The challenges in adopting residual radio frequency identification technologies in the business environment: a consumer segmentation approach

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Abstract: In today's global competitive environment, organisations face a variety of challenges. Many organisations are adopting Radio Frequency Identification Technologies (RFID) as part of their information supply chains. These technologies provide many benefits to the organisations that use them. However, how these technologies affect consumers and their willingness to adopt the technology is often overlooked. Many of the tags remain active after the consumers have purchased them. These RFID tags, placed in a product for one purpose and left in that product after it has served that purpose, are residual RFIDs. Residual RFID technology can have many positive and negative effects on consumers' willingness to buy and use products containing RFID and, thus, on the business's ability to sell products containing RFID. In this study, we outline some of the advantages and disadvantages of residual RFID from the consumer perspective, then follow it up with an in-depth survey and analysis of consumer perceptions. Using cluster analysis, the study identifies three distinct groups: the *moderate majority*, the *untrusting sceptics* and the *concerned realists*. The characteristics and likely behaviour of each group are identified and discussed.

Keywords: technology acceptance; emerging technological challenges in the business environment; risk; residual RFID; Radio Frequency Identification technologies.

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1 Introduction

Organisations face a variety of challenges in today's global competitive business environment. Organisations strive for continuous improvement as well as enhancing the entire supply chain in order to stay competitive. One of the ways an organisation can deal with this situation is to study and apply the methods of Supply Chain Management (SCM). The goal of SCM is to offer products at low cost with high customer satisfaction

by managing production, procurement, distribution, and inventory control. The critical issues of SCM are to integrate the inventory, distribution and sales information and to make the integrated logistics information visible to the other organisations in the distribution and sales channels in real-time (Hou and Huang, 2006; Caputo *et al*., 2004; Hsieh and Lin, 2004; Trappy *et al*., 2004; Wu *et al*., 2004; Helo and Szekely, 2005). According to studies conducted by Prater *et al*. (2005) and Smith (2005), RFID technology provides automatic data capture, data identification and information interchange. Therefore, merchandise tracking, product sorting, and distribution data collection and analysis can be efficiently accomplished.

It has been predicted that in the near future, the vast majority of the products manufactured, bought and/or sold will have a small tag that can remotely and uniquely identify that individual item. Any person or business with an appropriate scanner may be able to know the item type, price, where it was made, sold, purchased and resold by reading a small Radio Frequency Identification (RFID) tag. RFID tags are currently being deployed in the supply chains of many organisations worldwide. These tags offer many benefits to the organisations that implement them; however, many of these tags can remain active after they leave the organisation, broadcasting their identities and histories to anyone with a scanner and link to the proper database. These left over tags, installed to help the supply chain, but not removed after the purchase, are referred to as residual RFIDs.

Residual RFID technology can have many positive and negative effects on consumers' willingness to buy and use products containing RFID, and therefore on the business's ability to sell products containing RFID. If consumers refuse to buy products with RFID tags in them, the business harm is greater than the business benefit, regardless of any gain in supply chain efficiency.

Through the course of this study we began asking specific questions about consumers and their views regarding RFID technologies. Who are the consumers that are likely to recognise the consumer and/or business benefits of RFID and willingly accept the technology into their lives? Who are the consumers likely to distance themselves from all products containing RFID tags? Who are the fence sitters and what efforts in consumer privacy and security will cause them to lean one direction or the other? Is intention to adopt determined by demographics, by technology familiarity, or is it determined by consumer attitude towards the technology in general?

To answer these questions, we conducted an in-depth survey and analysis of consumer perceptions. We analyse the data using a clustering method, identifying three distinct clusters from our data, each with its own attitudes and unique behaviour characteristics. Through these methods, we determine the factors that guide consumer perceptions of RFID; specifically, we demonstrate that demographics (*e.g.*, age, income, gender, profession, education, even technology familiarity) are not significant factors in determining consumer perceptions and the resultant behaviour towards RFID adoption; but rather, that attitudinal variables and individuals' innate personalities determine perception and behaviour. Consumers' attitudes regarding the perceived usefulness of RFID technologies, their overall trust of the technology and the organisations that implement it, and the privacy risk likelihood resulting from the use of the technology combine to directly influence their intentions to use the technology. Consequently, persons who support or oppose RFID technologies may come from any demographic. The implications of these findings need to be considered before the pending implementation of residual RFID technologies in the supply chain on a mass scale.

