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Consumers' perception of item-level RFID use in FMCG: A balanced perspective of benefits and risks

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Abstract

The main purpose of this thesis is to explore how perceived consumer benefits affect the perceived privacy risks associated with the implementation of Radio Frequency Identification (RFID) tags at an item-level within the Fast Moving Consumer Goods (FMCG) industry. This research expanded upon Smith *et al*. (2013) that explored the idea of consumer benefits for RFID at an item-level, which only considered benefits within a store environment. This thesis proposes two new categories to measure benefits and risks, in-store and after sale. By splitting these benefit and risk categories, the respondents' willingness to accept RFID in both a public (grocery store) and private (home) environment could be measure individually. To test the theory a quantitative survey was conducted using primary household purchasers within the USA. A total of 261 responses were received and were subjected to a PLS-SEM data analysis through SmartPLS software.

The results suggest that while consumers' seem to be aware that there could be a certain degree of risk while using RFID both in-store and after sale, they would still be willing to use the technology if there were sufficient benefits. This research has both practical and theoretical contributions, as a study into how the benefits of RFID could affect consumer acceptance of RFID, It creates a framework for future researchers to explore the topic in more in-depth studies. However, the study was limited to grocery purchasers within the United States of America (USA) between the ages of 18 and 65. While the study focused on perceived benefits and risks for the grocery purchaser, it does not take into account the rest of the household's perception of potential benefits and risks for this technology. In practical terms, this research gives practitioners reason to consider consumer benefits as a strategy for item-level RFID implementation within the FMCG industry and importantly starts to build a case for a bottom-up approach to the implantation of RFID as apposed to the enormous cost of an entire supply chain fit out.

This research changes the conversation within RFID literature, moving away from a focus on consumer privacy issues to a balanced privacy / benefits approach for consumers and how that might affect their technology acceptance.

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I would like to express my special thanks to Dr. Lincoln Wood, who supervised me during this process, without his patience and support I would not have completed this thesis. I would also like to thank my family and friends who have supported me over the past 18 months.

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Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Student Signature: Date:

Chapter 1. Introduction

1.1. Background

As technology moves forward a future with more Internet enabled devices in households around the world, the Internet of things (IoT) paradigm becomes more relevant. "The basic idea of this concept is the pervasive presence around us of a variety of things or objects – such as Radio Frequency Identification (RFID) tags, sensors, actuators, mobile phones, etc. – which, through unique addressing schemes, are able to interact with each other and cooperate with their neighbors to reach common goals" (Atzori, Iera, & Morabito, 2010, p. 2787). The unique addressing schemes are key to accessing the potential benefits offered by using RFID. Each RFID chip is allocated a unique serial number, which can be associated with an individual user, allowing more in-depth tracking of how and when each item interacts with an RFID reader, creating a pattern used for future analysis.

New smart items are now being developed based on IoT principles, impacting on many areas of daily life that would have been impossible to automate a decade ago. The 2015 Consumer Electronic Show (CES) had an abundance of smarthome[1] products are being launched to make life easier or allow you to connect to your home in new and exciting ways. Items being demonstrated included smart LED light bulbs which respond to your presence[2], a next generation smart thermostat that accurately controls indoor temperature and conserves energy[3], a smart fridge with built-in camera provides users with real-time status updates anywhere, at any time, proving most helpful when grocery shopping[4], a central sleep monitoring hub with a sensor for each bed in the house[5].

At the moment, all of these technologies are being developed for use in their own proprietary ecosystem, as no universal standard has been agreed upon to allow different brands to easily create an overlapped technological ecosystem that the IoT implies. What they do have in common is the ability to access the Internet, whether it's for receiving updates, requesting information from a database or storing user information on a remote server. There are many connection technologies that allow these items to interact with others, Wi-Fi, Bluetooth, NFC or RFID, for either connecting to the Internet via

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[1] Smarthome products refer to devices that have the ability to connect to a computer or network router, which allows it to be controlled remotely via a mobile device.
[2] Stacked Lighting BR30 Alba lamp: Learns to adapt its brightness levels based on the time of day, pre-set preferences, and user behaviour. (http://www.stacklighting.com)
[3] Nest Thermostat: Learns the household schedule and makes adjustments to the homes temperature, creating cost savings by not unnecessarily wasting energy. (http://www.nest.com)
[4] LG SmartView Fridge: Every time the door is closed a photo is taken, using LG's HomeChat system these are viewable via a smartphone to check what products are needed while at the grocery store. (http://www.lg.com/ae/press-release/lg-rolls-out-premium-smart-appliances-that-chat)
[5] SevenHugs HugOne: A network of sleep monitors giving insights into household sleeping habits and set alarms to wake users at the ideal time in their sleep cycle. (http://www.seven-hugs.com/)

a router or smartphone. “This results in the generation of enormous amounts of data which have to be stored, processed and presented in a seamless, efficient, and easily interpretable form.” (Gubbi, Buyya, Marusic, & Palaniswami, 2013, p. 1645). For example, this information could be used for home automation, assisted living, e-health or enhanced learning (Atzori et al., 2010, p. 2787). Alternatively, “the extent that everyday objects become information security risks, the IoT could distribute those risks far more widely than the Internet has to date” (Atzori et al., 2010, p. 2787).

RFID technology has become synonymous with the IoT paradigm, as they are wireless uniquely identifiable chips that are low cost, easy to produce and easy to integrate into existing manufacturing processes. Since RIFDs gain in popularity in the early 2000s, there has been a focus to create an industry standard for RFID’s Electronic Product Code (EPC). A standard would improve visibility, traceability, awareness of the chips status and current location in the supply chain. All key components on the path to the full deployment of the IoT vision (Atzori et al., 2010, p. 2790). Combined, these components provide valuable supply chain information. For example, manufacturers would have greater production tracking, being able to view real-time stages of the production line from raw materials to finished item. Reduced production interruptions through raw material out of stocks, ensuring continuity in production and supply availability. An increase in time saving by reducing materials handling, this could be achieved through accurate labelling of material locations or through an automated materials handling system. For Suppliers or retailers, improved space utilisation, by effectively managing the inventory items kept in stock, reduced out of stocks, resulting in fewer lost sales, improved asset management, high-volume re-usable assets can be easily tracked through their cycle, resulting in better asset utilisation (Tajima, 2007, pp. 266 - 267).

While this vision of the future provides major benefits for manufactures, distributers and retailers, it doesn’t provide any major benefits for the consumer. Some retail outlets are exploring fast self-checkouts or eliminating checkouts altogether through the use of RFID, but while being a major cost saving benefit to a retailer (Prater, Frazier, & Reyes, 2005, p. 136), the consumer would gain minor time saving as a benefit. What is required are some substantial after sales benefits for consumers, but to do this, the RFID tags would have to remain active, potentially opening up consumers to massive unauthorised data collection within their home. H. J. Smith, Milberg, and Burke (1996) identify four dimensions of information privacy: collection, secondary unauthorised access (internal / external), improper access and errors.

For consumers in an after sales benefit context, initial data collection would happen in store and while purchasing the item (e.g. time, date, demographics, related purchases), the secondary unauthorised access (internal) would occur when data is collected about how the item is being used in the consumers home not only for the consumers benefit but also to benefit the collecting organisation to build a buyer profile (e.g. linked to home profile, user information, related item use, when items are used / discarded), secondary unauthorised access (external) would occur if the information is then sold to a third party and not used by the collecting organisation. Improper access would occur when an unauthorised party, normally not permitted to access the personal information being collected (e.g. hackers). Finally, errors, if the protection against deliberate or accidental errors in personal information put in place are not adequate (H. J. Smith et al., 1996, p. 171).

These additional dimensions would allow organisations to gain deep personal insights into consumers buyer / usage behaviours, which is one of the key fears held by consumers when RFID tags are allowed to remain active after sale (Günther & Spiekermann, 2005, p. 74).

Despite this, there has been a major increase in the popularity of Internet connected devices and wearable gadgets, which will only increase over the next decade and become more integrated with our everyday lives. "By 2025 Internet nodes may reside in everyday things – food packages, furniture, paper documents, and more" (National Intelligence Council, 2008, p. 9).

Over the past decade, RFID literature has concentrated on technological advancements, manufacturer benefits, improving supply chain efficiencies, retail implementation and consumer privacy issues, but few papers have set out to measure how consumers' perceptions are affected by benefits of RFID technologies. However, we still lack the knowledge of how the consumers' perceived benefits and perceived privacy risks affect the usage intensions of RFID when implemented at an item level within the FMCG industry.

1.2. Motivation

The focus of research has been on industrial adoption and acceptance of RFID, which leaves open the question: At what point does household technology over step the privacy boundary? An ever increasing amount of electronic consumer devices being integrated with various sensors, cameras, microphones and internet nodes to upload the collected data and very soon, these devices will be able to communicate with each other, allowing various aspects of individually collected data to be cross referenced, creating the ultimate personal shopper profile for marketers to tailor a campaign specifically for your household.

"The Internet of Things (IoT) is deeply connected with RFID" (Anderseck et al., 2012, p. 1), being low cost and uniquely identifiable, RFID helps keep track of lower cost disposable items, turning them from everyday grocery items, into smart grocery items. This is one of the most exciting advances in smart home technology and one of the most complex privacy issues faced by consumers, self-regulating bodies and government regulatory bodies.

While RFID enabled packaging may still be a way off for the Fast Moving Consumer Goods (FMCG) industry. The eventual successful implementation of this technology requires an in-depth understanding of how it may affect consumers, both in a retail and home environment. Authors have touched upon the subject within the retail sector; publishing limited studies and theoretical models to suggest potential consumer behaviour.

Angeles (2007) was one of the first to measure consumer willingness to purchase RFID enabled items in a retail environment. In Canada, on January 1st, 2004, the Personal Information Protection and Electronic Documents Act (PIPEDA) was introduced. The PIPEDA applies to situations where a firm collects, uses, or discloses their consumers' personally identifiable information in the conduct of its commercial activities, which includes the sale of items embedded with RFID tags (Angeles, 2007, p. 463). A survey was conducted with a total sample of 381 respondents; a majority of the questions were related to potential in-store based benefits, for example, improved food safety / quality, improved price accuracy, reduced counterfeiting, in-aisle comparison and items suggestions. The findings were that 80.2% of respondents would purchase RFID-enabled items if retailers observed the PIPEDA law. The study was limited by using business students with most being between 18 and 22 years old and well educated. However, the study "confirms the notion that consumers value their personal privacy, information, and ability to control the collection and use of that information." (Angeles, 2007)

Hossain and Prybutok (2008) proposed a model for the consumer acceptance of RFID, the first model to be based on the Technology Acceptance Model (TAM) (Davis, 1989) and contextualised for RFID technology. Their model suggests that convenience, culture, privacy, regulation and security and the principal factors influencing consumer acceptance of RFID. "The findings suggest that: 1) higher perceived convenience of RFID technology leads to greater acceptance of this technology; 2) societal beliefs, value systems, norms, and/or behaviors influence the extent of consumer acceptance of RFID technology; and 3) higher perceived importance of and less willingness to sacrifice personal information security lead to lower intention to use RFID technology" (Hossain & Prybutok, 2008).

J. S. Smith, Gleim, Robinson, and Kettinger (2013) have so far come the closest to measuring how these benefits could affect consumers' perceptions. Smith *et al.* used three different methodologies to gain an understanding of consumers' acceptance, but it was the study was limited to consumer benefits / privacy risks within a store environment.

Smith *et al.* took a look at RFID implementation from a consumers' perspective, they have laid the groundwork for others to expand upon. This Thesis takes cues from the Smith *et al.* paper, using a model based upon theirs but modifying it to include two additional and key category components. We wanted to investigate how the perceived benefits and perceived risks of RFID affected consumer acceptance after the sale had been completed. By adding these two additional categories "After sales benefits" and "After sales" risks, we can establish how perceived benefits and perceived risks affect the consumers' willingness to accept item level RFID in both the in-store and home environment. The objective of this research is to determine if consumers' would be likely to accept a level of risk associated with RFID at an item level in the FMCG industry if the benefits were great enough.

Chapter 2. Significance of Research

2.1. Aim of the Thesis

This thesis proposes to identify the research gaps in present literature and expand the understanding of consumer acceptance of radio frequency identification technology (RFID) tagging at an item level in the fast moving consumer goods industry (FMCG). Item-level tagging refers to attaching of an RFID tag to each individual item, within the FMCG industry a single unit is otherwise known as a Stock Keeping Unit (SKU). Attaching an RFID tag at an item-level gives each unit its own identity through a unique Electronic Product Code (EPC). EPC refers to a string of numbers encoded into an RFID tag; each EPC is unique to that particular RFID tag, giving it a unique identity when cross-referenced with a database. Additional levels of tagging are also available, case-level tagging refers to the outer case individual SKUs are shipped in and pallet-level tagging refers to a wooden pallet that cases are packed onto and delivered to a store, as shown below in Figure 1.

