The CFA initial findings presented in Table 5.26 demonstrate that the anticipated benefit model is not a fit and needs some modification to reach an acceptable level of fit.

Table 5.26: Anticipated benefit CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final	
			Standardised Loadings	C.R. (t)
AB 1	Using the RFID technology provides better services	.80	.79	10.164
AB 2	Using the RFID technology improves operational efficiency	.51	**Removed**	
AB 3	Using the RFID technology speeds up application processes	.59	**Removed**	
AB 4	Using the RFID technology improves data accuracy	.54	**Removed**	
AB 5	Using the RFID technology improves flexibility	.71	.70	9.473
AB 6	Using the RFID technology improves availability of services	.77	.79	10.141
AB 7	Using the RFID technology improves storage capacity	.75	.71	9.562
AB 8	Using the RFID technology improves security of data	.88	.90	10.950
AB 9	Using the RFID technology reduces the level of risk	.69	.71	9.492
AB 10	Using the RFID technology improves disaster recovery and backup	.58	.50	7.361

Items	Items wording	Initial Standardised Loadings	Final	
			Standardised Loadings	C.R. (t)
AB 11	Using the RFID technology provides cost reductions	.69	.72	9.564
AB 12	Using the RFID technology reduces IT infrastructure	.68	.68	9.262
AB 13	Using the RFID technology provides remote access	.74	.74	9.741
AB 14	Using the RFID technology reduces staff	.58	.57	
AB 15	Using the RFID technology provides time efficiencies	.69	**Removed**	
AB 16	Using the RFID technology improve the communications with suppliers	.55	**Removed**	

Fit Indices								
	CMIN/DF	**GFI**	**AGFI**	**RMR**	**IFI**	**TLI**	**CFI**	**RMSEA**
CFA Initial Findings	6.430	.751	.675	.090	.801	.769	.800	.135
CFA Final Findings	2.607	.939	.904	.037	.964	.952	.964	.74

The researcher found that one of the main reasons for the poor fit of the anticipated benefit model is the items loading. The first iteration involved examining the items loading which indicated that the regression weights of AB2, AB4, AB15, AB16, and AB3 were the lowest among the other items with AB2 (.51), AB4 (.54), AB15 (.59), AB16 (.55), and AB3 (59). Based on that, AB2, AB4, AB15, AB16 and AB3 were eliminated (Hair et al., 2010). The other main reason for the poor fit of the anticipated benefit model is the high standardised residual covariance between AB7 '*using the RFID technology improves storage capacity'* had a high residual covariance with AB10 '*using the RFID technology improves disaster recovery and backup'*. The value of the residual covariance for AB7 and AB10 (between *e10* and *e7*) was 45.919. According to Byrne (2001) and Holmes-Smith (2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (AB7 and AB10) (for more details see Figure 5.19). The results of the first iteration still showed that the anticipated benefit model did not achieve a good fit. The second iteration found that AB11 '*using the RFID technology provides cost reductions'* had a high residual covariance with other different items, and especially with AB12 *'using the RFID technology reduces IT infrastructure'*. The value of the residual covariance for AB11 and AB12 (between *e6* and *e5*) was 23.806. The results of the second iteration confirmed that the model was a good fit. As shown in Table 5.26, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

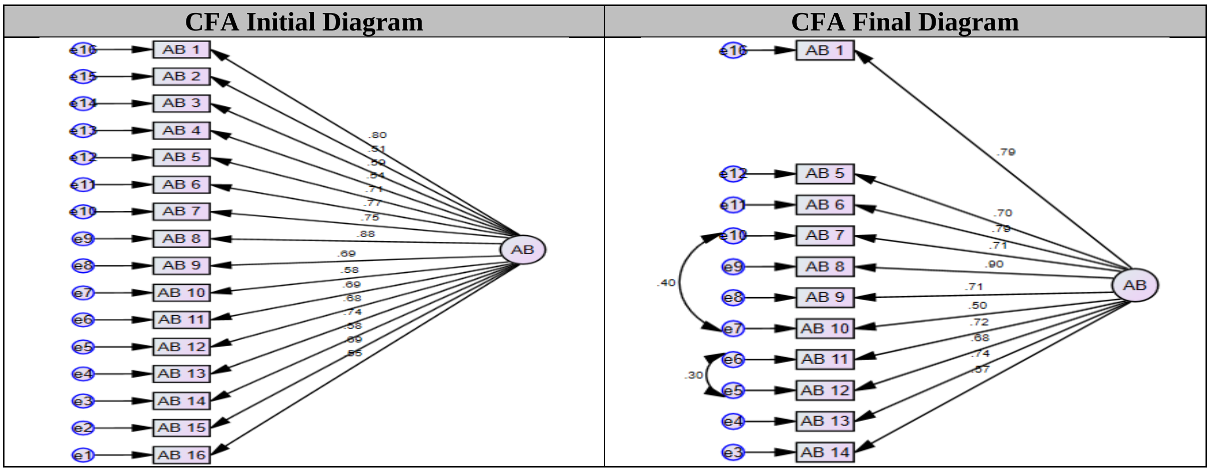


Figure 5.19: Congeneric model of anticipated benefit

- ***RFID Adoption: CFA Initial Findings***

At the first iteration of conducting one-factor congeneric measurement, there were five items used to measure the RFID adoption. The CFA initial results of RFID adoption model fit indicated that the model was a poor fit to the data because the cut-off range of several fit indices was not at an acceptable level (for more details see Table 5.27). The CFA initial findings presented in Table 5.27 demonstrate that the RFID adoption model does not fit and needs some modification to reach an acceptable level of fit.

Table 5.27: RFID adoption CFA initial findings

Items	Items wording	Initial Standardised Loadings	Final Standardised Loadings	Final C.R. (t)
RFIDD 1	Improved transaction accuracy attributable to adopt RFID	.70	.66	9.245
RFIDD 2	Improved supply chain planning attributable to adopt RFID	.81	.85	10.598
RFIDD 3	Improved data integrity attributable to adopt RFID	.73	.73	9.977
RFIDD 4	Increase in transportation efficiency attributable to RFID	.52	**Removed**	
RFIDD 5	Cost reduction attributable to adopt RFID	.65	.64	

Fit Indices	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
CFA Initial Findings	11.047	.934	.803	.049	.902	.801	.901	.184
CFA Final Findings	3.162	.989	.946	.017	.989	.967	.989	.080

The researcher found that the main reason for the poor fit of the RFID adoption model is the items loading. The first iteration involved examining the items loading which indicated that the regression weight of RFIDD4 was the lowest among the other items with 0.52. Based on that, RFIDD4 was eliminated (Hair et al., 2010a). The results of this iteration confirmed that the model was a good fit. As shown in Table 5.27, the CFA final findings of the model fit indicated and confirmed that the measurement model achieved a good fit and all the different indicators that were reported in this research met the recommended levels.

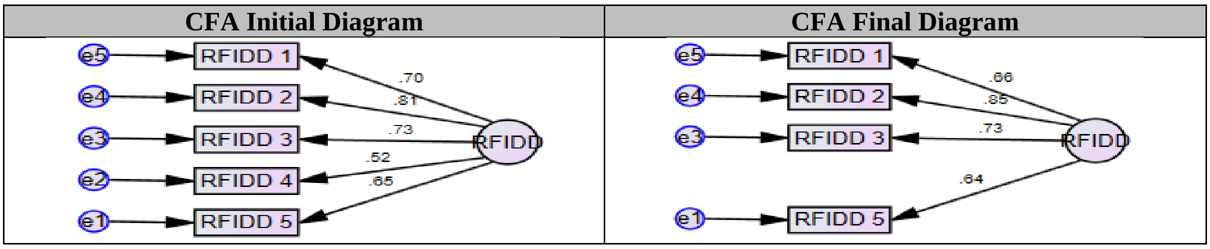


Figure 5.20: Congeneric model of the RFID adoption

- ***Summary of CFA One-factor Congeneric Measurement models***

  The previous section reported on the tests of the one-factor congeneric measurement model. Confirmatory factor analysis was employed to achieve this stage. All fifteen constructs were tested separately using this technique and the fitness of the one-factor congeneric measurement models was achieved. Table 5.28 shows the items that have been removed in the one-factor congeneric measurement model. The results of this stage are summarised in Table 5.28.

Table 5.28: Summary of congeneric measurement

Construct	No. Items Input	Eliminated Items	No. Items Output
Relative advantage	9	RA1, RA2, RA5, RA7, RA8	4
Compatibility	4	######	4
Complexity	5	######	5
Observability	4	######	4
Cost	7	######	7
Privacy	5	######	5
Security concern	5	######	5
Top management support	5	TMS3	4
Firm size	5	######	5
Prior similar IT experience	4	######	4
Competitive pressure	6	CP1, CP6	4
Government regulation	7	GR6	6
External support	5	######	5
Anticipated benefits	16	AB2, AB3, AB4, AB15, AB16	11
RFID adoption	5	RFIDD4	4
Total	**92**	**######**	**77**

- ***Stage two: Overall Measurement Model Fit***

All constructs presented in the research proposed model have been subjected to evaluation with respect to individual exogenous and endogenous variables in the measurement model fit. In this process, 15 items have been removed from the individual models, as illustrated in Table 5.28. The objective behind removing these 15 items via this procedure was to accomplish an enhanced fit to the data. An overall measurement model fit has been established with the intention of evaluating the competence of the measurement model, which tested the covariance structures for all constructs. Initially, as shown in Figure 5.36, almost 69 items were assessed in the overall measurement model.