We begin this paper with a discussion of prior research regarding RFID, wherein we discuss the benefits for business supply chains, as well as consumer benefits and liabilities and the impact of privacy risk on technology adoptions. We then discuss the basis for our research, a desire to ascertain the perceptions and usage intentions of individuals towards organisations and products that develop and/or employ residual RFID technology. This is followed by a discussion of our data collection method, consisting primarily of an in-depth survey of consumer perceptions regarding the potential wide-scale adoption of RFID technologies. Finally, we present the results of our findings and evaluate the validity of our hypotheses.

2 Literature review

While many researchers have looked at the benefits that accrue to corporations and supply chains through RFID technology, many organisations have not adequately considered the impact of residual RFID technology on consumers, business and society. The ultimate purpose of RFID technology is to provide retailers and suppliers with the ability, in time, to track any item remotely and uniquely at the individual level. The impact of this ability, both positive and negative, on consumers in our society will be enormous. Whether consumers are ready for it or not, RFID technology is becoming a part of their lives. Many of its applications have little to no effect on the general consumer; however, the integration of this technology into other aspects of consumers' lives raises certain concerns.

The study conducted by Lin *et al*. (2006) indicated that RFID technology can provide real-time data to make appropriate managerial decisions in the supply chain management systems since these systems are complex, dynamic, and stochastic. Caton (2004) indicated that RFID has a major advantage in supply chain management; however, the organisation should plan and test its successful implementation. The study also suggested that the focus of information technology should be on the supply chain since RFID will have a significant impact on all stages of SCM.

The two different types of RFID tags, active and passive, offer their own differing benefits and liabilities to consumers. Active RFID tags are driven by a power source, typically a small battery. These tags are capable of broadcasting their own signal over varying distances, depending upon the potency of the battery and range of the frequency. Although useful only for the duration of their power source, these tags may be extremely important in certain military and other applications, but may offer only limited practicality for consumer use, as the cost to produce such tags would render them prohibitive in a consumer environment.

Passive tags have no power source and are relatively inexpensive to produce. These economical tags are those that are most likely to be found on consumer goods. Lacking a power source, these tags are incapable of broadcasting their own signal. Initially, this sounds like a benefit in terms of consumer privacy, but the lack of a power source effectively makes these tags nearly immortal in consumer terms. They are activated only when scanned or read by a RFID scanning device. Such activation may occur at a retail location, airport security checkpoint, bus terminal, restaurant, mall, or as the result of a handheld scanner that could be used unobtrusively at any time or place. Active tags have

limited life span, but passive tags are forever. While both active and passive tags can become residual RFID devices, these passive tags are the tags that are especially of concern because of their long life and ubiquity.

There is an ever-increasing need for improvements in supply chain management that will enable suppliers and retailers to cut costs, reduce inventory, improve order forecast, improve asset management, and provide higher customer satisfaction (Attaran, 2006). The adoption and implementation of RFID technology in the supply chain may be a way to meet these needs.

Supply chain automation is probably the single most attractive factor behind the development of RFID technology. RFID is currently being used for tracking assets in offices, labs, warehouses, pallets and containers in the supply chain. Through RFID, suppliers are able to determine the location of a pallet, track its journey through the supply chain, and make instantaneous routing decisions (Attaran, 2006). In addition, there are distinct advantages to using RFID technology over barcodes. According to Juels (2005), an RFID tag provides a unique serial number that distinguishes among many millions of identically produced products. RFID tags are readable without line-of-sight contact and without precise positioning; as a result, RFID readers can scan tags at very high rates.

The drawback to implementing RFID in business supply chains, however, is the significant investment such an implementation requires. The return on investment is directly associated with the improvements such an investment enables. The challenge for information technology experts is to determine how to integrate RFID with existing supply chain management, customer relationship management, and enterprise resource planning applications within existing systems (Attaran, 2006).