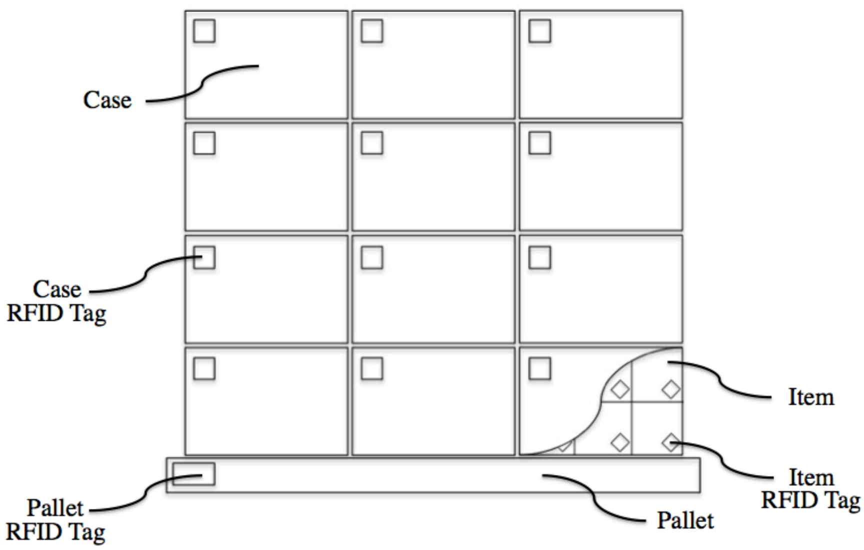

Figure 1: Diagram of a FMCG RFID tagging levels

The volume and speed at which items are turned over in an FMCG environment is the biggest incentive as well as the biggest barrier for the implementation of RFID. Being able to track inventory in real-time from the manufacture to the consumer, would provide unique insights into where cost savings could be made.

This thesis will be an intensive narrative and quantitative literature review that will cover all current literature and serve as a base for the development of an acceptance model that will explain consumers' usage intentions of RFID at an item level. This will be achieved by investigating consumers' willingness to accept a level of "in-store" and "after sales" risk while gaining the associated "in-store" and "after sales" benefits for FMCG based items.

2.2. Research Contribution

This research contributes towards an improved understanding of (Davis, 1989) technology acceptance model (TAM) and consumer acceptance of RFID contextualised model by J. S. Smith et al. (2013). The quantitative literature review will be the most in-depth model review on the subject of consumer acceptance of RFID.

This thesis will also propose a model that investigates consumer perceptions of the benefits / risks associated with RFID at an item-level within an FMCG environment. Through a quantitative survey we identify the level of perceived risks associated with item-level RFID within the FMCG industry and the level of consumer benefits required to negate the perceived risks to allow consumers' to accept the technology. This knowledge will provide a practical platform for the FMCG industry to use as a guide when creating RFID enabled consumer items.

2.3. Research Question

How do grocery buyers perceive the balance between the benefits and risks of RFID acceptance at an item-level within the FMCG industry? This will be investigated through a quantitative survey focusing on perceived benefits and perceived risks and how this affects FMCG consumers' intention to purchase / use item-level RFID tagged grocery items.

Chapter 3. Literature Review

This chapter provides a basic overview of RFID, a general understanding to give the reader an idea of how the short-range wireless technology works, various types of RFID tags, their current and future uses, before discussing the potential privacy / security issues surrounding the technology.

After the introduction, an FMCG industry background is provided which discusses the implementation attempts of Wal-Mart and the issues they faced, technical and the backlash from consumers worried about their privacy.

Later, a detailed literature review covers research conducted within the area of RFID consumer benefits and risks of item-level RFID within the FMCG industry.

3.1. Technical Overview of RIFD

An RFID device, frequently just called an RFID tag, is a small microchip designed for wireless data transmission. It is generally attached to an antenna in a package that resembles an ordinary adhesive sticker (Juels, 2006). These microchips contain a unique serial number known as an Electronic Product Code (EPC). The reason for the recent rapid and escalating use of RFID lies primarily in advanced miniaturisation, as well as the development of an international RFID standard, the Electronic Product Code (EPC) which became the foundation for many RFID Initiatives (Frédéric Thiesse, 2007). However, its the EPC that allows each item to have it's own unique identity, one that is traceable from manufacture to purchase, these unique identifiers in RFID tagged items can act as pointers to a database entries containing rich transaction histories for individual items. For example, you can have two identical boxes of cereal on a shelf at a grocery store but each will be individually identifiable due to the unique EPC contained in each RFID tag. This unique identity is one of the main reasons advocates of RFID see it as a successor to the optical barcode familiarly printed on consumer items (Juels, 2006).

The barcode was originally developed in the 1970s for the retail industry but quickly became the standard for many other industries. Today almost all new items will have a barcode attached. A barcode contains a Universal Product Code (UPC), which is a string of numbers unique to that particular item (Frederic Thiesse & Michahelles, 2006). The main differences between the barcode's UPC and the EPC is that the string of numbers contained in the barcode is much shorter, which only allows item identification to a certain degree, usually the manufacturer, brand, variant and weight. Another key difference is the way the two are read, barcodes are read with an optical scanner, the UPC is then cross-referenced with a database and item information accessed. The RFID tag is read using radio waves; the EPC information is extracted from the RFID microchip, cross-referenced with a database.

RFID tags are diverse and fall into several different categories. The two most popular types of tags are either an “active” tag, which is battery powered or a “passive” tag, which draws power from an RFID reader. There are also hybrid or “semi-passive” tags, which work as a combination of the two types. The pros / cons of each system is dependent on the indented application. “passive” or “near field” tags have a short range of communication, while “active” or “far field” tags have a much greater read / write distance (Sarma, Brock, & Engels, 2001). Within the FMCG industry, at an item level, passive tags are most likely to be used, as they are the cheapest to produce on a large scale. Passive RFID tags come in a few frequency variants and will most likely vary on the on the actual item it is attached to.

Figure 2 below gives a visual representation of a simple RFID ecosystem. Both passive and active tags are shown being accessed by an RFID reader. The actual read distance varies significantly depending on the type of tag used. By accessing the tag, the RFID reader extracts the embedded EPC data and then cross-references the EPC with a database / server to then complete its intended task.

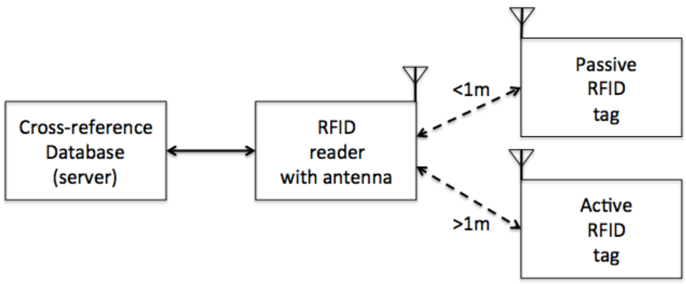

Figure 2: Diagram of a basic RFID system

The frequency ranges of tags vary depending on the application, low, high, ultra high and microwave frequencies. Low frequency tags (125 – 134Khz) are relatively inexpensive, but can only be read over very short distance and have a slow data rate. They are typically used in animal tagging applications. High frequency tags (13.56MHz) are an internationally regulated frequency with a moderate transfer rate over a distance of up to 1 meter. They have a simple antenna design, with a thin construction and have a low production cost. They are used in smart cards, item tracking, libraries and anti-theft devices. Ultra high frequency tags (860 – 930MHz) have a high data rate over a distance up to 9 meters but have a high production cost and require a power source. They are used in supply chain management, item management and in toll road payment systems. Microwave frequency tags (2.45Ghz) have a high data rate, on-board data storage and a long range up to 30m but are expensive and susceptible to noise (Curtin, Kauffman, & Riggins, 2007, p. 90).

It is most likely that item level tags will use the 13.56MHz range, as this would allow Near Field Communication (NFC) enabled mobile smart phones to access tags in a retail environment and allow the consumer to potentially gain benefits. NFC is an extension of RFID, the main difference being that NFC has a very limited range, up to 10cm (Hoy, 2013). The reason for the rise in popularity of NFC is the adoption of an agreed standard between industry manufacturers and developers. This allows different companies to manufacture hardware or develop software knowing that it will be compatible with other devices / software that use the same standard. Two major standards exist for NFC technology: ISO/IEC 14443 and ISO/IEC 18000-3. ISO/IEC14443 is used in all major proximity identification cards; a common use is to unlock doors to gain access to restricted access within a building. ISO/IEC 18000-3 provides "a framework to define common communications protocols for Internationally useable frequencies for radio frequency identification (RFID), and, where possible, to determine the use of the same protocols for all frequencies such that the problems of migrating from one to another are diminished" (*ISO/IEC 18000-3:2010*).

The adoption of NFC has been far more successful than RFID as a whole, although, they are in essence the same technology, the difference being that NFC is marketed as a benefit for the consumers, allowing the quick pairing of devices, thus saving time and being relatively easy to use. Its success lays the groundwork for larger scale implementation of RFID technologies through benefit promotion.

3.1.1. Applications

The potential applications for RFID within grocery store environment are so diverse, with the potential to add value for manufacturers, retailers and consumers (McHugh, 2004; Östman, 2013). This research will highlight some of the applications that could benefit the FMCG industry and their consumers. The conventional industry benefits include Inventory management, shrinkage reduction, theft reduction and faster checkout processing (Angeles, 2005; Jones, Clarke-Hill, Hillier, & Comfort, 2005; Li, Visich, Khumawala, & Zhang, 2006; McHugh, 2004; A. D. Smith, 2005; Taghaboni-Dutta & Velthouse, 2006). Other benefits are associated with building a better understanding of their customer base to personalise advertising, shopping lists and ultimately sell more goods (Albrecht, 2005; Alt et al., 2009). The main obstacles facing widespread adoption are the perceived privacy and security issues surrounding RFID, both in academic literature and mainstream media.

3.1.2. Privacy / Security

One of the major continuing conversations with RFID research is the potential for mass data collection on a level that, in theory, could cause major privacy issues for consumers. When RFID tags are introduced at an item-level; the ability to track objects or consumers through their use of the items could become a lot easier. This could lead to consumers becoming responsible for the objects they purchase, information collection while within stores to build a personalised advertising campaign or objects that punish misbehaviour and criminals using the system to their advantage. These types of privacy concerns are well documented (Bélanger & Crossler, 2011; Lockton & Rosenberg, 2005; Spiekermann & Evdokimov, 2009; Frédéric Thiesse, 2007). Various solutions have been proposed to either curb or completely remove the perceived potential privacy risks (Garfinkel, Juels, & Pappu, 2005; Juels, Rivest, & Szydlo, 2003; Ohkubo, Suzuki, & Kinoshita, 2005).

Garfinkel et al. (2005) present a number of theoretical scenarios stemming from the implementation of RFID. They have identified three main contexts for se of RFID tags. First, "Inside the Supply Chain" from manufacture until delivered to the final retail outlet. Second, the "Transition Zone", which covers the customer-facing portion of the retail outlet in which the RFID enabled item, is being sold to the consumer. Third, "Outside the Supply Chain", this includes all locations beyond the "Transition Zone" including the consumers' home.

Two of these three main zones provide points of direct interaction between consumers and item-level RFID. According to Garfinkel et al. (2005), this could be a personal privacy nightmare for consumers, most stemming from the unique IDs within RFID tags, meaning tags can be associated with a person's identity. An action threat, high value consumer items, such a razor blades, once removed from shelves could engage a security feature in which the consumer's photograph is taken to later determine if they have shoplifted. Another example, is a location threat, individuals carrying unique tags, once scanned, could reveal their location if a monitoring company knows the tag associated with that individual. The preference threat, thieves could identify potential targets by scanning their victim from a distance to identify any high-value items and targeting them.

These are just some of the privacy / security risk scenarios proposed by Garfinkel et al. (2005), they have also provided various technical solutions to protect consumers from these risks.

Garfinkel et al. (2005), Ohkubo et al. (2005) and Juels et al. (2003) believe that "The most straightforward approach for the protection of consumer privacy is to "kill" RFID tags before they are placed in the hands of consumers. A killed tag is truly dead, and can never be re-activated." (p. 104), they all also believe that "tags can have a post-sale value to consumers, so simply killing or removing them when items are purchased is not a cure-all for the RFID privacy problem." (Garfinkel et al., 2005, p. 39).

Rather than the usual password or encryption based solution, where a tag can only be accessed if the reader has the correct PIN or password. Garfinkel et al. (2005) suggest a rolling serial number approach, each time the tag comes into contact with a reader, the serial number is changed to 1 digit higher than it was, which essentially creates a fresh tag identity after each scan. Both Garfinkel et al. (2005) and Juels et al. (2003) also suggest a another similar solution that takes a different approach; a blocker tag, which essentially a second RFID tag that could be attached to the first, this second tag emits RF signals hostile to the first, essentially blocking the ability for the tag to emit its serial number, thus rendering it unreadable.

Ohkubo et al. (2005) propose a system similar to the rolling serial number solution except with integrated encryption. The re-writable tags change their serial number to a randomly generated number, instead of the next available number as proposed with a rolling serial number system.

In an internet-linked world, RFID or similar technology is likely to become prevalent within consumer goods, residential households and appliances (Ohkubo et al., 2005, p. 70). However, before it can be fully implemented and accepted by the general public, perceived privacy risks will still exist for consumers, varying depending on personal tolerance and the particular uses for the tag (Ohkubo et al., 2005, p. 70).

3.2. Industry Background

Radio frequency Identification (RFID) is capable of being integrated into almost any retail item for a relatively low cost. It's a technology that if implemented with a reasonable return on investment, could be considered the "holy grail" to supply chain practitioners, especially for the Fast Moving Consumer Goods (FMCG) industry.

RFID technology was a hot topic in the early 2000s; it was an exciting area of research, in a relatively new field and one that was expanding very quickly (Ngai, Moon, Riggins, & Yi, 2008, p. 511). A true innovation of the time, born from the need for an inter-organisational tracking system from manufacturing through logistics to retail, that identified possible supply chain efficiencies. It is estimated that by replacing labour intensive operations with RFID at a distribution level, that a labour cost reduction of 30% or higher could be possible (Pisello, 2005). A significant saving like this would get the attention of any business / government that heavily relies on distribution.