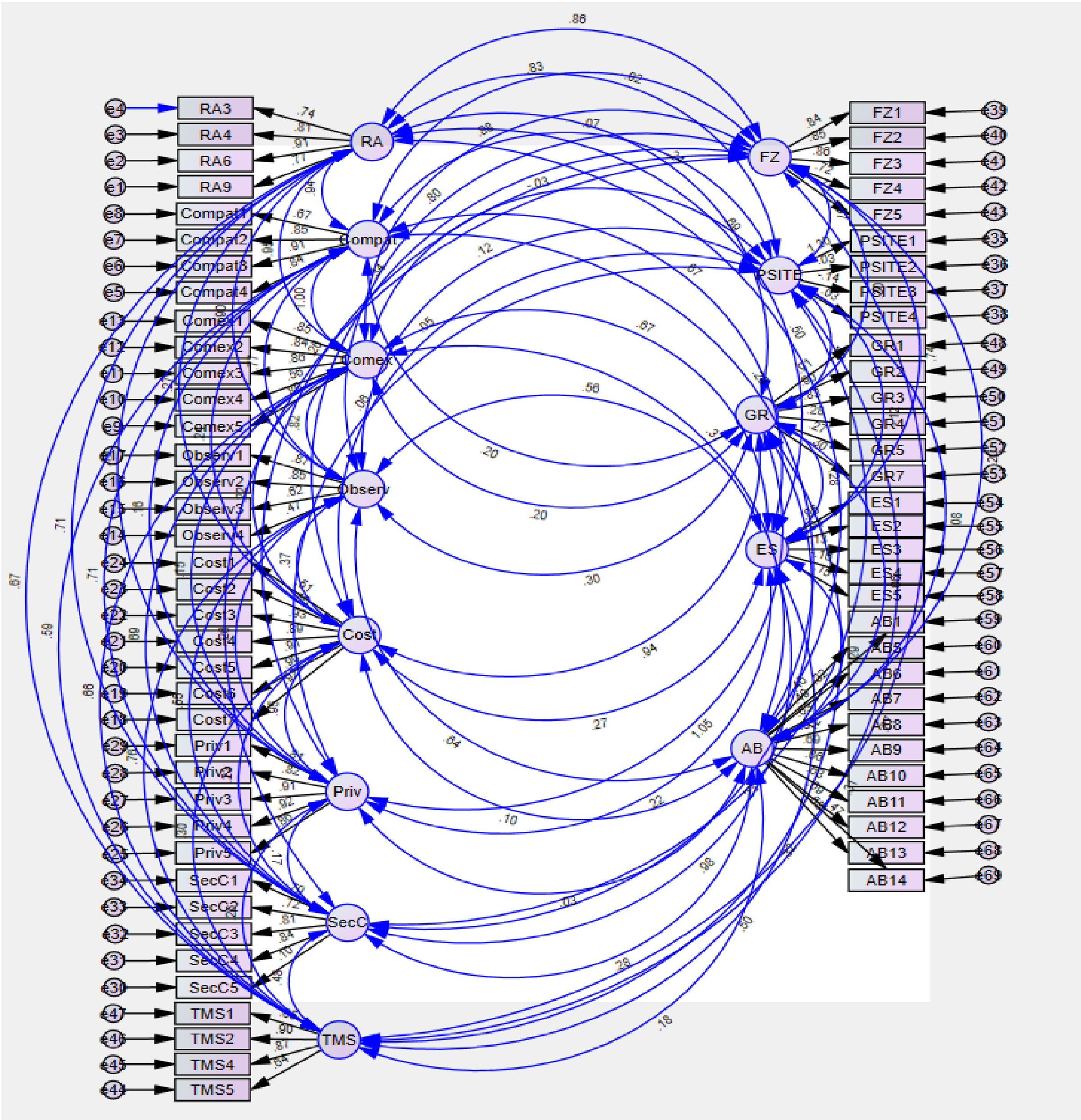


Figure 5.21: Initial overall measurement model fit

The results of the overall measurement model fit are presented in Table 5.29. These results indicated that the model was not an appropriate (poor) fit to the data because the cut-off ranges for the fit indices were not at an acceptable level.

Table 5.29: Overall measurement CFA initial model findings

Fit Indices		
Indices	**Results**	**Status**
CMIN/DF	7.753	Not acceptable
GFI	.416	Not acceptable
AGFI	.631	Not acceptable
RMR	.095	Not acceptable
IFI	.692	Not acceptable
TLI	.608	Not acceptable
CFI	.574	Not acceptable
RMSEA	.121	Not acceptable

Based on the results of the overall measurement model fit presented in Table 5.29, a number of alterations have been made to improve the overall measurement model fit. The first iteration was examining the items loading which indicated that the regression weight of (Comex 4, Observ 4, Cost 1, Cost 2, SecC 5, PSITE 1, PSITE 2, PSITE 3, PSITE 4, GR 4, GR 5, GR 7, CP 1, CP 2, CP 3, CP 4, AB 5, AB 6, AB 12, AB 14, ES 1, ES 2, AB, 1, AB 7, AB 8 and ES 4) was the lowest among the other items in the research proposal model (see Figure 5.22). Because of the low loading of these items the researcher decided to eliminate them to improve the overall measurement model fit. The overall results improved with this change but still showed that the overall measurement model did not achieve a good fit.

In the second iteration, the researcher found that there was a high standardised residual covariance between some items such as (e3 and e4 with 60.888), (e27 and e48 with 71.237), (e26 and e49 with 73.614), (e25 and e50 with 327.561), (e19 and e21 with 65.475), (e3 and e42 with 60.891), (e16 and e44 with 45.765), (e2 and e44 with 49.188), (e6 and e16 with 28.285), (e18 and e21 with 34.421) and (e43 and e47 with 33.249). According to Byrne (2001) and (Holmes-Smith, 2006), correlating the error covariance approach can be justified both statistically and substantively. As a result, the researcher made covering error variance terms of both items (e3 and e4 with 60.888), (e27 and e48 with 71.237), (e26 and e49 with 73.614), (e25 and e50 with 327.561), (e19 and e21 with 65.475), (e3 and e42 with 60.891), (e16 and e44 with 45.765), (e2 and e44 with 49.188), (e6 and e16 with 28.285), (e18 and e21 with 34.421) and (e43 and e47 with 33.249). The results of the second iteration confirmed that the model was a good fit.

Table 5.30 shows the items that have been removed in the overall measurement model. All twelve constructs in the research proposed model were evaluated in one model and the best fit of the overall measurement model was achieved.

Table 5.30: Summary overall measurement model findings

Construct	No. Items Input	No. Items Output	Eliminated Items
Relative advantage	4	4	#####
Compatibility	4	4	#####
Complexity	5	4	Comex 4
Observability	4	3	Observ 4
Cost	7	5	Cost 1 and 2
Privacy	5	5	#####
Security concern	5	4	SecC 5
Top management support	4	4	#####
Firm size	5	5	#####
PSITE	4	0	PSITE 1, 2, 3 and 4
Government regulation	6	3	GR 4, 5 and 7
External support	5	2	ES 1, 4 and 5
Anticipated benefits	11	4	Ab 1, 5, 6, 7, 8, 12 and 14
Total	**69**	**47**	######

In total, 22 items have been removed from the proposed model to achieve the overall measurement model fit. Thereafter, the proposed model achieved the final model fit as demonstrated in Table 5.30 with 47 items as shown in Figure 5.21.