2.1 Consumer benefits

The benefits of RFID technology in the supply chain have been well documented. The benefits of RFID for consumers, however, are often overlooked. Yet it is imperative consumers understand that there are legitimate consumer benefits associated with the use of this technology. Without realisable consumer benefit to counteract the perceived risks associated with RFID, retailers will find it difficult to maintain a solid customer base in the face of the perceived security and privacy risks. RFID developers have sought to limit the perceived risk by trying to educate consumers as to the positive benefits of RFID and providing privacy policies to explain what data is being collected and how it's being used (Eckfeldt, 2005). It is a difficult task for retailers and RFID developers to limit the risk of privacy invasion for consumers. The problems are many and complex. According to Eckfeldt (2005) it is much easier and more effective to improve the perceived value consumers receive through RFID by offering them better prices, service and/or experience.

Eckfeldt (2005) suggests that RFID-based technologies provide value to consumers in three primary ways:

1 peace of mind

2 consumer convenience

3 improved service.

According to Eckfeldt (2005), the RFID application with the greatest success in terms of adoption and proliferation involves security. It is interesting to note that the very ability that has been the source of so much public outcry against the technology – it's potential ability to positively identify and track individuals – is also one of its greatest consumer assets. This ability has enabled RFID to be integrated into security systems throughout the world. The perceived value in such cases is that the consumer trusts that only authorised persons have access to the sensitive data collected by these systems. When tracking lacks any obvious security benefit for consumers and delivers only marketing information for retailers, the risk/reward equation does not add up for consumers (Eckfeldt, 2005).

Another peace of mind benefit can be found in law enforcement, where Residual RFID technology can be used to easily track stolen goods. Police investigators can use RFID scanners to enhance tracking procedures, enabling faster recovery of stolen property and potentially even deterring such crimes.

The EZ-Pass toll-collection system is a perfect example of successful RFID adoption by consumers (Eckfeldt, 2005). The convenience benefit for consumers is considerable. Rather than stopping at a toll collection station, rolling down the car window, passing money to the toll-collector, receiving change and a receipt, rolling up the window and then resuming the business of driving, a consumer may simply approach the EZ-Pass entry point with an RFID-equipped pass on the dash and drive right through the toll station with barely a reduction in speed. Such systems could potentially be used to create a precise time log and map of the consumer's travels, but the perceived convenience benefit for daily commuters is likely greater than the perceived privacy risk such documentation poses.

Residual RFIDs may also simplify the process of returning retail goods. Products with embedded RFID tags may potentially be returned without a receipt, and aid both the consumer and the retailer in streamlining customer services. Future uses of RFID may also include improvements in checkout procedures, where consumers may checkout merchandise by simply rolling shopping carts past point-of-sale terminals. These terminals would automatically compute the total amount and even charge RFID-enabled payment devices. Another possible application of RFID technology in the customer relationships management arena includes interactive objects (Juels, 2005). Consumers could interact with RFID-tagged objects through their mobile phones, for example.

Some high-end fashion retailers are currently using RFID-based systems to enhance the overall customer service and consumer shopping experience. Casinos, such as the Wynn Las Vegas resort, use RFID to fight fraud and give guests easy access to house credit. Delta Air Lines uses RFID tracking systems to improve baggage handling. The net result of all these solutions is a tangible consumer benefit (Eckfeldt, 2005).

RFID could even be used to improve home insurance services. Insurance companies could quickly catalogue complete inventories of a person's belongings for home insurance purposes, rather than relying on hand-written lists and estimated replacement costs.

2.2 Consumer liabilities

While consumers may realise legitimate benefits from residual RFID, the liabilities likewise cannot be ignored. Spiekermann and Ziekow (2005) suggest that five immediate and key threats of RFID technology are:

1 unauthorised assessment of one's belongings by others

2 tracking of persons via their objects

3 retrieving social networks

4 technology paternalism

5 making people responsible for their objects.

The most obvious violation is perhaps the first listed by Spiekermann and Ziekow (2005). They suggest that "by scanning inventories of flats and houses or baggage at airports promising targets for theft or burglary might be identified". They also suggest that individuals may be tracked through the objects they carry (Spiekermann and Ziekow, 2005). The offending party may be an individual, organisation, or government. In addition, businesses could potentially target individuals with personalised advertising both in-store and out based upon objects they carry. While businesses may desire such efficiency in advertising, many consumers may view such efforts as intrusive.