In 2003, Wal-Mart launched its RFID initiative, which required mandatory tagging at a pallet level for its top 100 suppliers by January 2005 (Hunt, Puglia, & Puglia, 2007, p. 115). Wal-Mart calculated that it could gain a 10% - 20% improvement in labour efficiency by getting its top 100 suppliers to implement RFID into their supply chain (Brandel, 2003). This was followed by the US Defence Department and European companies such as Metro and Tesco (Ngai et al., 2008, p. 510).

This mandatory tagging resulted in the rapid advancement of the technology. At the same time, between 1999 and 2005, of the 85 papers published on RFID, technological advancement was the main focus of academia; 31 of the papers were related to RFID technology, 28 on potential applications, and only 11 focused on privacy / security issues (Ngai *et al*., 2008, p. 514)

From 2005, academia focused more on the benefits of RFID to the supply chain process, usually for its promise as a cost saving device. Examples of cost savings include shrinkage reduction (H. Lee & Özer, 2007, p. 42), material-handling efficiency (Angeles, 2005, p. 58), improved forecast accuracy (Baars, Gille, & Strüker, 2009, p. 579), improved asset management and labour reduction (Michael & McCathie, 2005, p. 2). It has been estimated by the Retail Industry Leaders Association that of the US$3 trillion spent throughout the worldwide retail supply chain, 6–10% is lost due to poor visibility (RILA, 2004). Through these visibility improvements, the decrease in warehouse staff, and other benefits, Wal-Mart alone expected to save US$407 million annually (McHugh, 2004, p. 2).

While this may have been true for Wal-Mart, it wasn't necessarily true for their suppliers. Five years into Wal-Mart's mandatory tagging program, the results were not as expected, the rollout of RFID infrastructure took longer than anticipated and suppliers voiced concerns regarding the inequitable distribution of returns, as their returns were quite low, compared to the returns that would be gained by Wal-Mart (Stafford, 2008).

Wal-mart only initiated mandatory RFID tagging at a pallet-level, despite all the expected supply chain benefits as most retailers were unsure how to fully launch the technology in areas where it interfaced with consumers at an item level (Fusaro, 2004, p. 34). However, in 2003, Wal-mart and Proctor & Gamble had already started testing item-level RFID tagging. When high value items such as lipsticks or razorblades were taken from a "smart shelf", it activated a camera that took a photograph of the customer's face. When the customer went through the checkout another photograph was taken, these photos compared by the stores security and used to identify potential shoplifters (Lockton & Rosenberg, 2005, p. 223). While this could be considered a privacy issue, most privacy advocates were more concerned about what the RFID tags enable after consumers leave the store. It's the tracking of individual shoppers, by tracking actions, purchasing actions and whereabouts, when data is collated from a number of sources, it could form very detailed buying behavior pattern for marketers (Lockton & Rosenberg, 2005, p. 224).

Spiekermann and Ziekow (2005) and Spiekermann (2009) give an overview of consumer risks and fears taken from four focus groups. Identified consumer concerns included, the unauthorised assessment of belongings, retailer tracking of their customers via an object, unauthorised retrieval of social networks and the uncontrolled autonomous action of machines that cannot be overruled by object owners.

> **Unauthorised assessment of belongings:** A very basic attack, where criminals or burglars could remotely obtain a list of items, either on an individual or in a household

and assess them as a potential target for theft.

Retailer tracking of their customer: Retailers might track customers within their shops in order to create profiles of movement, which can be used to improve marketing strategies at the point of sale.

Unauthorised retrieval of social networks: The use of data mining techniques to gain personal information about a consumer's social networks.

Uncontrolled autonomous action of machines: The fear that consumers would not be able to override actions of a machine. For example, a smart shelf in a supermarket that sounds an alarm if the incorrect item is placed on it.

These concerns only arise when RFID is embedded at an item-level, but there are a number of ways that these consumer issues could be overcome. This type of theoretical in-depth consumer tracking caused a massive "public debate over RFID technology and how it might affect consumer data privacy in the retail industry" (Günther & Spiekermann, 2005, p. 73). As well as the public debate, RFID security and privacy issues had become the hot topic of RFID researchers with peer reviewed journal articles jumping from 23 in 2004 to 59 in 2005, 66 in 2006 and 58 in 2007 (Spiekermann & Evdokimov, 2009).

In response to this public outcry for the after sales control of RFID, the industry / academia developed various theoretical Privacy Enhancing Technologies (PET), Spiekermann and Evdokimov (2009) reviewed publications related to security and privacy issues facing RFID implementation, particularly ones focused on tag-reader security. They identified and analysed 218 papers, 149 (68%) investigate security and privacy mechanisms and 97 (44%) describe their research goals as motivated by end-user privacy protection. Some of these papers investigated multiple areas of RFID security research including both end-user privacy as well as security and privacy issues. Of those 97 papers, Spiekermann and Evdokimov (2009) identified five PET categories, RFID kill function, Physical privacy, On-tag function, Agent schemes and User schemes.

RFID kill function: Where RFID tags are deactivated via software. Controlling cross-reference access to the database server where the RFID EPC is stored, an individual tag can be made redundant.

Physical privacy: Where the reading of RFID tags is physically restricted. Destroying the RFID tag or its antennae during the checkout process will ensure it is permanently disabled.

On-tag function: Where only authorised RFID readers communicate directly with RFID tags to access to their content.

Agent schemes: Where users delegate privacy management to a third party company to control their RFID information based on the consumer's privacy preferences.

User schemes: Where RFID tags are locked when leaving the store and users can authorise which information they choose to be read to access specific benefits.

These PETs resulted in the RFID tag being either permanently or temporarily deactivated depending on the stores privacy policy or the consumer's privacy preference. While deactivating the tags after the consumer leaves the store solves the privacy issues, it also negates any potential after sales benefits, for example, returning the item without a receipt. Another option is to restrict the tagging of merchandise to the pallet level; which would cause little alarm for privacy advocates, as at that level it is highly unlikely that any consumer would ever come into possession of a tag, as the tags would end their time of service in the warehouse (Lockton & Rosenberg, 2005, p. 223).

Spiekermann (2009) highlighted the main areas of concern that consumers had when proposed the idea of individually RFID tagged retail items. The outcome of the paper was that focus groups who participated in the research believed that RFID being used at an item-level in store was acceptable, but would like the device to be permanently disabled or "killed" at the checkouts. "The major problem in killing the tag is that the various RFID stakeholders would no longer be able to take advantage of the future emerging services that would rely on the millions of RFID tags likely to be dispersed throughout the consumer environment" (Ohkubo *et al*., 2005, p. 69). This means that as well as the manufacturers and retailers, the consumers would not be able to gain any after-sales benefits from the RFID-enabled device.

The alternative solution is keeping the tag active after the sale has been completed. This increases the potential benefit for the retailer and the opportunity to give something of value to the consumer. Recent study results indicate potential usage of RFID systems can be positively impacted by potential usefulness of the technology (J. S. Smith *et al*., 2013, p. 12).

3.3. Distribution of RFID research focus from 2008 to 2014

A major literature review, published by Spiekermann and Evdokimov (2009) highlighted the main research topics between 2002 and 2007. Of the 218 papers published during this period, 149 (68%) concentrated on security and privacy mechanisms for RFID, of those 149, 97 papers listed end-user privacy as a main motivation for the research. Since 2007 / 2008, a majority of RFID research has continued to predominantly focus on technical solutions, manufacturer supply chain implementation, retailer implementation and consumer privacy risks. To illustrate the areas in which research has focused, we have highlighted key papers from 2008 to 2014. Using the Web of Knowledge database, the term "RFID" was searched providing a list of research that was then refined. First by year, then by number of citations, then articles were identified based on their relevance to RFID, Supply chain, Retailing, FMCG, Consumer Acceptance and Security / Privacy. After the initial search, the same search results were double checked to identify any overlooked papers. Additionally, the selected article's references and articles that citing them were checked for any relevant overlooked papers. All of the selected papers have been listed below in Table 1.

Table 1: Summary of RFID research 2008 through 2014

(A full references for these works are provided in Appendix 1)

Year	Authors	Subject	Technical	Supplier	Retail	Consumer	Consumer risk	Consumer benefit
2008	Bottani & Rizzi	RFID Viability Study for FMCG		X				
2008	Cazier *et al.*	Consumer Perceptions				X	X	
2008	Chen & Pfleuger	RFID in Retail	X		X			
2008	De Kok *et al.*	RFID Break even analysis		X	X			
2008	Fortunato *et al.*	Flexible RFID	X	X				
2008	Hossain & Prybutok	Consumer acceptance of RFID				X	X	
2008	Le, Mayaram & Fiez	Energy Harvesting for Passive RFID	X					
2008	Lee, Fiedler & Smith	Customer facing RFID model				X		X
2008	Lee & Park	RFID traceability in the Supply Chain	X	X				
2008	Li, Xu & Li	Smart Home Architecture	X			X		
2008	Marrocco	Antenna Design	X					
2008	Medeiros *et al.*	RFID Smart Shelf	X					
2008	Rekik, Sahin & Dallery	Product placement error in retail	X		X			
2008	Rotter	RFID Security and privacy Risks	X		X	X	X	
2008	Sample *et al.*	Battery-free programmable RFID	X					
2008	Sheng, Li & Zeadally	Next-Gen RFID Applications	X	X				
2008	Simakova & Neyland	RFID Mobile Marketing			X			
2008	Spiekermann & Rothensee	Consumer Reaction to RFID				X	X	
2008	Thiesse & Fleisch	RFID enabled manufacturing	X	X				
2008	Tzeng, Chen & Pal	Case Studies: Viability of RFID		X				
2008	Wamba *et al.*	Impact of RFID on B2B eCommerce		X				
2008	Wang, Liu & Wang	Impact of RFID Supply Chain		X				
Year	**Authors**	**Subject**	**Technical**	**Supplier**	**Retail**	**Consumer**	**Consumer risk**	**Consumer benefit**
2009	Abad *at al.*	Monitoring Cold Food Supply Chain	X	X				
2009	Jun *et al*.	Product Lifecycle Management	X		X			
2009	Langheinrich	Survey of Privacy Approaches	X			X	X	
2009	Lin	Framework for Supply Chain	X	X				
2009	Meyer *et al.*	Intelligent Products	X	X				
2009	Miragliotta *et al.*	RFID in the FMCG Supply Chain		X				
2009	Muller-Seitz *et al.*	Consumer Acceptance oF RFID	X			X	X	
2009	Poon *et al.*	RFID Enabled Order Picking	X	X				
2009	Rekik *et al.*	Inventory Inacuracy in Retail	X		X			
2009	Roh *et al.*	RFID Adoption: Expected Benefits	X	X	X			
2009	Spiekermann *et al.*	Privacy Enhancing Technologies	X			X	X	
2009	Thiesse *et al.*	Case Study: Retail	X		X	X		X
Year	**Authors**	**Subject**	**Technical**	**Supplier**	**Retail**	**Consumer**	**Consumer risk**	**Consumer benefit**
2010	Atzori, Luigi & Morabito	Literature review		X				
2010	Luttropp & Johansson	Recycling		X				
2010	Preradovic & Karmakar	Barcode of the future	X					
2010	Tsai, Lee & Wu	Case Study: Retail Taiwan			X			
2010	Whang	Supply Chain Adoption		X				
2010	Zuehlke	Smart Manufacturing	X	X				
Year	**Authors**	**Subject**	**Technical**	**Supplier**	**Retail**	**Consumer**	**Consumer risk**	**Consumer benefit**
2011	Balocco *et al.*	FMCG Supply Chain Adoption	X	X				
2011	Bélanger & Crossler	Review of Privacy Research				X		
2011	Gaukler	Retail Supply Chain			X			
2011	Kiritsis	Product Lifecycle Management	X	X	X			
2011	Rekik	Accuracy in Supply Chain	X	X				
2011	Thiesse et al.	RFID Adoption Study		X				
2011	Xu	Supply Chain Quality Management	X	X				
Year	**Authors**	**Subject**	**Technical**	**Supplier**	**Retail**	**Consumer**	**Consumer risk**	**Consumer benefit**
2012	Lopez *et al.*	Smart object framework	X					
2012	Trocchia & Ainscough	Consumer attitude towards RFID	X		X	X	X	
Year	**Authors**	**Subject**	**Technical**	**Supplier**	**Retail**	**Consumer**	**Consumer risk**	**Consumer benefit**
2013	Chen, Cheng & Huang	Supply Chain Framework		X				
2013	Dwane	RFID Enabled Checkouts			X			
2013	Smith *et al.*	Consumer Acceptance of RFID				X	X	X
Year	**Authors**	**Subject**	**Technical**	**Supplier**	**Retail**	**Consumer**	**Consumer risk**	**Consumer benefit**
2014	Winter	Surveillance in ubiquitous networks			X	X		

3.4. Critical Analysis of Consumer Risks from RFID

Table 1 shows RFID research from 2008 to 2014, what can be seen is that research of consumer risks is much more apparent than that of consumer benefits. In this section, these papers will be analysed to gain an understanding of what risks have been identified. Three main themes emerge from the identified papers, identifying security privacy / security risks, privacy enhancing technologies and proposed consumer acceptance models.

Identifying Privacy and Security Risks

Rotter (2008) proposed a framework for assessing system security and privacy risks for RFID systems. These security and privacy risks are then listed and explained within the paper. Possible consumer risks include Eavesdropping, Relay attacks, Unauthorised tag reading, Tag cloning, People tracking, Tag content changes, Malware, RFID systems breakdown, Tag destruction, Tag blocking, Tag jamming and Back-end attacks.