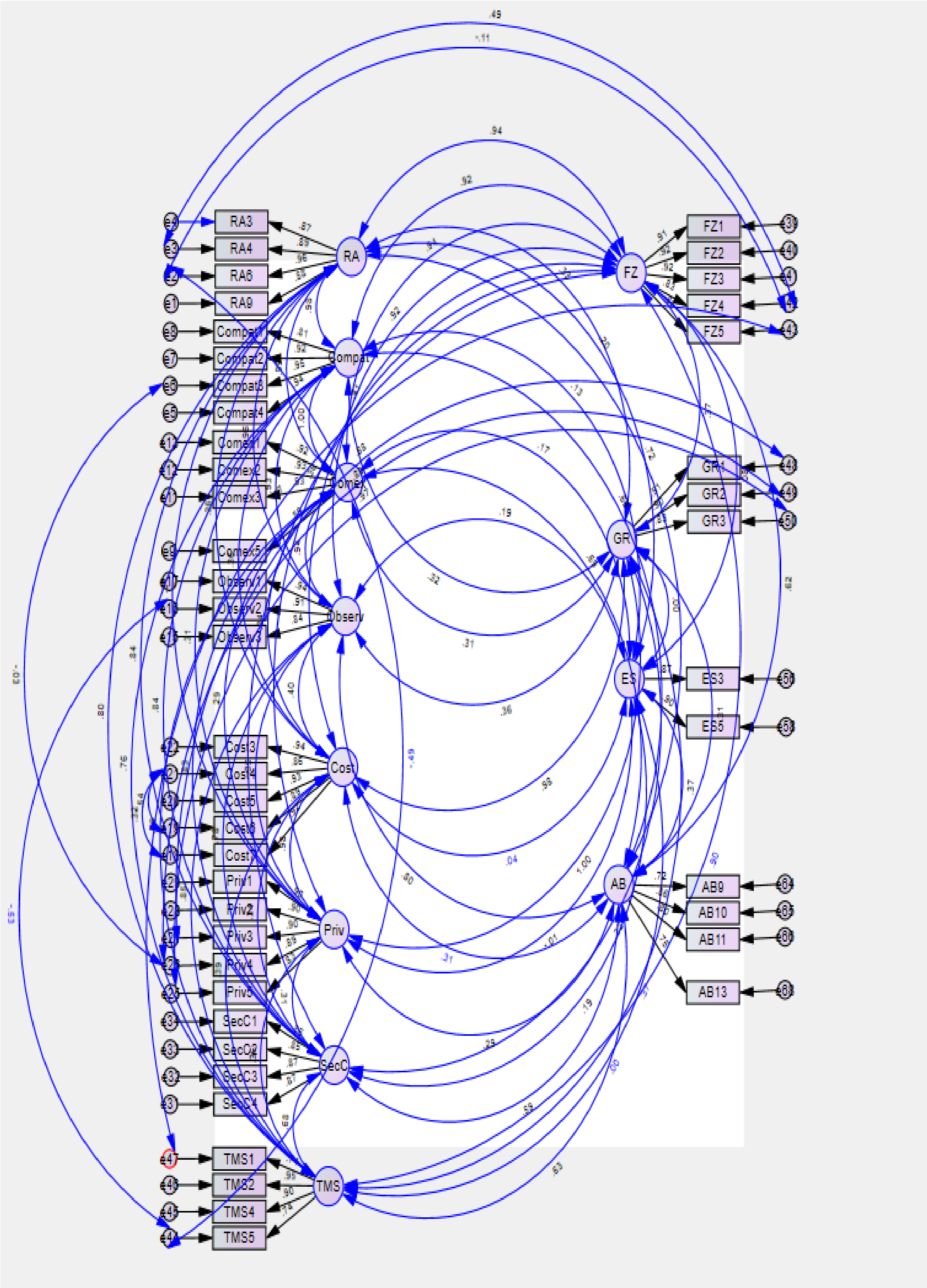


Figure 5.22: Final overall measurement model fit

The results of the final model fit are presented in Table 5.31. These results indicated and confirmed that the overall measurement model fit achieved a good fit and all the different indicators that were reported in this research met the recommended level.

Table 5.31: Overall measurement CFA final model findings

Fit Indices		
Indices	**Results**	**Status**
CMIN/DF	4.421	Good
GFI	.900	Good
AGFI	.822	Good
RMR	.039	Good
IFI	.905	Good
TLI	.897	Acceptable
CFI	.909	Good
RMSEA	.061	Good

The fit statistics validate the termination of 22 items from various constructs measures. This helps to enhance the values of the fit indices in the final model of measurement. The alterations made in the individual measurement model tend to bring significant changes in the model while improving its effectiveness. The remaining 47 items in twelve construct measures also show the significant similarity between data and the measurement model.

5.6.4 The Second Statistical Technique

In this stage, the validity and reliability of the measurement model have been examined. It is a very important stage designed to test the reliability and validity of the measurement model. This is because inappropriate measurements in validity and reliability caused by low values of the reliability or validity may lead to a negative impact on the quality of data that will be employed as an input in the next stages of the analysis process to test the reliability and validity of the proposed model. Consequently, it is essential to ensure the reliability and validity of the measurement model. In regards to analysing the reliability or validity, the results that were yielded from testing the overall measurement model were used. The assessment employed for testing the reliability and validity of the research proposed model is shown in Table 5.32. These instruments included: Cronbach’s Alpha (Hair et al., 2006b), Construct Reliability (Field, 2009); Squared Multiple Correlation (SMC) (Holmes-Smith, 2011); Convergent Validity (Hair et al., 2006b); and Construct Validity (Cunningham, 2008). Table 5.32 demonstrates the results of performing CFA to test the overall measurement model.

Table 5.32: CFA measurement model results

Items		Factors	Estimate	S.E.	C.R.(t)	P	SRW	SMC	Cronbach's Alpha	Construct Reliability	Composite reliability
*** Relative Advantage**											
RA	<---	Relative advantage	.634	.037	16.712	***	.710	.545	.848	.847	.870
RA	<---	Relative advantage	.821	.039	19.648	***	.804	.648			
RA	<---	Relative advantage	.902	.041	19.598	***	.877	.703			
RA	<---	Relative advantage	1.000				.906	.825			
*** Compatibility**											
Compa	<---	Compatibility	1.074	.055	19.355	***	.838	.708	.937	.937	.921
Compa	<---	Compatibility	1.098	.048	22.925	***	.917	.843			
Compa	<---	Compatibility	1.021	.052	19.475	***	.839	.713			
Compa	<---	Compatibility	1.000				.854	.732			
*** Complexity**											
Comex	<---	Complexity	.687	.036	18.208	***	.839	.669	.848	.867	.874
Comex	<---	Complexity	.658	.035	17.959	***	.810	.658			
Comex	<---	Complexity	.642	.044	17.999	***	.804	.695			
Comex	<---	Complexity	1.000				.769	.707			
*** Observability**											
Observ	<---	Observability	1.115	.052	23.539	***	.827	.697	.913	.913	.902
Observ	<---	Observability	1.183	.048	18.878	***	.937	.882			
Observ	<---	Observability	1.000				.865	.752			
Cost											
Cost	<---	Cost	.914	.030	28.195	***	.926	.861	.954	.956	.963
Cost	<---	Cost	.863	.029	27.791	***	.922	.853			
Cost	<---	Cost	.809	.033	23.933	***	.874	.766			
Cost	<---	Cost	.803	.034	22.843	***	.983	.816			
Cost	<---	Cost	1.000				.906	.824			
*** Privacy**											
Priv	<---	Privacy	1.039	.047	20.609	***	.854	.734	.940	.942	.931
Priv	<---	Privacy	.952	.041	21.612	***	.878	.774			
Priv	<---	Privacy	1.041	.045	22.778	***	.903	.818			
Priv	<---	Privacy	.860	.038	21.658	***	.879	.775			
Priv	<---	Privacy	1.000				.800	.708			
*** Security Concern**											
SecC	<---	Security concern	1.174	.063	17.423	***	.836	.702	.872	.873	.865

Items	Factors		Estimate	S.E.	C.R.(t)	P	SRW	SMC	Cronbach's Alpha	Construct Reliability	Composite reliability
*** Relative Advantage**											
SecC	<---	Security concern	.956	.064	14.729	***	.740	.549			
SecC	<---	Security concern	1.013	.062	15.604	***	.773	.599			
SecC	<---	Security concern	1.000				.795	.634			
*** Top Management Support**											
TMS	<---	Top management support	1.187	.100	12.501	***	.644	.506	.851	.852	.879
TMS	<---	Top management support	1.289	.104	13.129	***	.930	.868			
TMS	<---	Top management support	1.287	.106	13.223	***	.867	.852			
TMS	<---	Top management support	1.000				.851	.728			
*** Firm Size**											
FZ	<---	Firm size	.916	.041	21.291	***	.896	.807	.948	.951	.941
FZ	<---	Firm size	.847	.030	25.847	***	.911	.834			
FZ	<---	Firm size	1.002	.035	27.382	***	.913	.838			
FZ	<---	Firm size	.880	.031	27.199	***	.894	.802			
FZ	<---	Firm size	1.000				.820	.675			
*** Government Regulation**											
GR	<---	Government regulation	.984	.037	25.473	***	.891	.797	.950	.951	.944
GR	<---	Government regulation	.969	.034	27.368	***	.897	.807			
GR	<---	Government regulation	1.000				.910	.832			
*** External Support**											
ES	<---	External support	.869	.057	14.835	***	.787	.622	.865	.868	.871
EX	<---	External support	1.000				.765	.587			
AB	<---	Anticipated benefit	1.194	.106	12.490	***	.635	.510	.855	.853	.868
AB	<---	Anticipated benefit	1.315	.108	13.090	***	.926	.875			
AB	<---	Anticipated benefit	1.299	.105	13.122	***	.857	.864			
AB	<---	Anticipated benefit	1.000				.843	.737			
**** RFID Adoption**											
RFIDD	<---	RFID adoption	.708	.086	8.930	***	.604	.553	.774	.776	.794
RFIDD	<---	RFID adoption	.923	.099	10.257	***	.723	.524			
RFIDD	<---	RFID adoption	1.136	.112	10.214	***	.717	.516			
RFIDD	<---	RFID adoption	1.000				.680	.494			

**Exogenous Latent Constructs; **Endogenous Latent Constructs*

5.6.5 Reliability test

In regards to the reliability test, four assessments were used to evaluate the reliability of the research proposed model: Cronbach's alpha; Construct Reliability; Squared Multiple Correlation (SMC); and Composite Reliability (CR). Each of these reliability tests is addressed next.

Cronbach's Alpha: This is a useful test to assess the reliability of internal consistency (Zikmund et al., 2013). The recommended acceptable level of this indicator is 0.70 (Field et al., 2009, Stafford and Turan, 2011). Based on Table 5.32, all the constructs in the research proposed model were in the range of 0.774-0.954 and, thus, exceeded the acceptable level.

Construct Reliability: This tests the reliability of each construct. The recommended level of the construct reliability is 0.70 (Stafford and Turan, 2011, Hair et al., 2014a). The results of the construct reliability value of each construct in the research proposed model are presented in Table 5.32. The results show that construct reliability ranges between 0.776 and 0.956. These values confirm that the constructs achieved a good level of reliability because these values were all above the acceptable level, thus confirming a high level of reliability. High construct reliability indicates that internal consistency exists, meaning that the measures all consistently represent the same latent construct (Hair et al., 2014a).

Squared Multiple Correlation (SMC): This is considered the major indicator for assessment of every single item in the research proposed model (Hair et al., 2006b, Cunningham et al., 2006). According to Holmes-Smith (2011), the suggested value of SMC is >0.30. Table 5.32 illustrates that the items in the proposed model were between .494-.882. Consequently, the value of SMC demonstrated in Table 5.32 shows that all the items used to measure the constructs of the proposed model are reliable.