Cazier *et al.* (2007) states that privacy risk factors are found to negatively influence consumer intentions. While theirs was a study regarding e-commerce and privacy risk in a web environment, the principle from our point of view remains the same. If a consumer perceives a particular privacy or security risk as a result of residual RFID, that perception could profoundly affect that consumer's intention to purchase a particular product carrying a RFID tag or engage in commerce with a retailer that utilises RFID technology.

It should also be noted that when people perceive risks, they change their behaviours accordingly, often by performing a risk benefit calculation that assists them in deciding whether they should or should not disclose private information (Milne and Culnan, 2004). But in the case of RFID, that choice to disclose or not disclose may not be available. Whether it is the retailer's scanning of purchased goods or the illicit scanning by would-be thieves, consumer purchases will be tracked, catalogued, and evaluated for further action.

The adoption and implementation of RFID technology offers significant benefits for both the retail supply chain and the consumer, from dramatic improvements in inventory control to greatly reducing the number of lost luggage claims at airport terminals. But the liabilities of RFID adoption for consumers must likewise be given some attention. With these benefits and liabilities in mind, we set out to ascertain consumer perceptions regarding the pending wide-scale adoption of RFID technology.

3 Methodology

The research methodology was conducted using a survey instrument, based on previously validated scales where possible, that assessed the perceptions and usage intentions of individuals towards organisations and products that develop and/or employ residual RFID technology. While there has been some popular press about residual RFID technologies, such as the report by Abramson (2004) on National Public Radio (NPR), the implications of residual RFID technologies may not have fully entered the consciousness of the average consumer. Since mass adoption of these technologies is imminent, it is important to understand how consumers do and will react to mass residual RFID adoption.

Therefore, a brief education piece instructing subjects regarding the fundamental principles of RFID technology was presented to each subject prior to completing the survey. Great care was taken to ensure that the educational piece contained a purely factual and completely unbiased evaluation of certain common benefits and concerns regarding RFID technologies consumers may encounter. Because the purpose of this study was to learn about consumer reactions to the proliferation of RFID, it was essential to ensure that all participants possessed at least a minimum level of knowledge regarding the technology. The educational piece was therefore introduced to provide all participants with that necessary and unbiased information. The contents of the educational piece may be found in Appendix A.

In the interest of research accuracy and applicability, we selected questions for the survey instrument from previously validated instruments where possible, adapting them to meet the criteria of our survey. In addition, we conducted two separate pilot studies in an effort to further validate and refine the selected questions before conducting the final survey and compiling the results.

Following a pilot study to validate and test our original scale a revised instrument was used to collect a sample consisting of 320 individuals from the population of consumers of products with embedded residual RFID tags. Approximately 53% of the subjects were female, 47% male. While the mean age, collected in categories, was in the upper 20, lower 30 range, we had a wide range of age groups from under 20 to over 70. To obtain the greatest possible dispersion of consumers, including those with and without internet capabilities and familiarities, the research was conducted using a paper-based format as opposed to an online medium. Respondents were encouraged to participate in the research study by entering a drawing for a gift certificate from any one of five restaurants.

We looked at the cognitive characteristics of the individual participants through their responses to three factors – perceived usefulness, overall trust and risk likelihood – to predict their behaviour regarding RFID adoption. Demographic information of the respondents was also collected.

4 Results and discussion

In order to study the heterogeneity in the sample, an effort was made to divide the group of observation into smaller groups so that the observations within each group are relatively similar and the observations in different groups are relatively dissimilar. These distinct groups will contain the respondents' views pertaining to the use of RFID that are similar to specific variables. The data were first analysed using cluster analysis. The objective of cluster analysis is to group observations into clusters such that each cluster is as homogeneous as possible with respect to the clustering variables (Sharma, 1996) and to determine whether the data contain naturally occurring homogeneous subsets of observations (Lattin *et al*., 2003).