The paper puts into perspective all the things that could go wrong with an RFID system as well as the potential consequences for the system's end users. Rotter (2008) states "privacy risks exist only in systems that establish a link between the RFID tag and a specific person's identity" (p. 74). Thus, only items directly associated with an individual's identity will pose a privacy risk. Such items could include, RFID tagged items purchased through a retail environment that are somehow linked to the purchaser or a registered identification card. From this broad list presented by Rotter (2008), only in very specific instances do these factors actually affect a person's security or privacy.

Privacy Enhancing Technologies

Rothensee and Spiekermann (2008) present a paper, which name sums up the RFID acceptance situation, "Between extreme rejection and cautious acceptance". Two separate studies totaling 642 participants, saw an introductory RFID film and evaluated the potential privacy protection mechanisms. Although the films were unbiased, in theory no real world consumer benefits were identified within the videos. The videos merely served to explain RFID and how it is being used within the FMCG environment. Participants were then asked to rank potential privacy measures based on what they thought would be the most effective.

Overall, the paper, while educational for participants, added no real theoretical value except that some consumers hold a higher value on some of their personal information than other participants.

In 2009, Spiekermann and Evdokimov (2009) released a paper that highlighted and critically evaluated these potential Privacy Enhancing Technologies (PET). Having established in a previous paper (Günther & Spiekermann, 2005). These fears include that personal belongings could be assessed without prior knowledge or consent, consumers might become known and classified by others, people could be tracked and followed, consumers could be victimised, someone could be made responsible for each object that he or she owns, and people could be restricted or exposed through automatic object reactions.

In response to these, Spiekermann and Evdokimov (2009) presented their range of PETs to protect the privacy of end user consumers of RFID item-level products. These PETs come from a literature review of RFID from 2002 to 2007.

Cazier, Jensen, and Dave (2008a) revisit the privacy concerns highlighted by Spiekermann and Ziekow (2005) while proposing a model to measure the affect of residual RFID on consumers at an item-level within the supply chain. Results from their study "shows that positive and negative utility are both important to consumers when considering the adoption and acceptance of residual RFID tags, and that both risk likelihood and risk harm are strong and important deterrents to consumer acceptance of this technology" (Cazier et al., 2008a).

Proposed Consumer Acceptance of RFID Models

(Hossain & Prybutok, 2008) present another models for the consumer acceptance of RFID, based on the TAM. The model investigates the factors affecting the consumer's acceptance of the technology. Five factors are identified, Perceived Convenience, Perceived Culture Influence, Perceived Privacy, Perceived Regulations Influence and Perceived Security. Each of these measures are then used to determine the consumers intention to use RFID.

A survey was conduced on 256 students, of which the results found that higher perceived convenience of RFID technology leads to greater acceptance of this technology, societal beliefs, value systems, norms, and/or behaviors influence the extent of consumer acceptance of RFID technology and higher perceived importance of and less willingness to sacrifice personal information security lead to lower intention to use RFID technology.

Müller-Seitz, Dautzenberg, Creusen, and Stromereder (2009) present an adapted TAM for the consumer acceptance of RFID. They have extended the TAM by including a "Security Concerns" construct. The addition of this construct tries to balance the perceived consumer benefits and security concerns within the electronics retail environment. The subsequent surveys to test the model identified issues surrounding the challenges facing widespread RFID adoption. The results of the study show "that customer acceptance of the innovative RFID technology depends considerably on its perceived usefulness" (Müller-Seitz et al., 2009, p. 37). In addition, "the second most important factor for the acceptance of the RFID technology is customers' general attitude toward the protection of data privacy" (Müller-Seitz et al., 2009).

Trocchia and Ainscough (2012) attempt to determine what variables influence consumers' attitude towards RFID tracking of their purchase behaviour. A survey was conducted to explore this question, with the results providing five key findings.

- Consumers do not want to be tracked beyond the retail environment regardless of the incentive offered.
- Financial compensation was not able to induce consumers to participate in RFID programs in which they were not otherwise predisposed to participate.
- A timesaving checkout lane was not able to induce consumers to participate in RFID programs in which they were not otherwise predisposed to participate.
- Men were more likely to find RFID programs appealing than women.
- Older consumers were less willing to participate in RFID programs than their younger counterparts.

The key findings presented by Trocchia and Ainscough (2012) are damning for the future of RFID implementation at a retail level, let alone at an item-level. However, the paper focuses on the benefits gained by the retail owner as opposed to the consumer. The research question asks, "What variables influence consumers' attitudes toward RFID tracking of their purchase behavior?"

3.5. Critical Analysis of Consumer Benefits from RFID

Looking at the results of those searches, Table 1 provides us with an overview of key research published between 2008 and 2014. What's clear is that only three key papers have considered consumer benefits from RFID technology. And as shown in table 1, the academic conversation surrounding consumers and RFID is heavily weighted around the potential privacy risks of the technology, while not considering the potential benefits to consumers. Below are critical reviews of these three papers that do consider these benefits.

One of the earliest articles to examine the potential benefits for consumers was Lee, Fiedler, and Smith (2008). They proposed a novel approach to using RFID to add value. Instead of the traditional supply chain efficiency approach, Lee *et al.* suggests a customer-facing diffusion model, where RFID is used to add intangible value to a item or service, thus increasing customer loyalty or customer satisfaction.

Three case studies were presented and examined to develop the model. The first study was of a large public library where RFID was used to add a self-checkout service, reducing the number of staff dedicated to checkout and improving the simplicity of the self-checkout service. The second study involved the automation of the road race timing system, decreasing the amount of volunteers and providing runners with more accurate results. The third study, a hospital-patient tracking system, demonstrated improvements in the check-in of patients, the link between patient medical records and getting the right patient the right asset at the right time.

Even though the implementation of RFID through a supply chain can provide cost savings through efficiency, Lee *et al.* (2008) provides an alternative method for using RFID to add value to business processes through customer applications. While Lee *et al.* does provide some examples of benefits, they are all internal to the organisation being studied. There was no examination of benefits external to the organisation, focused on the consumer use of RFID.

Integrated RFID in the apparel industry

The second study of interest was the contribution of Frederic Thiesse, Al-Kassab, and Fleisch (2009) that concentrates on a major European department store, which participated in two RFID trials, one in 2003 and another in 2008. The main objective of the first trial was to examine to what extent RFID could create efficiency within supply chain operations under real-world conditions. The second trial extended the RFID implementation into the retail side of the department store; now offering customers the ability to engage with RFID via smart-shelves, mirrors, monitors and in-store mobile devices.

The data from the two case studies were examined and it was determined that by implementing RFID at a retail level and allowing customer to interact with their items before purchase, could create value in a retail environment. A limitation of the study is that all benefits were limited to in the retail environment and examples were limited to the fashion retail environment. Additionally, no after sales benefits were available for consumers.

> **Smart shelves:** RFID enabled garment shelves equipped with monitors, show sizes of each item in stock, saving the customer time looking for their size.
>
> **Smart mirrors:** Mirrors attached to RFID readers and monitors allow customers to view item information such as materials, care instructions, available sizes and colours.
>
> **Smart monitors:** Fitting rooms equipped with RFID readers are able to display item information, other sizes, other colours and complimentary items via a monitor.

In-store mobile devices: Handheld RFID scanners carried by staff can scan a particular item for customers to see if there are any other colours or sizes in the storeroom.

Frederic Thiesse *et al.* (2009) was one of the first case studies of a large-scale RFID rollout within the retail environment. Of particular interest was the way that they demonstrated that there could be a business case for engaging consumers by adding value to their shopping experience. While privacy considerations were not a part of the case study, the department store only noted three customer complaints of privacy issues during the trial period.

A regulatory perspective on consumer acceptance of RFID

J. S. Smith *et al.* (2013) explored RFID from consumers' perspectives with three studies, each using a separate methodology, examining a total of 800 consumers.

Study 1: A semi-structured qualitative preliminary study that focused on consumer's perceptions of RFID. The study involved 57 Masters of Business Administration students who were generally familiar with RFID technology. The results indicate that the respondents could see the benefits of the technology, but the study results may be representative of the general public as all respondents were MBA students familiar with RFID.

Study 2: The second study examines the promotional and preventative concerns noted by consumers via large-scale data collection. The results show that the type of message received related to the technology, either positive or negative, impacts subsequent evaluations.

Study 3: The third study focused on increasing consumer acceptance, by alleviating privacy concerns associated with RFID. This was achieved by providing consumers with a privacy statement before the survey, allow the consumers to understand what information is being collected and what will be done with it. A total of 104 respondents, who were all general consumers, took part in the study. When the results were analysed they showed that the consumers presented with the "new technology" label had a higher purchase intentions to those presented with the "RFID" label. In addition it showed that the respondents would be more willing to accept the technology, if presented with a privacy statement from the organisation.

Overall, the results of this paper indicate that consumer's acceptance of RFID could be positively impacted through perceived usefulness of the technology and that the perceived usefulness weighs more heavily on consumers acceptance than the associated perceived risks and that consumers are still adverse to name RFID when used at an item-level, but a privacy statement from the company could help reduce this negative attitude.

3.6. Research Gap

From the current research we can identify a gap within the literature that needs to be explored further. This research gap is to what degree will the perceived benefits of RFID at an item-level affect consumers' perceived risks and is there a difference between the benefits / risks within a store environment and the benefits / risks after the item has been purchased.

Chapter 4. Conceptual Model and Hypotheses Development

Chapter 4 lays the foundation for our model development; the proposed model expands on the Smith *et al.* (2013) model, which is derived from Davis' TAM but contextualised for RFID acceptance. The next few paragraphs will provide an overview for each of the models and why we have chosen to base the proposed model upon these.

4.1. Technology Acceptance Model

The Technology Acceptance Model (TAM) is "considered the most influential and commonly employed theory for describing an individual's acceptance of information systems" (Y. Lee, Kozar, & Larsen, 2003). Originally adapted from the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980). The main purpose of the TAM was to create a better measure for predicting and explaining the intention of use (IOU) to Information Systems (IS) technologies (Davis, 1989, p. 320). Davis believed that the two core factors influencing system use were Perceived Usefulness (PU) and Perceived Ease of Use (PEOU). The definition of each being, PU is "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis, 1989, p. 320) and PEOU is "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320), in other words, the TAM predicts behavior based on a self-motivated interest, the use of the technology will make that particular task easier.

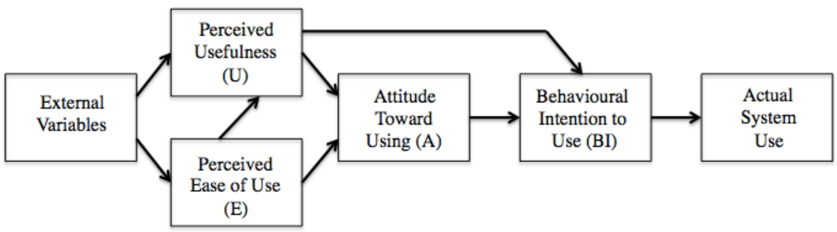

Figure 3: Technology Acceptance Model (TAM) (Davis, Bagozzi, & Warshaw, 1989, p. 985)

As shown in the above Figure 3, actual system use is determined by an individual's behavioural intention to use a proposed technology (BI), which is influenced by their attitude toward use (A) (Davis, 1989, p. 333). Perceived usefulness (U) has a direct influence over both attitude toward use and intention to use, as apposed to the perceived ease of use (E) which influences the perceived usefulness and attitude towards use. This makes sense since "users are driven to adopt an application primarily because of the functions it performs for them and secondarily for how easy or hard it is to get the system to perform those functions" (Davis, 1989, p. 333).

The use of the TAM as base for the proposed model as apposed to the model on which it is derived, the Theory of Reasoned Action (TRA) (Ajzen & Fishbein, 1980) "suggests that social behavior is motivated by an individual's attitude toward carrying out that behavior, a function of one's beliefs about the outcome of performing that behavior and an evaluation of the value of each of those outcomes" (Moon & Kim, 2001). The TRA uses both "attitude towards behaviour" and "subjective norm" constructs to determine behavioural intention. In the case of this proposed model, the use of a subjective norm is unnecessary as these norms, which are usually based of culture, age, gender or race don't affect intention to use of RFID technology within the FMCG environment.

The proposed model measures technology acceptance of the grocery decision maker, which changes depending on the household demographic, there are no subjective norms. The TAM was chosen for the proposed model's path from Technology Acceptance (TA) to Intention of Use (IOU) as this is the most tested and validated model for technology acceptance.

4.2. Smith *et al.* Model

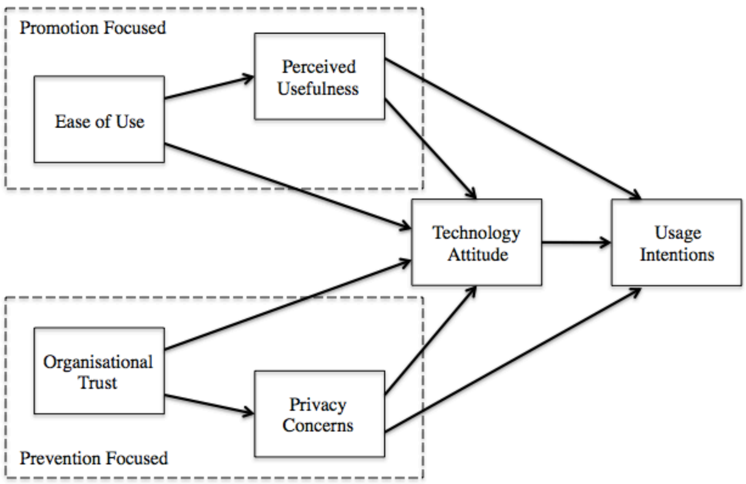

Figure 4: Proposed model of the factors affecting RFID utilization (J. S. Smith *et al.*, 2013)

Figure 4 shows the Smith *et al.* model and how it uses the TAM as a foundation their exploratory RFID research. Two key differences are immediately visible, Promotion Focus and Prevention Focus. Smith *et al.* have used the TAM as a core component of their model, using it almost entirely to validate their "Promotion Focused" section, an area where decisions are made based on the ability to gain subjective benefits from using the technology contrast, while the opposite area, "Prevention focus" centers on the need to minimize potential negative outcomes from any associated risks associated with a decision to use the technology (J. S. Smith *et al*., 2013, p. 5). These additional two constructs have been theorised from Smith *et al.* based upon previous privacy research, the organisation trust construct stems from Morgan and Hunt (1994) which defines trust to protect an individual and not misuse technology and the Privacy concerns from Wirtz, Lwin, and Williams (2007), in which users have opted out of the use of business services due the requirement to provide personal data.