Composite Reliability (CR): This is also an indicator of reliability (Nunnally, 1994). Its value ranges between 0 and 1 and, if greater than 0.7, it indicates that internal consistency exists. It also means that the measurement items represent the same measurement construct. The results of the CR value of each construct show that construct reliability ranges between .794 and .963 (for more details see Table 5.32). These values confirm that the constructs have a high level of reliability because these values were all above the acceptable level of .70.

Thus, the measurements of reliability tests for the research proposed model have been achieved. This indicates that the proposed model has good reliability and is suitable for further testing to check validity.

5.6.6 Validity test

The validity measurement has been tested by using two assessments employed to measure the validity of the research proposed model: Convergent Validity and Construct Validity. Each of these validity tests will be addressed next.

Convergent Validity: This was used to evaluate the validity of measurement. It aims to assess the consistency of the measurement items under each measurement construct. It intends to confirm that those measurement items are actually reflecting the latent constructs that they are designed to measure. Several methods are available to estimate the relative amount of convergent validity among item measures (Hair et al., 2014a). S*tandardised Regression Weights (SRW)* is one of the important considerations. It refers to the consistency between the construct and its relative variable. It illustrates the measurement limits of the items being measured. The factor loading of each item having an approximated value of 0.50 or more is considered as a significant validity (Hair et al., 2006b). In this research, the loading values of the factors were between 0.604 and 0.983, as provided in Table 5.32. This range is considered as a standard to measure the validity of the variables. Furthermore, *the critical ratios (CR)* of the proposed research model items presented in Table 5.32 were between 8.930 and 28.195, which were more than the standard value of 1.96 recommended by (Holmes-Smith, 2001). This indicates that the proposed research model retains significant regression validity (Hair et al., 2010a). Next, *Average Variance Extracted (AVE)* was also used to test the convergent validity (Fornell and Larcker, 1981, Hair et al., 2010a). All the constructs and items of research exceeded the acceptable level of 0.50 (Hair et al., 2010a). AVE is calculated manually using Equation 5.2 (Hair et al., 2014a). For more details see Table 5.32.

Construct Validity

This is used to measure the validity of indicators to evaluate their constructs. The indices of the goodness of fit measure point to construct validity (Cunningham, 2008, Holmes-Smith, 2006). The results of one-factor congeneric measurement model are illustrated in Table 5.34. The twelve constructs in this research have achieved a good fit and the indices provide evidence of the validity of these constructs.

Table 5.34: One-factor congeneric measurement model results

Constructs	Fit Indices							
	CMIN/DF	GFI	AGFI	RMR	IFI	TLI	CFI	RMSEA
Relative advantage	1.195	.996	.979	.009	.999	.996	.999	.026
Compatibility	3.267	.995	.945	.003	.998	.985	.998	.080
Complexity	1.481	.992	.969	.013	.998	.996	.998	.040
Observability	.008	1.000	1.000	.000	1.001	1.008	1.000	.000
Cost	3.444	.964	.916	.012	.981	.966	.981	.53
Privacy	1.481	.992	.969	.013	.998	.996	.998	.040
Security concern	.576	.998	.988	.003	1.001	1.005	1.000	.000
Top management support	2.213	.996	.963	.005	.998	.991	.998	.064
Firm size	3.062	.989	.943	.008	.995	.983	.995	.079
Government regulation	1.951	.983	.956	.021	.991	.982	.990	.057
External support	1.629	.992	.969	.006	.997	.993	.997	.046
Anticipated benefits	2.607	.939	.904	.037	.964	.952	.964	.74

5.6.7 Structure Equation Model (Gündüz et al. 2013)

SEM has been increasingly utilised in the business literature in the past few years. It has become a widely used umbrella term covering a broad range of statistical concepts. SEM is an advanced statistical analysis technique (Hair et al., 2006b). It is one of the strongest multivariate techniques and allows researchers to assess the data quality of their studies' measurement models (Awang et al., 2016). The wide use of SEM is due to the ability of this technique to develop and test the theories. According to Hair et al. (2010a), SEM is defined as *'particularly useful for the process of developing and testing theories and has become a quasi-standard in research*'. SEM encompasses statistical techniques such as the testing of correlations, regression analysis, covariance testing and factor analysis (Cunningham, 2008). SEM also comprises techniques such as path analysis and CFA that determine to what degree variables are interrelated (Hair et al., 2010a).

There are three types of SEM, namely: measurement models; structural models; and the combination of the measurement and structural models (McQuitty, 2004). This research employed measurement and structural models of SEM for evaluating the proposed model because this type of SEM uses both measurement and structural parameters for the complete testing of the proposed model. SEM refers to a quantitative data assessment tool that identifies, evaluates and tests the theoretical relationships between observed endogenous constructs and unobserved exogenous constructs (Byrne, 2001).

SEM includes two steps: identification and valuation**.** In the first step, model identification is described in the SEM approach, which further relates to the influence constructs have on each other and their dimensions (Kline, 2005). A method of visual demonstration of measurement arrangement and theoretical hypothesis consisting of data, the developed model and the relevant theory is known as a specification (Diamantopoulos et al., 2000). In the valuation process, SEM gives rise to regression weight, variances, covariance and correlations during its repetitive stages which conjoin each other as per the standard measures (Holmes-Smith, 2006).

- ***Justification for using SEM***

SEM was selected in this research for the following reasons:

- SEM presents methods for testing hypotheses associated with relationships between multiple independent composite variables and dependent composite variables by simultaneously estimating a set of multiple regression equations (Lau et al., 2017).
- SEM enables testing of the whole model fit and provides comprehensive statistical indicators for assessing and modifying the models (Kline, 2011).
- It is capable of testing the relationships among observed variables and constructs to identify the weak variables that do not represent the construct significantly (Purpura, 1998).
- SEM can be employed to examine complicated models that may include several independent factors and several dependent factors (Hair Jr et al., 2016).
- It is able to confirm the factor structures of the scales used to measure the variables and examine the series of dependence relationships of multiple variables proposed by the study's conceptual model (Cunningham, 2008).
- SEM is able to detect significant errors in terms of providing measurement models that specify the level of reliability (Hair et al., 2006b).
- SEM offers more accurate causal relationships between endogenous and exogenous composite variables, extracting the size of the effect, and assessment of the appropriateness of the data (Jeon and Engineering, 2015).
- SEM is a confirmatory and exploratory method that allows researchers to use it in order to build a model in a system of non-directional influences or conditions, from one variable to another (Lau et al., 2017).

- ***Structure Model Test***

The proposed model in this research was designed to determine the factors that influence the adoption of RFID technology in Australian construction companies. In this regard, the model specifies twelve constructs (exogenous constructs) chosen to test the impact of these factors (constructs) on RFID adoption (endogenous variables). The structural model is an essential approach that represents the relationships between latent variables in the proposed model (Arbuckle, 2005). The relationships between constructs include direct or indirect effects of some constructs. However, Byrne and Campbell (1999) explained the structural model as the approach employed to determine those variables that have a direct or indirect effect on the values of other latent variables. The purpose of the structure model in the research is to evaluate the links via major paths between latent variables, as well as to examine the hypotheses for providing answers to the research questions and objectives highlighted in Chapter 1. AMOS software was used in this study to assess the structure model, where it utilised the same criteria that were used to assess the model fit indices. In addition, the assessment used the standardised path coefficients, which represent the study hypotheses, to determine the accepted and rejected hypotheses. Byrne (2001) stated that the value of standardised path coefficients, which are known as critical ratios, determine the t-value between (CR< - 1.96, CR > + 1.96) to achieve a significant level when $p < 0.05$. The following sections provide results of the structural model assessment.

- ***The results of the structural model assessment.***

The final measurement models of exogenous and endogenous were employed to generate the structural model. (Byrne and Ragin, 2009) suggested that the mean values of measurement items (observed variables) yielded by CFA could be used to develop the structural model. Figure 5.23 shows the structure model testing.