Next, the canonical discriminant analysis was performed using the input data set as the output of the cluster analysis. Finally, two canonical variables were plotted specifying the cluster as the identification variable. Figure 1 (see Appendix B) shows a plot outlining the distribution of the three clusters and shows a distinct cluster pattern. All variables in the cluster analysis were significant at .01 level and all multivariate statistics

including Wilk's Lambda were found to be significant at .01 level. The cluster analysis technique identified three distinct clusters: (1) the *moderate majority*, (2) the *untrusting sceptics*, and (3) the *concerned realists*.

The *moderate majority*, the largest segment representing 48% of the sample, does not wholeheartedly embrace the new technology; however, they generally see it as useful and have the highest (compared to the other clusters) intention to adopt. They have reasonable (but not overly high) levels of trust and view the risk as moderate. This group is the most likely to accept and use RFID technologies.

The *untrusting sceptics* are characterised by their distrust in companies, by their belief that they will be harmed by the new technology, and by their doubt that the technology will be useful. This cluster showed low behavioural intentions regarding RFID adoption. This cluster represents 10% of the sample, and is the group that will likely never be convinced to fully adopt this technology.

The *concerned realists* recognise that the technology has the potential to be very useful to them, and they have some base level of trust. However they are also very concerned about the risks involved with adopting the technology. This cluster represents 42% of the sample, and is the segment that *might* be convinced to eventually accept the technology, given that they see it as useful and have a base level of trust, but it will require significant persuasion, particularly in the form of visible measures to protect consumer privacy and security taken by the organisations that create and employ RFID technologies.

For each of these groups, the dimensions of perceived usefulness, overall trust and risk likelihood proved to be reasonable means by which to evaluate consumer perceptions and resulting behaviour. It would be especially helpful to industry to focus on improving people scores on these dimensions as opposed to strict demographics, as demographics elements proved, in this study, to be insignificant in determining consumer behaviour regarding RFID adoption.

This survey instrument was constructed using questions from several previously validated surveys. Modifications were made where necessary to tailor the questions to the nature of RFID technology. All items in the survey were measured on a seven-point Likert scale, with endpoints labelled 'Very Strongly Disagree'/'Almost Impossible'/'No Harm At All' (Value = 1) and 'Very Strongly Agree'/'Almost Certain'/'Severe Harm' (Value = 7) as dictated by the form in which the items were stated. All data collected during the study was stored in a secure database for later statistical analysis.

As shown in Table 1, there were four significant factors that loaded cleanly in the model. All alpha values are .8 or higher, and factor loadings are routinely high as well.

These factor loadings, alpha scores and descriptive statistics for each factor used in analysing the cluster data are presented in Table 1.

All factors shown in Table 1 load cleanly and have high factor loadings. Consequently, we have collapsed the variables into three distinct factors – Perceived Usefulness (PU), Overall Trust (OT) and Risk Likelihood (RL) – and displayed an average alpha score for each factor. Utilising the average alpha score for the three attitudinal variables offers a clearer and more defined picture of the individual cluster means. The resulting three-cluster solution of our study, along with significant differences across cluster means, is presented in Table 2.

Table 1 Rotated factor matrix, Cronbach alpha and descriptive statistics

					*Factor loadings**[a]		
Factor/Alpha	*Items*	*Description*	*Mean*	*Std. dev.*	*1*	*2*	*3*
PU	PU3	Using RFID technology will improve the quality of my shopping experience	4.24	1.100	.899	.202	–.085
α = .83	PU4	RFID technology will improve the efficiency of my shopping experience	4.29	1.113	.916	.162	–.045
	PU5	The widespread adoption of this technology will ultimately lead to lower prices	3.88	1.201	.686	.287	–.033
OT	OT1	Overall, I trust the organisations behind RFID technology	3.78	1.107	.265	.847	–.177
	OT2	Overall, I trust the organisations that use RFID	3.78	1.105	.288	.818	–.190
α = .90	OT3	Overall, organisations that use RFID technology are worthy of receiving consumer trust	3.82	1.086	.291	.785	–.211
	OT4	I trust the government not to abuse RFID technology	3.65	1.242	.133	.817	–.176
	OT5	I trust the government to protect me from RFID abuse	3.73	1.259	.063	.765	–.133
RL	RL1	How likely is it that someone will use Residual RFID to steal your personal information?	4.93	1.209	.010	–.139	.888
α = .94	RL2	How likely is it that your personal information will be stolen as a result of residual RFID?	4.92	1.146	–.080	–.137	.936
	RL3	How likely is it that your privacy will be violated as a result of residual RFID?	4.73	1.120	–.093	–.226	.896
	RL5	How likely is it that your privacy will be violated as a result of residual RFID?	4.86	1.150	–.071	–.239	.886

Notes: * Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalisation.
[a] Rotation converged in five iterations.