Due to the nature of RFID and factors influencing technology acceptance, both positive and negative factors need to be taken into account. While a consumer may see the benefits for using RFID, they may feel that the overall risks outweigh the potential benefits (J. S. Smith *et al*., 2013, p. 6). The ideas explored within the Smith *et al.* model serve as inspiration for the proposed model, the idea of promotion and prevention focused constructs measuring the potential technology acceptance of consumers, is a sound measure. However, it needs to be expanded beyond a single location in which the benefit and risk assessment can take place.

4.3. Hypothesis Development

This proposed model is derived from the Smith *et al.* model, which is a contextualised TAM model for consumer acceptance of RFID technology as the TAM predicts behaviors based upon a self-serving motivation to make a task simpler, thus causing a higher likelihood of acceptance. This is exactly what the proposed model wanted to measure. The likelihood that the perceived benefits from using RFID at an item-level will outweigh the perceived risks.

Although the proposed model is derived from the Smith *et al.* model, it expands upon the research by exploring how balancing the benefits and risks of RFID at an item-level within the FMCG industry affects consumer acceptance. The extensive examination of the consumer acceptance of RFID found through the three studies by J. S. Smith *et al.* (2013) showed that overall the usage of RFID can be positively impacted by perceived usefulness and a significant influence of its potential utilisation. Additionally, there are differences in privacy concerns, technological attitudes and usage intentions. They suggest that offering the consumer potential value through the implementation of RFID from a promotion focused path by marketing resources, could be an important strategy (J. S. Smith *et al*., 2013).

As the Smith *et al.* paper did not differentiate between the types of potential consumer benefits and their differing associated risks, both in-store and after sale, there is room to expand upon their model to gain further insight into consumer acceptance of RFID after the purchase has been completed. Differentiating between these two types of benefits available to consumers allows for a greater understanding of how consumers might react to RFID at an item-level and to what degree they are willing to accept its integration into their everyday lives. This thesis' model proposes exactly that, the idea that the potential benefits to consumers be split into two separate categories, in-store benefits and after sales benefits. The reason being that consumers' expectation of privacy would change depending whether they are using benefits associated to RFID technology in a grocery store or at home. Below are some examples of what would be considered benefits in each of the categories.

In-store Benefits

Consumer in-store benefits are those, which a consumer would consider of value while in a store environment. For example, Smart shopping cart, Instant coupons, Suggested complementary items, Returning an item without a receipt, Detailed item information (Environmental impacts / Nutritional information), Rapid self-checkouts, Item reviews, Interactive promotional displays.

> **Detailed ingredient information:** Scanning an item will bring up a complete list of ingredients. This could be useful for highlighting ingredients that you or a family member is allergic to (Woody, 2009).
>
> **Environmental Item information:** A quick scan of an item with your mobile phone could bring information of its environmental impact. For example: Where it was manufactured, where the ingredients were sourced, the packaging used, is it recyclable. Alternatively, consumers could set up a prerequisite for environmental impact; once scanned, a green, amber or red pop-up will appear to indicate how inline that particular item is with your list of prerequisites (Woody, 2009).
>
> **Instant coupons:** A scannable advertisement that allows consumers to collect coupons for instant discounts in-store. Once the consumer gets to the checkout, they swipe their mobile phone and the coupons are activated on the checkout / disabled on the mobile phone (O'Shea, Polzin, Schrodt, & Clusman, 2003).
>
> **Interactive promotional displays:** An interactive promotional store display that could allow consumers to interact with marketing materials by scanning a mobile phone and submitting personal data in order to gain free samples, coupons or enter competition (Begum & Geiger, 2000).

Item reviews: The ability to instantly lookup a review on a particular item. For example, if you scan a bottle of wine, it could give you tasting notes, wine score and food pairings (O'Neill, 2011).

Rapid self-checkouts: Once consumers have proceeded to the checkout aisle, the smart trolley will automatically communicate with the payment system, which will display the amount of the purchase. This process would be a lot quicker, as items would not need to be individually scanned. Once the items are paid for, the consumer could just walk out of the store without the need for items having to leave the shopping cart (A. D. Smith, 2005).

Returning an item without a receipt: If a consumer needed to return or exchange an item to a store, all necessary purchasing information would be associated with that individual item's RFID EPC, making the process much more efficient (Günther & Spiekermann, 2005)

Smart shopping cart: Fitted with an RFID reader and a display. The reader automatically scans items put in or taken out of the cart, keeping a real-time list. This information could be used to keep a running total of the value of the cart. It could also display a list of complimentary items or promotional offers on similar / previously purchased items (Östman, 2013).

Suggested complimentary items: Based on what you have in your shopping cart, suggestions could be made as to what items could compliment your current purchases (Östman, 2013).

After Sales Benefits

Consumer After sales benefits are those, which a consumer would consider of value while at home. For example, Budgeting assistant, Recipe suggestion, Shopping list generation, Real time access to a kitchen inventory, Company promotional interaction (competitions), Meal planner based on dietary requirements / workout regime.

The below benefits are examples, which are theoretically possible, if RFID is implemented at an item-level and smart appliances and kitchens integrated with medium-range RFID readers become popular.

Automatically generated shopping lists: After the "Smart system" has learned what you usually purchase, the frequency at which you purchase and the amount you usually spend. The smart app will be able to automatically generate a shopping list based on your defined criteria.

Budgeting assistant: After generating the automatic list of regularly purchased items, the budgeting assistant can show you where to find the best deal on said list of items or suggest similar items that will meet your required budget.

Company promotional interaction (competitions): After the sale has been completed, consumers can enter a promotion by scanning the RFID tag embedded in the label. This will automatically send the relevant details to the company in order to enter the promotion.

Real-time access to kitchen inventory: When grocery items are enabled with RFID, each will be given an EPC (Electronic Product Code) that will give it a unique identity, allowing it to be individually tracked in real time via PC or smartphone app.

Recipe suggestions: If you are stuck for meal ideas, your mobile device can scan your kitchen for ingredients and suggest meals based on what you have available as well as provide you with a recipe.

Reduce Wastage: By suggesting recipes based upon live data from your pantry contents, it is less likely that food will be go bad and be wasted, thus reducing household perishable food wastage and saving the consumer a significant amount of money annually.

Meal planner based on dietary requirements / workout regime: Combined with the shopping list generator and the recipe suggestion application, the meal planner will change your dietary intake based on what your body requires. Information can be gathered from various other in-home smart devices to gain the required data.

Trocchia and Ainscough (2012) presented a compelling argument as to why consumers may be prepared to have a lower expectation of privacy in a grocery store and a much higher expectation of privacy in their home.

> Legal [academics] have said that a "reasonable expectation of privacy" exists when a person has "exhibited an actual (subjective) expectation of privacy" and, second, that the expectation is "one that society is prepared to recognize as reasonable. Thus, a man's home is, for most purposes, a place where he expects privacy, but *objects, activities, or statements that he exposes to the plain view of outsiders are not protected, because no intention to keep them to himself has been exhibited*" (Katz

> 1968). […] Similarly, consumers may be less sensitive to such violations in locations in which such expectation would not reasonably exist, such as a grocery store sales floor (Trocchia & Ainscough, 2012, pp. 67, emphasis added).

Therefore, as there are clearly two separate expectations of privacy, then this differential level of sensitivity suggests that while consumers may be more willing to forgo privacy in a shop they will be far more sensitive to forging privacy at home. This thesis proposes a model that builds on the theory laid out by J. S. Smith *et al*. (2013), developed from the Davis (1989) Technology Acceptance Model (TAM) by differentiating between the two types of benefits, calling one in-store benefits for all benefits gained while in a shopping environment and two, after sales benefits, which are benefits gained after the checkout process which leads to this paper's first two hypotheses.

> ***H1.*** *In-store benefits will have a positive influence on consumers' perceived usefulness of RFID.*
>
> ***H2.*** *After sales benefits will have a positive influence on consumers' perceived usefulness of RFID.*

These In-store Benefits (ISB) and After Sales Benefits (ASB) will measure the consumer's Perceived Benefits (PB) of RFID within the Fast Moving Consumer Goods Industry (FMCG). Similarly to the PB, the Perceived Risks (PR) are separated into two types of risks, In-store Risks (ISR) and After Sales Risks (ASR). This is done for the same reason as the benefits that a consumer's expectation of privacy within a shopping environment will differ from their expectation of privacy at home. Giving the fourth and fifth hypotheses.

> ***H4.*** *In-store risks will have a negative influence on consumers' perceived risks of RFID.*
>
> ***H5.*** *After sales risks will have a negative influence on consumers' perceived risks of RFID.*

The above four hypotheses (H1, H2, H4, H5) serve as the measure for the PB and PR for this model. As consumer RFID acceptance is still a relatively untested subject, other higher risk new technology platforms were explored, for example the adoption of online banking. Pikkarainen, Pikkarainen, Karjaluoto, and Pahnila (2004) studied factors influencing consumer acceptance of online banking. They found "that perceived usefulness and information on online banking on the web site were the main factors influencing online-banking acceptance" (p. 229). In the proposed models case, Perceived

Usefulness (PU) can be equated to Perceived Benefits (PB), which will indicate positive influence on overall Technology Acceptance (TA).

Therefore, this thesis posits that a combination of both in-store and after sales benefits will indicate the perceived benefits of RFID will provide a similar result within the at an item-level within the fast moving consumer goods industry. PB is a contextualised version of the Davis (1989) Perceived Usefulness (PU) construct. As perceived usefulness (PU) is a well accepted indicator of consumers Technology Attitude (TA). This thesis posits that the PB will have a positive influence on consumer's technological attitude towards RIFD for fast moving consumer goods.

> ***H3.*** *Perceived usefulness of RFID will have a positive influence on technology attitude towards RFID.*

The possible in-store and after sales benefits differ in terms of the type of benefits they offer the consumer. After sales benefits will be predominately be seen in the home environment, although, to gain the full benefit consumers will likely have to purchase "smart kitchen" appliances, such a RFID enabled fridges / retrofitting kits for their kitchen. This will allow consumers to have real time access to their kitchen inventory via a PC or mobile phone application.

In-store benefits are unique to the shopping environment and have different perceived associated risks, so may have a different affect on consumers' intention of use. Much like the in-store benefits, perceived risks have been separated into in-store risks and after sales risks. Sticking with consumer acceptance of online banking, Roy, Kesharwani, and Singh Bisht (2012) explored the impact of perceived risk on online banking acceptance; the findings were "that perceived risk has a negative impact on behavioural intention of internet banking adoption" (p. 316). So, it can be assumed that in the proposed model, Perceived Risk (PR) will have a negative influence on Technology Acceptance (TA).

> ***H6.*** *Perceived risks will have a negative influence on technology attitude towards RFID.*

As the proposed model uses the well-established Technology Acceptance Model (Davis, 1989) to measure the consumers technological attitude and usage intentions, using the same constructs will allow us to gain insight into whether they view this technology positively or negatively, which will give an overall indication as to whether or not they would accept the technology. In this model, both PB and PR will directly affect the overall Technology Acceptance (TA) of RFID, which as the TAM dictates will have a direct affect of the consumers overall Intention of Use (IOU), bringing us to the final hypothesis.

H7. The overall positive or negative attitude towards RFID will affect the intention of use the technology at an item level.

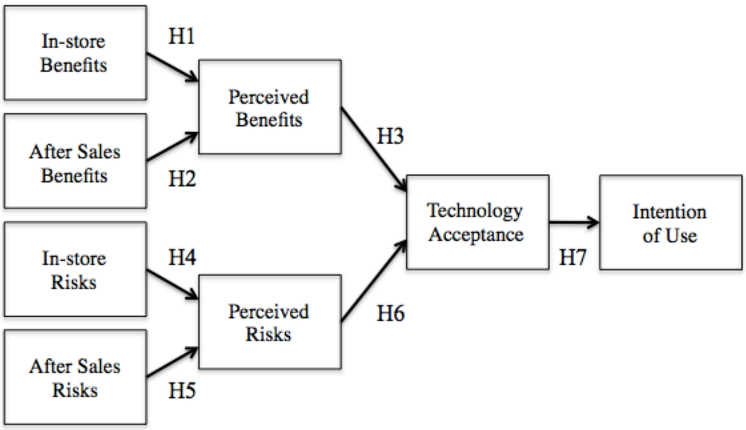

Figure 5: How in-store and after sales benefits / risks affect consumer's RFID acceptance

Chapter 5. Research method and Design

This chapter outlines the methodology used to prove the hypotheses and answer the research question, *how do grocery buyers perceive the balance between the benefits and risks of RFID acceptance at an item-level within the FMCG industry?* In this section the survey instrument, data collection, sample size, identification of participants and the data analysis method are discussed.

Due to the nature of our research topic, RFID at an item-level within the FMCG industry will have widespread effects on the privacy of consumers (McCullagh, 2003, p. 1). While the potential consequences of the incorrect implementation RFID are rather large, the information required to gain an understanding of how consumers perceive the implementation and what could change that perception (Chen & Pfleuger Jr, 2008, p. 56).