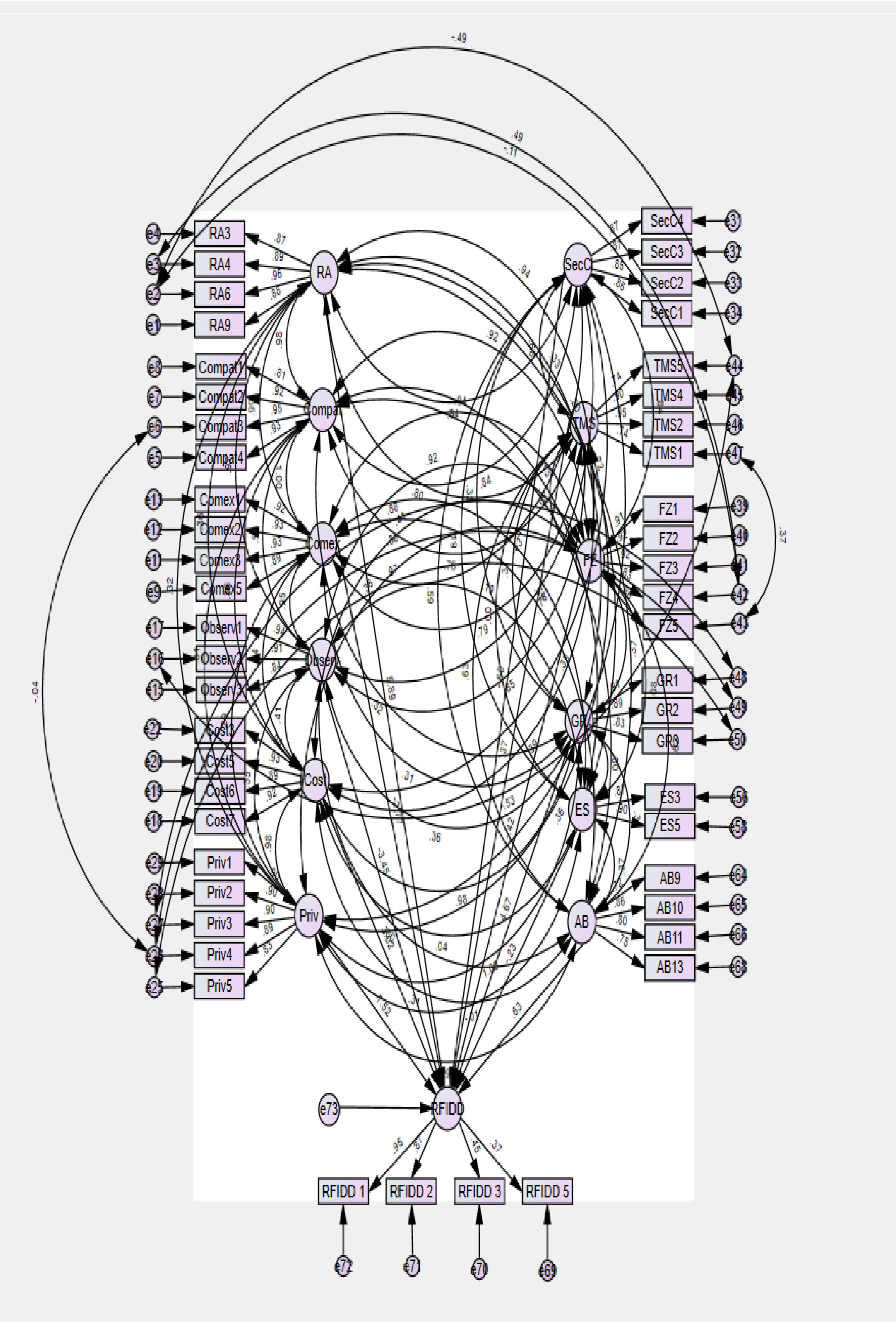


Figure 5.23: Research structural model testing

Table 5.35 shows that the results of the structural model fit indicated and confirmed that the measurement model achieved a good fit and most of the different indicators that were reported in this research met the recommended levels.

Table 5.35: Structural model fit results

Fit Indices		
Indices	**Structural Model Fit**	**Results**
CMIN/DF	2.895	Good
GFI	.897	Acceptable
AGFI	.844	Good
RMR	.040	Good
IFI	.901	Good
TLI	.908	Good
CFI	.907	Good
RMSEA	.061	Good

However, GFI with .897 as shown in Table 5.35, were less than the acceptable level of ≥.90. This is because of the complexity of the proposed model that included thirteen constructs and 50 variables (12 exogenous latent constructs with 47 observations; and one endogenous latent construct with 4 observations), as well as being due to the large size of the research sample (Alsabawy et al., 2012). Figure 5.23 shows the research structure modelling test.

Table 5.36 illustrates the results of the regression analysis among the constructs of the research structural model.

Table 5.36: Regression weights of the structural model

Path			Estimate (B)	S.E.	C.R. (t)	P
RFID Adoption	**<---**	**Relative advantage**	**.542**	**.058**	**10.398**	*******
RFID Adoption	**<---**	**Compatibility**	**.439**	**.073**	**7.256**	*******
RFID Adoption	**<---**	**Complexity**	**.087**	**.051**	**1.706**	**.088**
RFID Adoption	**<---**	**Observability**	**.049**	**.075**	**.650**	**.516**
RFID Adoption	**<---**	**Cost**	**.071**	**.040**	**2.562**	**.038***
RFID Adoption	**<---**	**Privacy**	**.215**	**.074**	**1.841**	**.432**
RFID Adoption	**<---**	**Security concern**	**-.105**	**.061**	**-1.722**	**.085**
RFID Adoption	**<---**	**Top management support**	**.154**	**.046**	**4.006**	**.002****
RFID Adoption	**<---**	**Firm size**	**.605**	**.075**	**7.926**	*******
RFID Adoption	**<---**	**Government regulation**	**-.309**	**.038**	**-7.112**	*******
RFID Adoption	**<---**	**External support**	**.374**	**.056**	**6.289**	*******
RFID Adoption	**<---**	**Anticipated benefits**	**.118**	**.036**	**3.127**	**.002****

** = value is statistically significant at P < 0.05 level*
*** = value is statistically significant at P < 0.01 level*
**** = value is statically significant at p < 0.001*

The results of the regression tests presented in Table 5.36 indicated and confirmed that seven out of twelve constructs in the research structural model have been accepted. These constructs are: relative advantage; compatibility; cost; top management support; firm size; external support; and anticipated benefits. Meanwhile, the other four constructs in the research structural model have been rejected. These constructs are complexity; observability; privacy; and security concern. Only one construct became significant, but has a negative impact on the adoption of RFID technology. This construct is government regulation.

5.7 Results of Hypotheses Examination

In this chapter, a research structural model and a series of hypotheses were developed to provide a suitable answer to the research questions outlined in Chapter 1. In this section, the research structural model and hypotheses will be evaluated by employing the results of the SEM. The hypothesised path results of the research structural model are reported in this section to test the hypotheses.

The SEM findings reported in Table 5.38 are measured on the basis of estimated path coefficient (β) value with critical ratio (t-value), and p value. The standard decision rules t-value greater than 1.96, and p value is ≤ .05, ≤ .01 and ≤ .001 apply in this research. It tends to determine the importance of the underlying path coefficient between the dependent variable and independent variables (Kline, 2011).

Hypothesis 1: Relative Advantage. The results of the regression test confirmed that relative advantage demonstrates a strongly significant positive impact on the adoption of RFID technology. Table 5.38 illustrates that the standardised regression coefficient (β) was 0.542 with critical ratio (t-value) 10.398, and p value is < 0.000***. This means that when there is an increase in the relative advantages, the possibility of adoption is expected to increase. Therefore, this hypothesis was supported.

Hypothesis 2: Compatibility. The results of the regression test confirmed that compatibility demonstrates a significant positive impact on the adoption of RFID technology. As shown in Table 5.38, it is apparent that the regression path is reasonably acceptable and sufficient to describe the relationship between compatibility and the adoption of RFID technology. This is indicated by an accounted value of C.R (t) 7.256 with a P-value of 0.000***. The standardised regression coefficient (β) was 0.439. Therefore, this hypothesis was supported.

Hypothesis 3: Complexity. The results of the regression test indicated that complexity demonstrates a non-significant and negative impact on the adoption of RFID technology. From Table 5.38, it is apparent that the regression path is weak and insufficient to describe the relationship between complexity and the adoption of RFID technology. The standardised regression coefficient (β) was 0.087, the critical ratio (t-value) 1.706, which is lower than the minimum acceptance level of significance (1.96) with standard error 0.051, and p value 0.086, which is greater than 0.05. These results confirm that there is no significant positive influence on complexity and the adoption of RFID technology. Based on these results, complexity is unlikely to have a positive impact on the adoption of RFID technology. Therefore, this hypothesis is not supported.

Hypothesis 4: Observability. The results of the regression test indicated that observability demonstrates a non-significant and negative impact on the adoption of RFID technology. From Table 5.38, it is apparent that the regression path is weak and insufficient to describe the relationship between observability and the adoption of RFID technology. The standardised regression coefficient (β) was 0.049, the critical ratio (t-value) 0.650, which is lower than the minimum acceptance level of significance (1.96), and p value 0.516. These results confirm that there is no significant positive influence for observability and the adoption of RFID technology. Based on these results, observability is unlikely to have a positive impact on the adoption of RFID technology. Therefore, this hypothesis is not supported.

Hypothesis 5: Cost. The results of the regression test indicated and confirmed that cost demonstrates a significant positive impact on the adoption of RFID technology. From Table 5.38, it is obvious that the regression path is acceptable and sufficient to describe the relationship between cost and the adoption of RFID technology. This is indicated through a calculated value of standardised regression coefficient (β) which was 0.071 with a critical ratio (t-value) of 2.562, which is greater than an acceptance level of significance (1.96) and a P-value is 0.038*. These results confirmed that there is a significant positive influence of the cost on the adoption of RFID technology. Therefore, this hypothesis was supported.

Hypothesis 6: Privacy. The results of the regression test indicated that privacy demonstrates a non-significant and negative impact on the adoption of RFID technology. From Table 5.38, it is apparent that the regression path is weak and insufficient to describe the relationship between privacy and the adoption of RFID technology. The standardised regression coefficient (β) was 0.215, the critical ratio (t-value) 1.841, and a p value 0.432. These results confirm that there is no significant positive influence for privacy and the adoption of RFID technology. Based on these results, privacy is unlikely to have a positive impact on the adoption of RFID technology. Therefore, this hypothesis is not supported.

Hypothesis 7: Security concern. The results of the regression test indicated and confirmed that security concern proves to have a non-significant impact on the adoption of RFID technology. As shown in Table 5.38, it is apparent that the regression path is reasonably weak and insufficient to describe the relationship between security concern and the adoption of RFID technology. The standardised regression coefficient (β) was -0.105 with a critical ratio (t-value) -1.722, with a P-value of 0.085, which is higher than a minimum acceptance level of significance (0.05). Based on these results, privacy does not show a significant positive influence on the adoption of RFID technology. Therefore, this hypothesis is not supported.