A quantitative approach was decided upon as the research is trying to measure consumer acceptance of a hypothetical technology within a foreign country. Besides the logistics and cost of conducting a qualitative study using either focus groups or one-on-one interviews, the use of practical examples in this environment would bias the result. When people are presented with a new technology, in this case RFID-enabled smart groceries, the novelty of the technology could skew the results. A quantitative survey allowed the questions to be structured in a way to minimise bias as well as be conducted locally through a US based research company, gaining the maximum amount of data within budget and in the required timeframe.

In addition, since this research is using an experimental model with the goal of measuring consumer perceptions to predict potential technology acceptance in a reliable and repeatable manner, the use of quantitative method to test these hypothetical generalisations is the best solution (J. K. Smith, 1983, p. 11).

5.1. Instrument design

To test the validity of the model, a large-scale data collection was undertaken via an online structured survey. This research sought to improve on the Smith *et al.* questionnaire, which measured "Perceived usefulness" and "Privacy concerns", but there was no differentiation between the consumers perceived usefulness in-store and after sales. This differentiation is key to understanding to what degree consumers will really accept such an invasive technology on such a large scale. The Smith *et al.* paper also gathered data from a group of MBA students, of which many already had a good understanding of the workings of RFID; this is considerable limitation of their study and as it is not necessarily a true reflection of a general consumers' potential acceptance.

For the survey, a five point Likert scale was chosen, from 1 (strongly agree) to 5 (strongly disagree). The survey deals with consumers' being asked questions regarding the perceived benefits and risks for the implementation of an unreleased unfamiliar technology. The questions are situational, putting consumers in hypothetical scenarios where they would be interacting with this new wireless technology and being told the potential benefits or risks. The use of a simple scale, with the extremes of "strongly disagree" and "strongly agree" were preferred to a numbered scale system, as qualifying the perceived risk or benefit on a 10-point format places greater reliance on the respondent using a numerical response, for which the precise meaning has not been defined (Dawes, 2008), which would affect the reliable and validity of the survey.

The remaining choices were either a 5-point or 7-point Likert scale. Dawes (2008) presents a simple study in which he conducts the same survey three times, but uses a different scale system and compared the results. The mean scores from the 5-point and 7-point responses were identical. Smith *et al*. used a 5-point Likert scale and as the proposed model expands upon the Smith *et al*. research model, the use of a 5-point Likert scale allowed for easy modification of a validated survey instrument for use to test our proposed model with minor modifications.

The new constructs for testing in-store / after sales benefits / risks, while not previously tested or validated within the literature are based upon the *reasonable expectation of privacy* theory (*Katz v. United States - 389 U.S. 347*, 1967). The case states that while in a public place, such a grocery store a person has a lesser expectation of privacy, as apposed to at home, where someone would have a definite expectation of privacy.

The structured survey (See Appendix 2) asks respondents to rate the potential benefits and risks of "a new smart grocery technology", the use of the word RFID was intentionally avoided due the possibility of negative associations with the word. The structure of the survey asks respondents to rate a positive benefit of the technology, then in the following question a negative risk of the technology.

A pilot test was conducted on 20 fellow students to identify any potential bias within the survey. Originally, the survey was structured with all questions referring to the positive aspects of RFID within the first half first, then the negative questions within the last half of the survey, with the final set of questions at the end asking what would be the likelihood of use. This was identified as a potential bias as the likelihood of use would be negatively biased due to the negative questions directly preceding the final section.

To negate this potential bias within the survey, one choice was to randomise the questions for each participant, but due to the nature of the questions, this would not have been possible. The solution was to pair questions together, this "pairing" of positive and negative questions helped reduce a positive or negative bias within the survey through "order effect" (Steinberg, 2001), the use of this method has been shown to create more extreme answers from respondents, except in situations where the questions are well defined and not vague (Furrer & Sudharshan, 2001). As this survey was based upon hypothetical situations, which have an impact on privacy, but also offer previously unknown benefits, it would be easy for a positive or negative bias to occur, thus the use of "order effect" was the best option for this survey.

5.2. Data Collection

A quantitative approach was taken through a large-scale data collection via an online survey research company. This research company was able to call upon members whom met the predetermined demographic criteria of the survey, in this case, household grocery decision makers between the ages of 18 and 65. While respondents are not directly incentivised for their participation, a small donation was given to a charity of their choice.

5.3. Data Analysis Method

After the data has been collected, it was processed using Partial Least Squared Structural Equation Modeling (PLS-SEM) (Henseler, Ringle, & Sinkovics, 2009). The use of PLS-SEM was preferred as new and the relationships between attributes have not been previously tested (Ainuddin, Beamish, Hulland, & Rouse, 2007). Hair Jr, Hult, Ringle, and Sarstedt (2013) recommends sample sizes, based on the maximum number of indicators pointing at individual constructs. In the case of this research case, there are three indicators for each construct, recommending a sample size of 124 respondents to gain an R^2 of 0.10 and a 5% level of significance. 250 respondents were chosen, which should yield an R^2 of 0.10 and a significance level of greater than 1%. PLS-SEM was chosen over Covariance-based structural equation modeling (CB-SEM), as this thesis is not proposing a new model to test, but exploring the relative strengths of the model's pathways. "PLS-SEM is an ordinary least squares (OLS) regression based model rather than the maximum likelihood (ML) estimation procedure for CB-SEM" (Hair Jr *et al.*, 2013, p. 15) this means that PLS-SEM estimates the path model relationships that maximise the R^2 value of the endogenous constructs, minimising unexplained variances, which allows for better theoretical model development (Hair Jr *et al.*, 2013, p. 16).

5.4. Identification of participants

The 250 respondents were based in the United States; this allowed the research to gain data from a demographic that would more than likely be first to be exposed to such a technology as well as allow the results to be compared to other US based research. Respondents between the ages of 18 and 65, who were the primary grocery decision maker for their household, were chosen. As the online survey company was used, there is no way to determine total number of survey links sent to potential participants, which limits our ability to produce a response rate for the survey.

Chapter 6. Results and Synthesis

In this chapter, the outcome of the PLS-SEM analysis will be reviewed. Starting with the respondent demographics, following onto the measurement and structural model validation.

6.1. Demographics

In total there were 262 responses. The survey asked household grocery purchasing decision makers between the ages of 18 and 65, based in the United States and looked at Gender, Age, Education and Household Income. Detailed demographics data is presented in Table 2. The data shows slightly different frequency numbers for the age demographic, due to the anonymous nature of the data received from the US based data collection survey company there was no way to cross-reference data to identify each age response. However, the rest of the demographics have been linked to the original responses.

Table 2: Demographics Data

Demographic	Category	Percentage	Frequency [N=248]
Gender	Male	33.5%	83
	Female	66.5%	165
Age	18 to 25	0.8%	2
	26 to 34	12.1%	32
	36 to 44	20.5%	54
	46 to 55	31.1%	82
	56 to 65	35.6%	94
Education	Middle School - Grades 4 - 8	0.4%	1
	Completed some high school	2.0%	5
	High school graduate	25.8%	64
	Other post high school vocational training	4.8%	12
	Completed some college, but no degree	21.0%	52
	Associate Degree	12.5%	31
	College Degree (such as B.A., B.S.)	21.0%	52
	Completed some graduate, but no degree	1.2%	3
	Masters degree	10.1%	25
	Doctorate degree	0.8%	2
	Prefer not to answer	0.4%	1
Household Income	Less than $9,999	4.4%	11
	$10,000 to $19,999	14.1%	35
	$20,000 to $29,999	10.5%	26
	$30,000 to $39,999	12.5%	31
	$40,000 to $49,999	8.9%	22
	$50,000 to $59,999	15.7%	39
	$60,000 to $69,999	8.9%	22
	$70,000 to $79,999	6.0%	15
	$80,000 to $89,999	4.0%	10
	$90,000 to $99,999	4.0%	10
	$100,000 to $124,999	3.2%	8
	$125,000 to $149,999	3.6%	9
	$150,000 to $174,999	0.8%	2
	$175,000 to $199,999	0.4%	1
	Over $200,000	0.4%	1
	Prefer not to answer	2.4%	6

After reviewing the quality of the data, 14 responses were discarded, leaving a total of 248. One response answered "No" to the prerequisite question of "Are you the household buyer?" since the responses needed to be from persons responsible for the household grocery purchases, this response was discarded. We then ran a standard deviation of the remaining results this highlighted 13 responses with a 0 standard deviation, upon closer inspection of the individual responses, all of the 13 had the same selected answer throughout the entire questionnaire, suggesting that these respondents completed the survey without actually reading the questions, so these responses were also discarded.

The number of respondents falling into the 18-25 range was a lot lower than expected, but as respondents were selecting based on being the primary purchaser and decision maker for the household. In addition, 56% of young adults aged 18 to 24 still live at home with their parents (Fry, 2013, p. 1), therefore more grocery buyers would be of an older age.

Overall, The sample was primarily female (66.5%) over the age of 45 (70.9%). There was an even distribution of respondents' level of education, with 25.8% of them had completed high school, 21% had some college education but no degree and 21% had graduated from a college. 75% of surveyed household income is under $70,000pa.

Table 3 compares the sample to the household income of the 2011 United States census (US Census Bureau, 2012). The sample was representative of an average household, up until $100,000+, which can be argued that they may not be as willing to take a survey as apposed to a census, which is compulsory.

Table 3: Household Incomes – Sample Vs. 2011 US Census

Household Income	Survey	2011 US Census
Less than $9,999	4.4%	7.6%
$10,000 to $19,999	14.1%	11.6%
$20,000 to $29,999	10.5%	11.3%
$30,000 to $39,999	12.5%	10.6%
$40,000 to $49,999	8.9%	8.9%
$50,000 to $59,999	15.7%	7.8%
$60,000 to $69,999	8.9%	6.8%
$70,000 to $79,999	6.0%	5.8%
$80,000 to $89,999	4.0%	4.6%
$90,000 to $99,999	4.0%	4.0%
$100,000 to $124,999	3.2%	7.5%
$125,000 to $149,999	3.6%	4.4%
$150,000 to $174,999	0.8%	3.2%
$175,000 to $199,999	0.4%	1.7%
Over $200,000	0.4%	4.2%
Prefer not to answer	2.4%	N/a

6.2. Measurement Model Validation

This section will assess the reliability and the validity of the model. Measurement model validation measures the relationships between the indicators and the constructs. This empirical measurement enables us to compare the theoretical measurement with structural model data as well as the collected sample data (Hair Jr *et al*., 2013, p. 96).

To evaluate the proposed model, the PLS-SEM evaluation process outlined by Hair Jr *et al*. (2013) was followed. By following these processes, including internal consistency reliability, convergent validity and discriminant validity, it was ensured that that all necessary measures for validation were met. Validating the proposed model through this process will ensure reliable and repeatable results for future research.

Reflective indicators examine an underlying construct that is unobservable as opposed to an indicator in which case it determines the construct (Petter, Straub, & Rai, 2007). This means that while there could be a greater number of reflective indicators, only a representative sample of those is used and when some are discarded or replaced, the same result should remain. However, a formative indicator is examined as if it is the cause of the construct, with each indicator adding a certain piece of the construct puzzle. If an indicator is removed, this fundamentally changes the construct (Hair Jr *et al*., 2013). Our research model consists of eight reflective constructs including, *in-store benefits* (ISB), *after sales benefits* (ASB), *in-store risks* (ISR), *after sales risks* (ASR), *perceived benefits* (PB), *perceived risks* (PR), *technology acceptance* (TA) *and intention of use* (IOU).

6.2.1. Internal Consistency Reliability

Testing the internal consistency reliability is typically the first criterion to be evaluated. In this instance, composite reliability (CR) was used to test the model. Results vary between 0 and 1; usually a higher value indicates a higher reliability (Hair Jr *et al*., 2013). The results indicate a range from 0.856 to 0.977. Most results are all within acceptable range of 0.70 and 0.90. However, two constructs have an undesirable result of above 0.95 (Hair Jr *et al*., 2013) Technology acceptance (TA) and intention of use (IOU) indicate 0.965 and 0.977 respectively. However, under these circumstances, the constructs have been derived from Davis' (1989) Technology Acceptance Model, with proven solid and reliable constructs.

Table 4: Internal Consistency Reliability Results

Construct	Composite Reliability
After Sales Benefits	0.878
After Sales Risks	0.875
In-store Benefits	0.892
In-store Risks	0.856
Intention of Use	0.977
Perceived Benefits	0.929
Perceived Risks	0.941
Technology Acceptance	0.965

6.2.2. Convergent Validity

Convergent validity measures the positive correlation between a construct's indicator and the alternative indicators of the same construct. This is done by considering the outer loadings of the indicators as well as the average variance extracted (AVE). The recommended acceptable value of the AVE should be 0.50 or higher (Hair *et al.,* 2013). Our results are all within the acceptable value, with an AVE ranging from 0.665 and 0.933. This suggests that the convergent validity is confirmed.

Table 5: Convergent Validity Results

Construct	AVE
In-store Benefits	0.733
After Sales Risks	0.700
Perceived Benefits	0.814
In-store Risks	0.665
After Sales Risks	0.700
Perceived Risks	0.842
Technology Acceptance	0.901
Intention of Use	0.933

6.2.3. Discriminant Validity

Discriminant validity was used to determine to what extent each of the constructs were distinct from each other. This was done by using the Fornell-larcker criterion (Fornell & Larcker, 1981), that compares the square root of the AVE values with the latent variable correlations. The AVE value should be higher than that of its highest correlation with any other construct (Hair Jr *et al*., 2013). Table 6, below, shows the models construct's outer loadings and cross loadings. In all cases, the outer loadings are higher than the cross loadings, indicating that each indicator was measuring a unique concept and there was no need to remove any indicators from the proposed model.

Table 6: Discriminant Validity Results

Construct	ASB	ASR	TSB	ISR	IOU	PB	PR	TA
After Sales Benefits (ASB)	**0.840**							
After Sales Risks (ASR)	-0.315	**0.837**						
In-store Benefits (ISB)	0.699	-0.237	**0.856**					
In-store Risks (ISR)	-0.285	0.8	-0.217	**0.815**				
Intention of Use (IOU)	0.684	-0.428	0.672	-0.336	**0.966**			
Perceived Benefits (PB)	0.748	-0.364	0.791	-0.321	0.828	**0.902**		
Perceived Risks (PR)	-0.437	0.663	-0.292	0.615	-0.543	-0.455	**0.917**	
Technology Acceptance (TA)	0.751	-0.452	0.693	-0.389	0.878	0.85	-0.593	**0.949**

6.3. Structural Model Validation

This section assesses the effect of the proposed model and gives an indication of prediction quality. Structural model validation measures proposed model constructs and allows it to be compared with the theoretical measure model and sample data (Hair Jr *et al*., 2013). Full outputs of the PLS-SEM results are shown below in Figure 6.

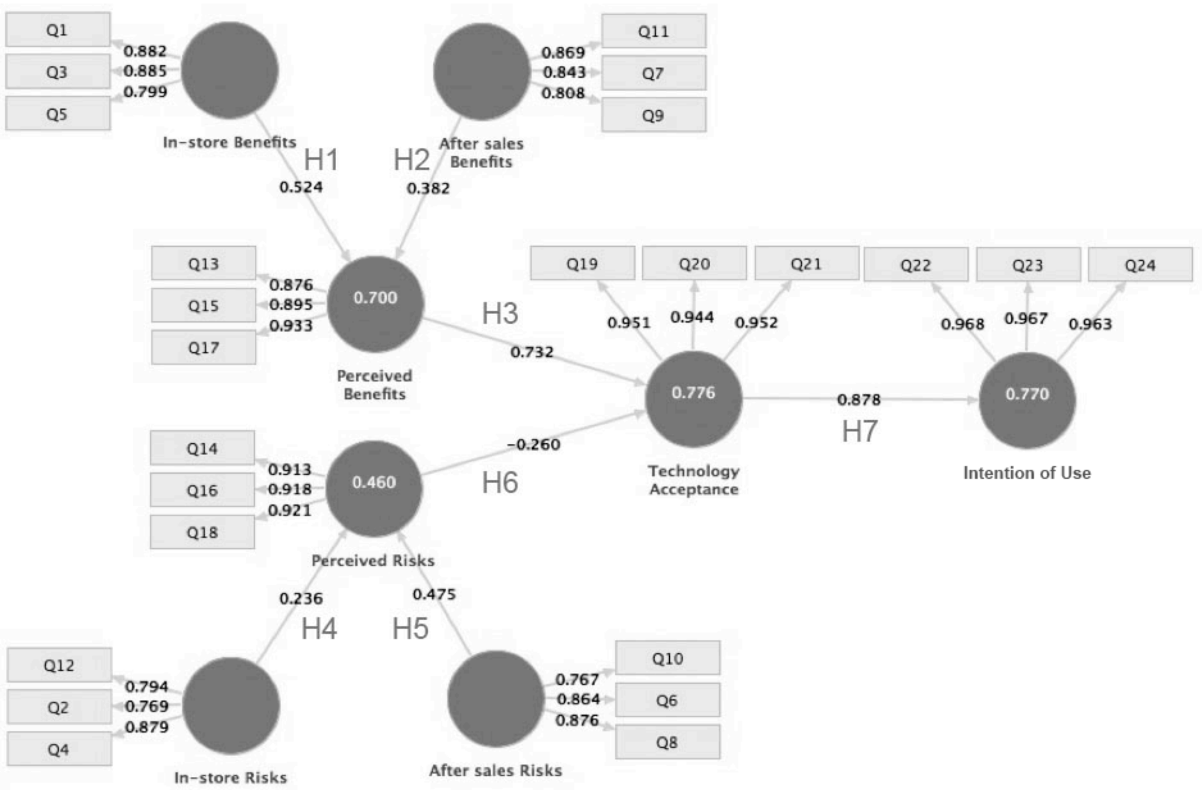

Figure 6: PLS-SEM modeling results

After completing all of the validation testing, the model passed all the criteria for assessment. The next step is to assess the statistical relevance of the models loadings and path coefficient. This was done using the PLS bootstrap procedure. In bootstrapping, a large number of additional samples are taken from the original sample at random and replaced with another when an observation is drawn. For our bootstrap procedure, 5000 bootstrap samples were used as recommended by Hair Jr *et al*. (2013) (original sample size was 262). The raw output from the PLS-SEM bootstrap analysis is presented in figure 7 below, with full results in Table 8. Bootstrapping also provides R^2 values, which assesses the reliability of the model; results are shown in Table 7.

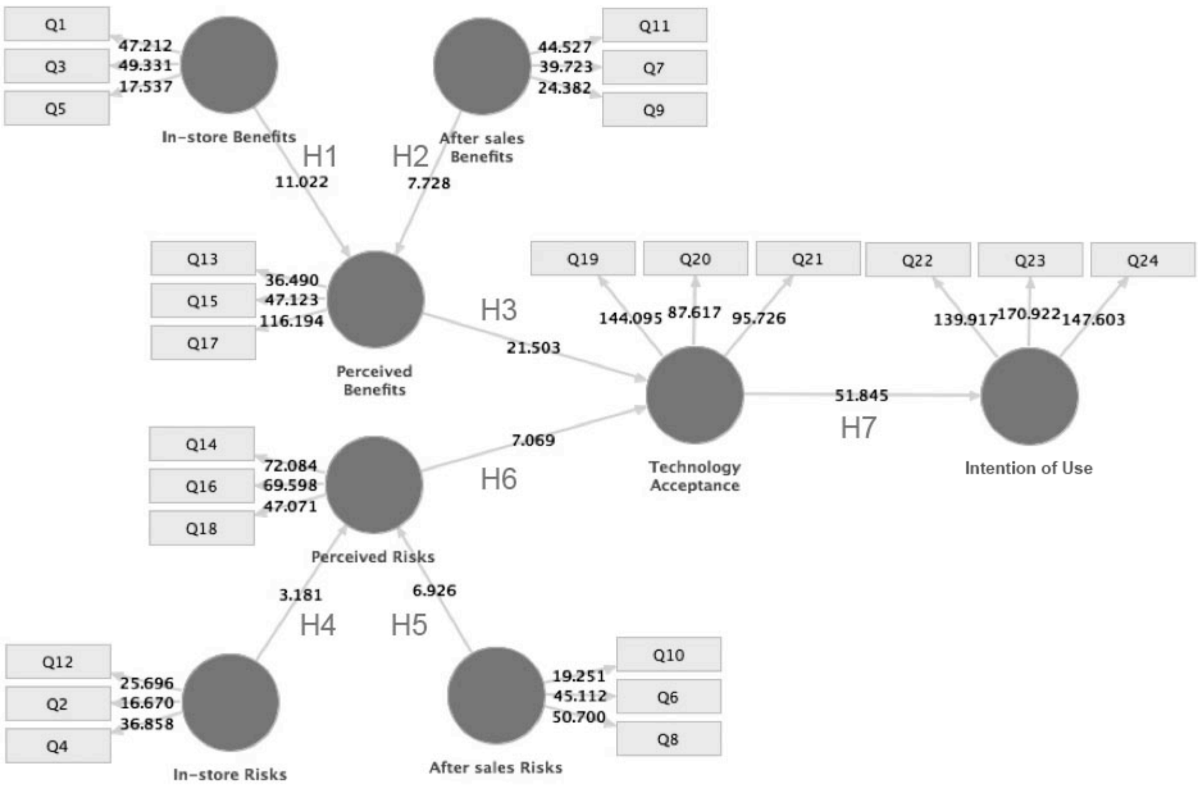

Figure 7: PLS-SEM bootstrap modeling results

6.3.1. Coefficient of Determination

The most common method used to evaluate the structural model is the coefficient of determination (R^2 value). This measures the model's predictive accuracy and is calculated as the correlation between a specific construct's actual and predicted values (Hair Jr *et al*., 2013). The R^2 value range is between 0 and 1, where a value over 0.2 is considered high when measuring certain disciplines, but a result of 0.75 or higher is required when measuring customer satisfaction or loyalty (Hair Jr *et al*., 2013). The structural model's R^2 values are presented in Table 7; it shows all values exceed the required minimum values as only consumer perceptions and their potential behaviours are being measured. The strongest relationship is Technology Acceptance (0.775), followed by Intention of Use (0.769), then Perceived Benefits (0.698) and Perceived Risks had the lowest value (0.456).

Table 7: R^2 Value for the Constructs

Construct	R-Square Value
Perceived Benefits	0.698
Perceived Risks	0.456
Technology Acceptance	0.775
Intention of Use	0.769

Table 8: Bootstrap Path Co-Efficient and T-Values for their Hypothesised Relationships in the Structural Model

Hypothesis	Path	Original Sample (O)	Sample Mean (M)	Standard Error (STERR)	T-Value	P-Values
H1	**In-store Benefits -> Perceived Benefits**	0.524	0.523	0.049	10.777	0.000
H2	**After Sales Benefits -> Perceived Benefits**	0.382	0.384	0.050	7.656	0.000
H3	**Perceived Benefits -> Technology Acceptance**	0.732	0.733	0.033	22.186	0.000
H4	**In-store Risks -> Perceived Risks**	0.236	0.241	0.074	3.165	0.002
H5	**After Sales Risks -> Perceived Risks**	0.475	0.474	0.070	6.800	0.000
H6	**Perceived Risks -> Technology Acceptance**	-0.260	-0.260	0.036	7.302	0.000
H7	**Technology Acceptance -> Intention of Use**	0.878	0.878	0.016	54.666	0.000

In-store benefits and perceived benefits

Table 8 shows a strong relationship between potential in-store benefits and consumers' perceived usefulness of RFID technology (Path=0.524, t=10.777, $p<0.000$). These results indicate that H1 is supported.

After sales benefits and perceived benefits

Table 8 shows a moderate relationship between potential after sales benefits and consumers' perceived usefulness of RFID technology (Path=0.382, t=7.656, $p<0.000$). Therefore H2 is supported.

Perceived Benefits and technology acceptance

In table 8, the relationship between consumers' perceived benefits of RFID and the acceptance of the technology has a significantly strong relationship (Path=0.732, t=22.186, $p<0.000$). Therefore H3 is supported.

In-store risks and perceived risks

Table 8 shows a weak relationship between in-store risks and consumers' perceived risks of RFID technology (Path=0.236, t=3.165, $p<0.02$). This relationship is weaker than the others due to consumers' having a lower expectation of personal privacy while in a public / in-store environment. This could mean that, either consumers' are unaware of the potential risks or are not as concerned with potential in-store risks. Hence, H4 is supported.

After sales risks and perceived risks

Table 8 shows a moderate relationship between the after sales risks and the perceived risks of RFID technology (Path=0.475, t=6.800, $p<0.000$). Therefore, H5 is supported.

Perceived risks and technology acceptance

Table 8 shows a moderate relationship between the perceived risks of RFID technology and its technology acceptance (Path=-0.260, t=7.232, p<0.000). Therefore, H6 is supported.

Technology acceptance and intention of use

Table 8 shows a significantly strong relationship between the technology acceptance of RFID and the consumer's intention of use (Path=0.878, t=54.666, p<0.000). The strong relationship is not unexpected as our model is based on Davis' (1989) Technology Acceptance Model. Therefore, H7 is supported.

Chapter 7. Discussion and Research Findings

This thesis focused on consumer acceptance of the implementation of RFID within the FMCG industry and how the perceived benefits of the technology could affect any perceived risks. While there have been a few attempts to gain a better understanding within an overall RFID context, no other paper has actually given consumers a reason to adopt the technology beyond the checkouts. This research survey gave examples of both the potential benefits and potential risks to consumers.

In the following chapter the outcomes of the research, the implications for managers, research limitations and potential future research opportunities will be discussed.

7.1. Answers to the Research Questions

This thesis hypothesised that consumers would be more willing to accept RFID technology at an item-level within the FMCG industry if they felt the potential benefits outweighed the potential risks in the technologies implementation.

Research Question

How do grocery buyers perceive the balance between the benefits and risks of RFID acceptance at an item-level within the FMCG industry? This will be investigated through focusing on both the in-store and after sales perceived benefits and perceived risks.

Table 9: Results of Hypothesis

	Hypothesis	Result
H1	In-store benefits will have a positive influence on consumers' perceived usefulness of RFID	Supported
H2	After sales benefits will have a positive influence on consumers' perceived usefulness of RFID	Supported
H3	Perceived usefulness of RFID will have a positive influence of technology attitude towards RFID	Supported
H4	In-store risks will have a negative influence on consumers' perceived risks of RFID	Supported
H5	After sales risks will have a negative influence on consumers' perceived risks of RFID	Supported
H6	Perceieved risks will have a negative influence on technology attitude towards RFID	Supported
H7	The overall positive or negative attitude towards RFID will affect the intention of use of the technology at an item-level.	Supported

The first hypothesis was supported. This means consumers' within a grocery store environment will view the implementation of RFID as positive as long as they gain a sufficient benefit. The second was also supported, meaning, if these benefits continue into the home, consumers' will remain positive about RFID, despite the potential risks. They will also have an overall positive view of the technology, as the third hypothesis was also supported.