Hypothesis 8: Top management support. The results of the regression test indicated and confirmed that top management support demonstrates a positive and significant impact on the adoption of RFID technology. As shown in Table 5.38, the standardised regression coefficient (β) was 0.145 with a critical ratio (t-value) of 0.006, with a P-value at 0.002**. Based on these results, the top management support has a positive and significant impact on the adoption of RFID technology. Therefore, this hypothesis is supported.

Hypothesis 9: Firm size. The results of the regression test indicated and confirmed that firm size shows a strongly significant positive impact on the adoption of RFID technology. As shown in Table 5.38, it is obvious that the regression path is reasonably acceptable and sufficient to describe the relationship between firm size and the adoption of RFID technology. This is indicated through a calculated value of a critical ratio (t-value) of 7.926, which is greater than 1.96 or 2.56 (the acceptance level of significance). The value of beta (β) is 0.605. The effect of firm size on the adoption of RFID technology is significant, p value is < 0.000*** level. These results confirm that there is a significant positive impact of firm size on the adoption of RFID technology. Therefore, this hypothesis is supported.

Hypothesis 10: Government regulation. The results of the regression test indicated that government regulation shows a significant but has a negative impact on the adoption of RFID technology. As shown in Table 5.38, it is apparent that the regression path is reasonably weak and insufficient to describe the relationship between government regulation and the adoption of RFID technology. This is demonstrated through the standardised regression coefficient (β) which was -0.309 with a critical ratio (t-value) of -7.112, with a P-value of 0.000. These results confirm that there is a significant impact but negative influence of government regulation on the adoption of RFID technology. Based on these results, government regulation is not more likely to have an impact to adopt RFID technology. Therefore, this hypothesis is not supported.

Hypothesis 12: External support. The results of the regression test confirmed that external support demonstrates a significant positive impact on the adoption of RFID technology. As shown in Table 5.38, it is obvious that the regression path is reasonably acceptable and sufficient to describe the relationship between external support and the adoption of RFID technology. This is specified through an accounted value of the critical ratio (t-value) 6.289, which is greater than 1.96 or 2.56 (the acceptance level of significance). The value of beta (β) is 0.374. The impact of the external support on the adoption of RFID technology success is significant (P= 0.000) at the level of < 0.000***. These outcomes emphasise that there is a significant positive effect of external support on the adoption of RFID technology. Therefore, this hypothesis is supported.

Hypothesis 13: Anticipated benefits. The results of the regression test indicated and confirmed that anticipated benefits show a significant positive impact on the adoption of RFID technology. As shown in Table 5.38, it is clear that the regression model is reasonable and sufficient to describe the relationship between anticipated benefits and the adoption of RFID technology. The standardised regression coefficient (β) was 0.118 with a critical ratio (t-value) of 3.127, which is higher than 1.96 or 2.56, and the p value is *0.002***. These results confirm that there is a significant positive impact of anticipated benefits on the adoption of RFID technology which demonstrates that anticipated benefits positively impacts the adoption of RFID technology. Therefore, this hypothesis is supported.

Table 5.38: SEM output for hypothesised path relationships in the research structural model

Hypotheses		Paths		Research Structural Model				Impacts	Results
				Standardised (β)	S.E.	C.R. (t)	P		
H1	Relative advantage	→	RFID Adoption	.542	.058	10.398	***	Positive and significant	Supported
H2	Compatibility	→	RFID Adoption	.439	.073	7.256	***	Positive and significant	Supported
H3	Complexity	→	RFID Adoption	.087	.051	1.706	.088	Negative and not significant	Not supported
H4	Observability	→	RFID Adoption	.049	.075	.650	.516	Negative and not significant	Not supported
H5	Cost	→	RFID Adoption	.071	.040	2.562	.038*	Positive and significant	Supported
H6	Privacy	→	RFID Adoption	.215	.074	1.841	.432	Negative and not significant	Not supported
H7	Security concern	→	RFID Adoption	-.105	.061	-1.722	.085	Negative and not significant	Not supported
H8	Top management support	→	RFID Adoption	.154	.046	4.006	.002**	Positive and significant	Supported
H9	Firm size	→	RFID Adoption	.605	.075	7.926	***	Positive and significant	Supported
H10	Government regulation	→	RFID Adoption	-.309	.038	-7.112	***	Significant but negative	Supported
H11	External support	→	RFID Adoption	.374	.056	6.289	***	Positive and significant	Supported
H12	Anticipated benefits	→	RFID Adoption	.118	.036	3.127	.002**	Positive and significant	Supported

Results supported at significance level: $p \leq .01$, $p \leq .05$, $p \leq .001$

5.8 Chapter summary

This chapter commenced with the results of the descriptive analysis on the survey respondents' demographics, followed by outlined CFA; SEM test and, finally, an examination of the hypotheses results. This chapter represents the findings of the research structural model with path coefficient relationships which were evaluated using SEM. All hypotheses were examined and reported. Subsequently, seven hypotheses in the proposed model were found to be significant and as having a positive impact on the adoption of RFID technology. Four hypotheses in the proposed model were found to have an insignificant and negative impact on the adoption of RFID technology. Only one hypothesis has been found significant but has a negative impact on the adoption of RFID technology. The next chapter discusses the findings of the thesis topic.

5.9 Discussion

This part of the research will provide an in-depth discussion about the results of responses from respondents that include the factors to be considered in the adoption of RFID in SMEs in Australia. This includes the anticipated benefits of RFID adoption, the challenges which influence RFID adoption and, finally, the research model is revised.

5.9.1 Respondents Demographic Analysis

This research aims to use an online survey to discuss the participants' demographic location. There are four main demographic issues in this research: the roles in information technology; experience within IT; experience in the construction industry; and experience in RFID technology. An analysis of the results shows that IT system development/Analyst/Programmer has the highest level of participation recorded (46.5%) by (138) participants; followed by (28.3%) for IT management role, then Operation/system administration/user support (24.6%) from 73 participants, while two recorded the lowest level (0.7%). In general, the role of IT is positive. Concerning *Experience within IT* the results show that 97 participants had 10 to 15 years experience (32.7%), followed by 61 respondents (20.5%) who had more than 15 years of experience. In addition, a group had between 2 to 5 years experience also respondents 61 by (20.5%). 51 (17.2%) respondents had 5 to 10 years of experience. There was a recorded low level of IT experience, while those who had between 1 to 2 years IT experience was recorded by 26 of the respondents (8,8%). The lower level of IT experience within the groups who had less than one year is 1. Consequently, in this section, the results indicate most of the participants had a high level of IT experience, therefore, IT experience has a positive effect. In addition, the results show that experience in the construction industry also recorded good results, such as the highest proportion recorded participation being 104 (35%) by staff who had experience of between 2 to 5 years in the construction industry. Also, 77 of the respondents (25.9) had between 1 to 2 years of experience. The participants who had experience in the construction industry from 5 to 10 years numbered 62 participants (20.9). Staff who had experience of between 10 to 15 years in construction was indicated by 39 participants (13.1%). However, the lowest level recorded for those who had more than 15 years of experience in the construction industry is 6 participants (2%). In general, the results indicate that most of the participants had significant experience in the construction industry, which shows a positive effect. However, the results of this survey recorded the lowest of 10 participants (3.4%) who had from 10 to 15 years of knowledge of RFID; followed by 44 (14.8%) of the respondents who had experience of between 5 to 10 years. For example, the results of the survey showed that those who have the highest knowledge of RFID is 117 participants (39.4)—they had between 1 to 2 years of experience. This was followed by 68 of the respondents (22.9%) who had from 2 to 5 years of experience with RFID. These percentages suggest that more than half of the respondents had a sound level of RFID experience.

5.9.2 How likely will your company be to adopt RFID

The probability of adoption of RFID technology in SME construction companies in Australia is considered essential to this research in establishing how these companies can accept RFID as new technology to help improve their performance. The positive point in this section of the survey is that most of the participants in the research (138 ([6.5%]) indicated they are likely to adopt RFID in their companies. A further 126 participants (42.4%) indicated a certain intent to adopt RFID technology in their companies. Just one participant (0.3%) believes it unlikely or impossible to adopt RFID in his/her company. However, a further 31 participants (10.4%) are equally likely to adopt RFID as new technology in their companies. This growing number is an indication that these companies have the ability to adopt RFID technology within their companies.

CHAPTER SIX: CONCLUSION, LIMITATION, AND FUTURE RESEARCH

The main objective of this research is to investigate, develop and improve the supply chain performance of SMEs construction companies in Australia via the adoption of RFID. This research uses three framework theories—DOI, TOE and ANT—to reach a proposed theoretical investigation model. This research uses thirteen important constructs modelled on RFID adoption in SMEs construction companies in Australia to investigate how to improve and develop the performance of the supply chain in these companies.

The main purpose of this research is to analyse if the decision-makers in SMEs in Australia have the requisite motivation to adopt or use new technology which, in turn, may solve the problem of material delays facing their companies involving innovation factors, technological, organisational and environmental factors, and benefit factors.

6.1 The Research Objectives Summary

This research has three main objectives. Every objective has a different scale that focused on the factors to be considered for the adoption of RFID by SMEs in Australia. Therefore, each objective will be addressed in turn according to factor scales.