The fourth hypothesis was supported, meaning that while in a grocery environment, consumers' will not feel that there are significant privacy risks while using the technology as there was no reasonable expectation of privacy while shopping in such a public place. While privacy may not be an issue in public, the fifth hypothesis showed, that consumers would consider RFID a privacy risk while in their own home and that overall, the potential risk would have an overall negative influence on the technology. However, the after sales risks as perceived risk R^2 is 0.456 (Table 7) which only explains 45.6% of the variance, therefore, there could be other contributing factors that may affect after sales adoption other than perceived risk. Hypothesis seven was supported meaning that the combined benefits and risks would give a good indication of the likelihood of consumers to adopt RFID.

Overall, while consumers' seem to be aware that there could be a certain degree of risk while using RFID both in-store and after sale, they would still be willing to use the technology if there were sufficient benefits.

7.2. Research Implications

As the Internet of Things paradigm becomes more relevant within our day-to-day lives, this research provides a timely reminder to researchers that there is more to explore beyond privacy concerns for consumers when RFID is implemented at an item-level. First, the literature review identified an opportunity to expand the current conversation within the literature. By exploring consumer acceptance through the balancing of the benefits and risks of RFID, a new conversation can start to emerge. It is worth noting that this has previously been mentioned as a gap in the literature, "despite the overall appropriateness of the TAM, refinements to the model seem to be needed." (Müller-Seitz et al., 2009)

Second, this research presents a framework for the evaluating the balance between the benefits and the risks of RFID at an item-level within FMCG products. By differentiating between in-store and after sale measures for consumer benefits and risks, this research gains insight into the first of two important factors influence consumer acceptance. The first being, customers must be aware of a specific usefulness that outweighs the potential disadvantages of the technology and the second, which could be addressed in future research, customers must believe that the novel technology is secure (Müller-Seitz *et al.*, 2009).

Third, this research finds that consumers given sufficient benefits will overlook any potential privacy risks associated with RFID technology. This has a major impact on how researchers could create models for RFID integration for more controlled and scalable integration into the supply chain. For example, a bottom-up strategy could be used to test how consumers react to RFID implementation in different item categories. If successful, implementation could be expanded to other item ranges, categories and further up the supply chain, eventually creating an entire RFID enabled eco-system.

Overall, this thesis expanded RFID literature by questioning the current conversation that focused on privacy risks for consumers and asked what if consumers were able to gain sufficient benefit for RFID at an item-level, that the potential privacy risks were a non-issue. There is now a framework for future researchers to measure consumer acceptance of RFID at an item-level within the FMCG industry.

7.3. Managerial Implications

Traditionally, both the FMCG industry and academic literature talks about the implementation of RFID from a supply chain perspective. Meaning the inclusion of an RFID tag, either at a pallet-level, case-level or item-level. While some companies have achieved a pallet-level rollout, giving delivery of items good traceability and providing some information to identify potential efficiency gains. This top-down approach, meaning the widespread adoption from manufacturing through distribution and retail has significant infrastructure costs and a potential for lack of a return of investment for some parties, not to mention the consumer privacy issues at a case-level or item-level roll out. Most FMCG manufacturers cannot justify a top-down rollout at this point in time.

Based on the work done within this thesis, it's this author's opinion that the FMCG industry should consider an alternative method for the item-level implementation of RFID. A bottom-up approach, meaning the inclusion of RFID on certain item-level products, solely for the benefit of the consumer. For example: promotions, item information, suggested items or coupons. This approach is scalable, meaning manufacturers / retailers have the ability to control the initial rollout, select the potential value for their businesses and gain an understanding of what benefits are gained from the roll-out as well as the cost of further implementation. This approach will give manufacturers valuable insight into how their consumers' use the technology and how they can incorporate consumer benefits into the over all architecture of their RFID system.

This thesis identified which benefits a potential consumer would find useful, allowing them to overlook the potential privacy issues in exchange for these benefits. For managers, this means by understanding what would affect this acceptance, they have the opportunity to tailor the potential benefits to cater for what consumers' would find most useful, making the roll out of this new technology much more likely to be accepted.

In saying this, FMCG Managers considering implementing RFID either within the supply chain, marketing or for security purposes should consider the following before launching their system.

- Consumers are adverse to the name RFID, associating the name with privacy invasion and personal tracking.
- Consider to what level you need to implement the system, pallet level, case-level or item-level and what is the likelihood that consumers will come into contact at these different levels.
- If consumers are likely to come into contact with the RFID tag, what benefits do they gain from its implementation?
- Consumers would be more likely to use RFID at an item level if they can gain sufficient value through the benefits offered by the technology.

Chapter 8. Conclusions

The Internet of Things paradigm (IoT) continues to move forward, companies are launching new wireless smart technologies within ordinary household consumer devices, which allow them to connect to the Internet and thus provide various additional services previously unavailable. In the future, these individually connected household items will be able to communicate with each other via a brand specific proprietary networks, as the years progress a universal standard will be developed to allow different brands / manufacturers devices to communicate with competitors' devices. All of this data would then be collated, analysed and sent to your laptop or mobile phone providing the consumer with unprecedented amounts of information about their household, from notifications informing them that their laundry is done to letting them know their toothbrush is three months old and needs replacing and automatically adding it to their shopping list.

If a normal consumer is able to retrieve this level of detail, imagine what a database full of consumer's daily habits and demographics information is able to produce for the company managing this system. This information is the Holy Grail for marketers. This is why when the initial concept and rollout of an RFID system within Walmart was met with such a negative response from consumers worried about privacy issues in-store and after sales.

Academic literature over the past decade has concentrated on these perceived consumer privacy issues, supply chain implementation and the technological advancement of RFID. Few papers have looked at the actual potential benefits to consumers from the item-level implementation of an RFID system. For the IoT and item-level tagging to gain mainstream acceptance from consumers, the perceived benefits gained should outweigh any perceived risks from using the technology.

This thesis expanded the conversation within academic literature beyond privacy risks to the consumer by expanding the research of J. S. Smith *et al.* (2013), which suggested that consumers' perceived privacy risks could be negated by sufficient benefits. The idea was revisited and expanded by exploring perceived potential benefits and perceived potential risks, both in-store and after sale categories. This idea was explored and tested using a quantitative survey within this thesis.

By investigating both of these categories in this research, insights start to emerge about how consumers' may react to RFID implementation at an item-level within the FMCG industry and how the inclusion of consumer focused benefits; both in-store and after sale, could negate consumers' perceived risks towards the technology. The results of this research suggest that consumer's would expect a level of risk while using item-level RFID within a store environment regardless of the benefit, however, after sales, they require a more substantial benefit to overcome perceived potential risks.

This thesis provides a solid foundation for future researchers to explore how consumer benefits of RFID technology at an item-level affect perceived risks. In addition, this research should give a solid foundation for research into consumer acceptance of IoT appliances, as they will have a similar privacy risk / perceived benefit balance.

8.1. Limitations

There were a few limitations with this study. First, the survey asked for opinions based on a hypothetical technology, which followed the same approach taken by J. S. Smith *et al*. (2013). The respondents had to consider their answers based on scenarios (potential benefits / potential risks) presented to them within the survey. The survey was constructed from previous RFID acceptance / privacy risk surveys (Cazier, Jensen, & Dave, 2008b; J. S. Smith et al., 2013), both of these papers used a theoretical RFID implementation example, which ensured a more accurate overall result.

Second, while conducting the survey respondents were limited to the grocery buyer decision maker within each household. This inadvertently biased the results towards an older female demographic, as the mother figure in the household is usually the primary grocery purchaser. In addition, a report by the PEW research centre (Fry, 2013, p. 1) reported that 56% of all 18 – 24 year olds still lived at home with their parents within the USA. This could explain the low response rate for that demographic within the survey. While this could explain the higher response rate for females, there are other factors not taken into account within this survey. For example, as Venkatesh and Morris (2000) discuss in their paper that "men only consider productivity related factors, women consider inputs from a number of sources including productivity assessments when making technology adoption and usage decisions" (p. 129), further studies could probe deeper into the differences between gender within RFID acceptance in this field.

Third, respondents were all based in the United States of America, so their attitude towards item-level RFID technologies may vary when compared to data from other countries. The technology acceptance model (TAM) and its many variations have been well tested and validated within USA. Therefore, models based upon the TAM and surveyed within the USA and other westernised countries should be an accurate representation of the likelihood of consumer acceptance. However, non-westernised countries may react differently to new technology and should be used with care (Straub, Keil, & Brenner, 1997, p. 9).

Finally, a 3rd party company conducted the survey and respondents would have been limited to members of their online survey research panel, in addition, there was a small donation to the charity of the respondent's choice.

8.2. Future Research

The research presented within this thesis is a study of consumer acceptance of RFID within the FMCG industry. It provides a foundation for future expansion, more in-depth study and testing of the topic. Future studies could expand the sample size and demographic to gain a broader understanding of potential consumer acceptance.

As discussed in the previous section, there was a much higher response rate from females within the survey; perhaps future researchers could focus on how female acceptance of RFID technology would differ from men. Additionally, taking into account from other gender based technology acceptance research papers such as Venkatesh and Morris (2000) to gain insight into how perceived ease of use would affect the technology acceptance of RFID at am item-level within the FMCG industry.

It would be interesting to gain further insight into what input other members of the household had on the purchasing behaviour of the primary household purchaser, for example if another family member specified a certain brand over another and what the implications would there be if one had RFID and the other did not. As well as how the in-store / after sales benefits of an RFID product affect the perceived risk of other family members who are not the primary decision maker.

As mentioned, more in-depth surveys could be conducted. A large independent quantitative study done within the USA could help validate the results of the study, while this would help understand general acceptance based upon a theoretical technology, a qualitative study conducted through a series of interviews or focus groups could help understand which benefits and risks grocery buyers are more concerned with at an item-level. Combined, these results would provide a great insight into how the next stage of implementation of this technology should progress and how consumers may react to it.

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Appendices

Appendix 1: Table 1 Reference List

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Appendix 2: Survey Questions

The Future of Grocery Shopping

PQ1 How old are you?
* Under 18 (1)
* 18 to 25 (2)
* 26 to 34 (3)
* 36 to 44 (4)
* 46 to 55 (5)
* 56 to 65 (6)
* Older than 65 (7)

PQ2 Are you the grocery purchasing decision maker for your household?
* Yes (1)
* No (2)

I1 My name is Wesley Kukard, a Masters student at the Auckland University of Technology in New Zealand. I would like to invite you to complete the following survey on the future of grocery store technologies. The survey is designed to capture a general understanding of how consumers perceive future technologies within the grocery industry. I would be delighted if you decide to participate in this research. It is anonymous, completely voluntary and you may withdraw at any time prior to the completion of the survey. Before starting the survey, please click the link to view the Participant Information Sheet. This will give you an overview of who is conducting the survey and what will be done with the data. If you would like a copy of the findings from my thesis, a copy will be available for download from my personal academic website in early 2015. Thank you for your participation.

I2 In the near future, a new Smart Technology will emerge allowing effortless wireless interaction between mobile phones and individual grocery items or items as a group. There are a number of ways in which to interact with the items, the most popular being a mobile phone app, which requires you to register your personal information and log in to be able to use it. This app needs to store information about your previous purchases, current grocery items at home and shopping patterns to work accurately. While answering the survey, pretend that you have access to this technology now. Read each statement carefully and select the option that you most identify with, from strongly agree to strongly disagree.

Q1 The smart technology would make it possible to take previous shopping lists and calculate the current cheapest grocery store to purchase the exact items again. This feature will benefit me.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q2 The smart technology could potentially place consumers in a shopper group or label them a type of buyer based on purchase history. I would consider this a potential risk.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q3 The smart technology would make it possible to scan products and keep a running total of a current shopping list. This feature will benefit me.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q4 The smart technology could allow stores to track your movements and buying patterns in a grocery environment. I would consider this a potential risk.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q5 The smart technology would enable discounts on items by scanning your mobile phone on in-store coupons. This feature will benefit me.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q6 The smart technology could allow a company to access your grocery purchase history for future targeted marketing. I would consider this a potential risk.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q7 The smart technology would make it possible to completely automate the shopping process based on previous sales data and a set budget limit. This feature will benefit me.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q8 The smart technology could make it possible for companies to collect demographics data (Gender, Age, Ethnicity, Annual salary and hometown). I would consider this a potential risk.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q9 The smart technology would make it possible to view the inventory of a pantry / kitchen, live via smartphone. This feature will benefit me.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q10 The smart technology could allow other people to scan grocery items and see where and when they were purchased and how much was paid. I would consider this a potential risk.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q11 The smart technology would make it possible to automatically generate shopping lists based on previous purchases and current pantry / fridge inventory. This feature will benefit me.
* Strongly Agree (1)
* Agree (2)

* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q12 The smart technology could suggest items that consumers may not want, need or want to be associated with. I would consider this a potential risk.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q13 This Smart Technology will save me money while grocery shopping.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q14 I am concerned that this Smart Technology may track my purchases.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q15 Using this Smart Technology will make grocery shopping more efficient.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q16 I am concerned that this Smart Technology may monitor where I have visited.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q17 Overall, this Smart Technology will be useful to me.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q18 I am concerned that this Smart Technology may track where I have visited.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q19 I like the idea of using this Smart Technology.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q20 Using this Smart Technology will be positive.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q21 Using this Smart Technology is a good idea.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q22 I intend to use this Smart Technology when it is made available.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q23 I intend to use this Smart Technology when it is placed on items.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)

Q24 I intend to use this Smart Technology frequently when it is available.
* Strongly Agree (1)
* Agree (2)
* Neither Agree nor Disagree (3)
* Disagree (4)
* Strongly Disagree (5)