First goal: *To investigate the factors that impact on using RFID technology to improve the performance of SCS in SMCCA.*

This research focuses on the factors of the DIO innovation theory model and TOE framework on the anticipated factors of adoption of RFID to improve the performance of SCS in Australian SMEs. The findings from this study indicate that RFID positively improves the performance of SCS based technologies while depending on many different factors including innovation characteristics factors; relative advantage, compatibility, complexity, observability and technological factors (which include cost, privacy and security concerns). In addition, organisational technology factors include top management support, firm size and prior experience. Environmental factors include government regulation and external support. These factors implemented from DOI theory and TOE framework helped measure the extent of the relationship between the suppliers and their customers when adopting RFID to develop and improve performance. The results show that RFID has the ability to improve the performance of SCS, and it helps to develop a level of productivity of their companies and increase trust between their customers.

Second goal: ***To determine the challenges and problems that decision-makers face in Australian SMEs construction companies in relation to SC.***

RFID technology has offered significant development in various fields in recent years, and, based on previous studies shown in the literature review above, the RFID played important role in escalating the quality of performance competency and increasing productivity with suppliers. Despite this, RFID is still facing some challenges and issues in the adoption of this technology. The results of this study suggest that cost is the highest challenge facing RFID adoption, followed by a lack of real understanding of the RFID. These challenges include trust between the suppliers, integration and business transformation—most of which are caused by the lack of sufficient knowledge about RFID. Therefore, the results of this study's findings aim to spread awareness among managers and decision-makers and, in turn, to their staff and increase their awareness about how to face these challenges and issues that could affect the adoption of RFID technology in the future.

Third goal: ***To study the potential benefits of using RFID in Australian SME construction companies.***

In general, this element of the research focused on the method used to scale factors that need to be considered in the adoption of RFID to improve the performance of SCS in SMCCA. This research depended on the use of different key factors that were considered for RFID adoption in SMEs construction companies in Australia which included; 1-Improved inventory control; 2- Improved efficiency of store operation; 3- Data accuracy; 4-Tag cost at item level; 5- System automation; 6- Security; 7-Data back-up; 8- Business activity monitoring; 9- Provider dependability;10- Transportability; and 11- Improved connection with suppliers. This section details the outcomes of the research which aims to build on the findings of previous research and add to knowledge in this field. The study participants perceived a requirement for high quality and improved inventory control to help develop their performance. However, others respondents viewed improved connection with suppliers as a priority to maintain relationships and assistance with suppliers. Others suggest the need to improve the efficiency of store operations as a key factor for success. Furthermore, some respondents identified transportability control, business activity monitoring and data backup as important factors in gaining support and trust between suppliers. Other participants held a different opinion about tag cost at item level and data accuracy: they saw it as important and congruent with their work system.

6.2 Contributions to Theory

The main aim of this research was to identify how the IT/IS contribution is playing a significant role in improving and developing the performance of the global industry. The research investigated the adoption of RFID technology to develop the supply chain system to improve the performance of SME construction companies in Australia. Based on the findings and knowledge of the Australian SME construction companies, they have the aspiration and ability to adopt RFID as a tool to move toward the latest technology that can help them develop and improve their performance. This research considered different factors that can help SME construction companies planning to adopt this new technology. In addition, the results of the research highlight the factors, challenges and issues which have a direct impact on the adoption of RFID. The results of this thesis also provide expected advantages of new technology.

While this research considered RFID as new technology for adoption by SME construction companies in Australia, it was developed as a measure based on combinations of TOE framework (Tornatzky et al., 1990), DOI theory (Rogers, 1995b) and ANT theory (Law, 1992) and showed the significant role of each factor used above on adoption behaviour of RFID to develop SCS in Australian SME construction companies.

This research builds on previous studies on IS/IT to build the research model. These studies relate to the research model demonstrate how IS innovation in organisations has a direct effect by using the organisational factors and technology factors that improve overall performance (Rai and Howard, 1994, Grover et al., 1992, Moore and Benbasat, 1991). Based on the previous studies which explain the effect of innovation, technology, organisation, environment and actor network on the behaviours of adoption of new technologies, various constructs have been adopted as an investigative method and to add a new model for this research. According to the available literature, the combination of the TOE framework (Tornatzky and Fleischer, 1990), DOI theory (Rogers, 1995b) and ANT theory (Law, 1992) has not been used before as a performance indicator employed to investigate RFID adoption process models. Most of the previous studies have not shown the effect of technological, organisational, and environmental context, innovation characteristics, and benefits characteristics of the ANT behaviours on RFID adoption, or by employing appropriate model modifications which can be used in SME construction companies in Australia.

There are four key features that helped in delivering the results of this research and which contribute to the rising body of literature on the adoption of RFID. These are (1) Innovation characteristics, including relevant advantage, compatibility, complexity and observability; (2) Technology, including cost, privacy and security concerns; (3) Organisational, including firm size, top management support, prior similar IT experience; and (Das) Environmental, including government regulation, external support, characteristics benefits and RFID adoption. The main constructs dependent on this research was considered from the literature and helped to develop the design model, which was an investigative tool concerning the approach to adopting new technologies and the behaviour of the organisations seeking to develop and improve their operations to keep pace with the contemporary era of technology.

6.3 Actual Contribution

The results of this research seek to contribute to various fields including the development of the supply chain system in industry organisations which, currently, face a decline in sound relationships with suppliers and a loss of trust between them. It also contributes to understanding all the issues directly related to RFID adoption in SMEs and opens new of avenues of research to contribute to future development in IS research projects. Most of the factors used in this research and the findings are significant and greatly influence the adoption uptake of RFID by SMEs in Australian construction companies. They also help to identify strategies for SMEs construction companies in Australia to ensure a greater RFID adopt rate to develop SCS and improve their performance. From a practical perspective, the results and findings of this research can help to evaluate possible alternatives to the knowledge of the factors which influence decisions on RFID adoption and identify how it enables the accomplishment of tasks efficiently and improves the trust between suppliers and their customers. The results of this research offer effective support in the advancement of supply chain systems by determining the influence of different factors which can help to develop the performance of SMEs construction companies in Australia. The main stakeholders who participated in this research included RFID providers and decision-makers and IT staff of SMEs in Australia will significantly benefit from the detailed discussion about the extent of their influence and their response to the adoption of new technology.

According to the results of this study, awareness is the key factor in the diffusion of RFID adoption, therefore, the RFID providers can use these results to increase the rate of adoption of RFID between all the construction companies—which currently face the problem of delays in the delivery of material on time—and will also reduce the cost of their IT operations and achieve global market success.

6.4 Contribution to Practice

This study expands on existing knowledge about the implementation of ICT innovation adoption among SMEs construction companies in Australia through developing and creating a model and employing a comprehensive framework to improve and develop the performance of those companies. Also, this study considered the limitations of the research and valid measures of study variables in analysing data—which contributed to achieving positive results. This research was committed to following academic restrictions based in previous studies to provide advantageous results. However, this research represents only parts of the knowledge area of IT adoption and innovation, but it contributes to enhancing knowledge—which is important in changing the Australian Government's view of companies' looking to improve their performance through the adoption of RFID technology. Therefore, it was important to plan carefully in undertaking this research into the implementation and adoption of RFID technology in SMEs.

This research is exploratory and used the technique of online survey to collect the data from SME construction companies in Australia. The study depended on the use of an online survey investigation model to provide findings relating to RFID adoption in SME construction companies as a new service among Australian industries, but further research is needed to fully comprehend the adoption issues. Despite the methods used to analyse the decisions of all the stakeholders in this study, it is possible to use other methods to evaluate and discuss the issues. Despite current IS innovations, it is beneficial to further our knowledge about factors that help in the adoption of new technology and IS innovations in different industries. This research was mainly limited to SME construction companies in Australia. However, this could extend to include different size construction companies in Australia and different countries, including the effects on industries' culture and social convictions on the issue of innovation. This research depended on the use of one form of data collection, due to time limitations. However, in future, researchers can use a quantitative approach to focus on different industries facing delays of material with their suppliers; and it could help to provide a new comprehensive model and allocate data for more reliable comparison. Further, the variables impacting the adoption of RFID at a specific stage may change after some time and through different stages. It would likewise be fascinating to observe industries'/companies' pre/post-selection of RFID developments in future as they review their approach to further enhancing relationships with their supplier and improving their performance.

The model could be further analysed by applying SEM, as this is a more vigorous measurable procedure. As mentioned by Tabachnick et al. (2007) regarding the focal points in the decomposition of complex models, SEM inspects connections that are free from estimation errors.

6.5 Limitations and Future Research Directions

This research has some limitations. First, this research focused on the SMEs construction companies, future research may conduct the research in other industries. Second, this research focused on the companies in Australia, future research may extend this research to other countries to improve developing theory. Third, this research followed the quantitative approach to collect from the respondents, future research may use mixed method or qualitative research to gain more in-depth insights about the topic.

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Appendix 1: Survey Questionnaire

USQ
AUSTRALIA

University of Southern Queensland

The University of Southern Queensland

Survey Questionnaire

Dear Participant,

You are invited to take part in a research study which aims to explore the potential use of RFID technology in Australian small and medium construction companies. The study also aims to identify factors that are perceived likely to influence the adoption of RFID technology.

Completion of the survey is expected to take 10-15 minutes.

All information provided will remain confidential and only aggregate data will be published. No individual information will be released to any third party.

Thank you for taking the time complete the questionnaire. Your views are critical to the success of this research study.

Yours sincerely,

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A. [redacted]

Definition of RFID technology is classified as a wireless automatic identification and data capture (AIDC) technology system ADDIN EN.CITE <EndNote><Cite><Author>Wamba</Author><Year>2008</Year><RecNum>246</RecNum><

1. **How would you describe your Information Technology/ System (IT) role in your company?**
   - **Management**
   - **Systems development/Analyst/ Programmer**
   - **Operations/Systems administrator/User support**
   - **Other (please specify)**
2. **How many years of experience do you have in IT?**
   - **No experience**
   - **Less than 2 year**
   - **Between 2 and 5 years**
   - **Between 5 and 10 years**
   - **Between 10 and 15 years**
   - **More than 15 years**
3. **How many years of experience do you have in the construction industry?**
   - **No experience**
   - **Less than 2 year**
   - **Between 2 and 5 years**
   - **Between 5 and 10 years**
   - **Between 10 and 15 years**
   - **More than 15 years**
4. **How many years of experience do you have in RFID technology?**
   - **No experience**
   - **Less than 2 year**
   - **Between 2 and 5 years**
   - **Between 5 and 10 years**
   - **Between 10 and 15 years**
   - **More than 15 years**

B. [redacted]

5. **What is the size of your company in terms of total number of staff?**
   - ☐ **less than 50)**
   - ☐ **Between 50-100**
   - ☐ **Between 100-150**
   - ☐ **More than 150**

6. **What type of construction is your company mainly engaged in?**
   - **Building (Houses, schools, building of public structures)**
   - **Road construction maintenance.**

Bridges building services.
Other (______________________________)

7. Which of the following computer systems/applications does your company use? (tick all that apply)

Basic Internet services (email and web).
Web site with advanced ecommerce functions.
Transaction Processing Systems such as: Payroll, Order Tracking, etc...
Management Information Systems such as: Sales management, inventory control, etc...
Enterprise Resource Planning (Dwivedi et al.)
Supply Chain Management Systems
Other (please specify) ______________________

8. In your company, how frequently are site materials delivered to work locations on time?

☐ Always
☐ Often
☐ Sometimes
☐ Rarely
☐ Never

9. What communication system does your company use during the delivery process of site materials? *(Tick all that apply)*

Email ☐ Web conferencing
Telephone service/VoIP ☐ SMS/text messaging
Website hosting ☐ Collaboration software
ERP system ☐ Social networking/Web 2.0
Other (please specify):____

C. [redacted]

10. Which of the following situation best describes your company's knowledge of RFID? (please choose one)

☐ Certain

- ☐ Likely
- ☐ Equally likely
- ☐ Unlikely
- ☐ Impossible

11. How likely will your company be to adopt RFID based services solution in the near future?

- ☒ Certain
- ☐ Likely
- ☐ Equally likely
- ☐ Unlikely
- ☐ Impossible

Highly Likely	Likely	Unsure	Unlikely	**Slightly Important**
1	**2**	**3**	**4**	**5**

12. Using the scale below, rate the importance of the following benefits of implementing RFID on your company performance.

Item					
Improved inventory control					
Improved efficiency of store operation					
Data accuracy					
Tag cost at item level					
System automation					
Security					
Data back-up					
Business activity monitoring					
Provider dependability					
Transportability					
Improved connection with suppliers					

D.

13. Rate the importance of identifying the following challenges of RFID adoption on your company performance.

Item					
Effective network					
Data storage location					
Cost					
Loss of control over data and applications					
Privacy					

Trust					
Integration					
Policy-making					
Lack of real understanding of RFID					
Business transformation					

E.

Often when new IT investments such as RFID are made, or are being considered, organisations will look at various innovation characteristics; technological factors; organisational factors; environmental factors; and benefit characteristics.

Highly Likely	Likely	Unsure	Unlikely	Slightly Important
1	**2**	**3**	**4**	**5**

F.

14. Using the scale below, please rate the following statements regarding the *relative advantage* of RFID technology compared to traditional IT technology.

Item					
Using the RFID technology improves the quality of operation for the organisation					
Using the RFID technology provides better services					
Using the RFID technology allows for improved inventory management					
Using the RFID technology reduces the level of risk					
Using the RFID technology improves disaster recovery					
Using the RFID technology leads to cost reduction					
Using the RFID technology provides improved security against theft and counterfeiting					
Using the RFID technology improves productivity					
Using the RFID technology increases efficiency					

15. Please rate the following statements regarding RFID compatibility.

Item					
RFID technology is easily connected with the existing IT infrastructure of my organisation					
Using RFID technology is compatible with all aspects of my company					
RFID is compatible with my company's values and beliefs					
RFID compatibility is not an issue for my company					

16. Please rate the following statements regarding the complexity of RFID technology.

Item					
Using RFID technology is not seen as complex for business operations in my company					
The skills needed to adopt RFID are not seen as complex for employees in my company					
Compared to other types of technologies RFID is less complex					
Integration of RFID with the existing IT system presents no problems for my company					
Massive amounts of data generated by RFID is not difficult to manage					

17. Please rate the following statements regarding RFID *Observability*.

Item					
Adoption of RFID is important in developing innovation in your company					
Using RFID is important to improve the performance of your company					
Using RFID could enhance confidence with customers and increase the competitiveness of your company in the marketplace					
Adoption of RFID could increase the supplier's ability of controlling the time					

G. [redacted]

18. Please rate the following statements regarding the cost of RFID technology.

Item					
Maintenance costs of the RFID technology are very low					
Energy and environmental costs of the RFID technology are very low					
RFID has low training costs					
RFID decreases the investment cost in new IT infrastructure					
RFID reduces the costs of system upgrades					
RFID is cost effective compared with the other IS technologies					
RFID reduces the total cost of operational processes					

19. Please rate the following statements regarding privacy when adopting RFID technology.

Item					
My company can provide strong support to maintain privacy with the adoption of RFID					
My company can maintain the personal privacy when adopting RFID					
My company can maintain the location privacy when adopting RFID					
My company can maintain the forward privacy* when adopting RFID **<u>Forward privacy:</u> pushing forward the privacy protections in advance to prevent the competitor from tracing back the data stored in RFID tag and associate it with the current output*					
My company has capacity follow the measures of protocols to keep location privacy when adopt RFID					

20. Please rate the following statements regarding security concerns related to RFID technology.

Item					
RFID provides a sufficient security transfer channel during the process of mass data interchange					
Using RFID technology solutions is trustworthy					
RFID provides a secure service					
RFID tags can provide more authentication by preventing unauthorised duplication					
Security concerns are not an issue with RFID					

[redacted]

21. Please rate the following statements regarding the top management support within your company when adopting RFID technology.

Item					
Top management is willing to take the risks (financial and organisational) involved in adopting RFID technology					
Top management is seriously considering the adoption of an appropriate RFID technology in my company					
Top management understands the benefits of RFID technology					
Top management provides resources to support the adoption of RFID technology					
RFID technology adoption is a top management decision					

22. Please rate the following statements regarding the firm size when adopting RFID technology.

Item					
The number of employees in my company is high compared to others in the industry					

The revenue of my company is high compared to others in the industry					
Small & medium companies are more flexible in adopting RFID technology					
Bigger company with larger resources can easily move to adopt RFID technology					
The size of an company impacts its adoption of RFID technology					

23. Please rate the following statements regarding your company's *prior similar IT* experience when adopting RFID technology.

Item					
IT staff in my company have the ability to support RFID technology development					
IT staff in my company have previous IT development experience					
Overall, our firm has extensive technical knowledge about technologies similar to RFID					
RFID is a familiar type of technology					

[redacted]

24. Please rate the following statements regarding the competitive pressure of your organisation in adopting RFID technology.

Item					
My company would experience a competitive advantage if it adopt RFID technology					
Adoption of RFID technology by the competitors put pressure on my company to adopt it					
It is a strategic necessity for my company to use RFID to compete in marketplace					
My company may lose its customers to competitors if it does not adopt RFID technology					
The rivalry among companies in the industry which my company is operating in is very intense					
RFID can offer both competitive advantages based on cost and differentiation					

25. Please rate the following statements regarding *government regulation* when adopting RFID technology.

Item					
Government effectively promotes RFID technology adoption					
The data protection policies are regulated by government regulation					
Government regulation can provide a better process for adopting RFID technology					
Current government regulation is focused on privacy					
Current government regulation is focused on security					
Current government regulation is focused on all of the risk factors					
There is no specific government regulation on adoption of RFID technology					

26. Please rate the following statements regarding the *external support* needs of your company.

Item					
Technology vendors promote RFID technology by offering free training sessions					
Technology vendors actively market RFID technology by providing incentives for adoption					
It is necessary to have adequate technical support before RFID adoption					

It is necessary to have adequate technical support after RFID services adoption.					
it is necessary that a good relationship with other parties will be crucial					

[redacted]

27. Please rate the following statements regarding the anticipated benefits once RFID technology is implemented.

Item					
Using the RFID technology provides better services					
Using the RFID technology improves operational efficiency					
Using the RFID technology speeds up application processes					
Using the RFID technology improves data accuracy					
Using the RFID technology improves flexibility					
Using the RFID technology improves availability of services					
Using the RFID technology improves storage capacity					
Using the RFID technology improves security of data					
Using the RFID technology reduces the level of risk					
Using the RFID technology improves disaster recovery and backup					
Using the RFID technology provides cost reductions					
Using the RFID technology reduces IT infrastructure					
Using the RFID technology provides remote access					
Using the RFID technology reduces staff					
Using the RFID technology provides time efficiencies					
Using the RFID technology improve the communications with suppliers					

H. [redacted]

[redacted] **To what extent have the following measures of business performance been impacted by your company's adoption of RFID?**

Item **Drivers of adoption**					
Cost reduction attributable to adopt RFID					
Improved transaction accuracy attributable to adopt RFID					
Improved supply chain planning attributable to adopt RFID					
Improved data integrity attributable to adopt RFID					
Increase in transportation efficiency attributable to RFID					

Additional Comments:

Thank you very much for completing this questionnaire

Appendix 2: Final overall measurement model fit