Table 2 Mean differences across clusters

Group statistics	*Cluster 1: moderate majority*	*Cluster 2: untrusting sceptics*	*Cluster 3: concerned realists*	*p-value for mean difference*		
	Mean	*Mean*	*Mean*	*1 vs. 2*	*1 vs. 3*	*2 vs. 3*
Age	2.62	2.88	2.63	0.387	0.948	0.377
Gender	0.49	0.47	0.44	0.800	0.369	0.773
Income	2.88	2.67	2.83	0.622	0.871	0.687
Tech_Fam	4.40	4.00	4.18	0.174	0.199	0.536
RFID_Fam	3.29	2.74	2.93	0.121	0.090	0.571
PU_AVG	4.43	2.69	4.14	0.000**	0.004**	0.000**
OT_AVG	4.33	1.86	3.52	0.000**	0.000**	0.000**
RL_AVG	4.05	6.17	5.48	0.000**	0.000**	0.000**
Beh1	4.35	2.03	3.73	0.000**	0.000**	0.000**
Beh2	4.05	1.76	3.19	0.000**	0.000**	0.000**
Beh3	4.69	3.73	4.86	0.000**	0.187	0.000**
Beh4	4.75	3.87	5.02	0.000**	0.024*	0.000**
Beh5	3.73	1.97	3.04	0.000**	0.000**	0.000**
	n = 154	n = 34	n = 132			

Notes: * = Significance level of 0.05.
** = Significance level of 0.01.

Review of Table 2 indicates that, interestingly and rather surprisingly, in spite of having a very diverse sample in terms of age, gender, income, and technical familiarity, demographic variables were not found to be significantly different between clusters. This suggests that the intention of accepting the RFID technology is based solely on the attitudinal variables rather than individual's demographic characteristics.

The most important attitudinal variables are Perceived Usefulness (PU) of the technology, Overall Trust (OT) in the organisation, and Risk Likelihood (RL) that their information will be abused. These variables are represented in this analysis by their factors as determined by factor analysis as presented in Table 1.

Cluster 1, the *moderate majority* is characterised with the highest levels of perceived usefulness and trust with the lowest level of risk perception. This group is generally the most willing to accept residual RFIDs for everyday uses. However, their acceptance level is only moderately above the neither agree nor disagree level of the scale, even they will need some training and education before accepting this technology. Cluster 2, the *untrusting sceptics* are characterised by a very sceptical view of the potential usefulness of the technology, and extreme distrust of the organisation behind it and very high perception of the likelihood of their information being abused. This group is the most unlikely to accept this technology and will probably rebel if it is pushed upon them. Cluster 3, the *concerned realists* are characterised by a moderate perception of potential usefulness or an 'open mind' towards the advantages of this technology. However, they have some moderate concerns about the risk involved and the trustworthiness of the

organisations that deploy this technology. This group will be most likely to accept this technology if the retailer automatically disables the RFID tags or at least gives them the choice to have the tags disabled.

The results found significant difference in all attitudinal and behavioural variables between clusters except for one behavioural variable, BEH3. This variable is regarding the willingness to purchase the product with the technology if the RFID tags could be disabled. The *untrusting sceptics* are still significantly less likely to adopt than the other two groups, which are similar in their greater willingness to adopt under this condition. Figure 2 (see Appendix B) graphically depicts the cluster group differences.

Note that according to the *p*-values for the demographics variables (age, gender, income, tech familiarity, RFID familiarity) shown in Table 2, these variables are not significant factors (greater than .05) in determining consumer behaviour.

Table 3 describes the questions used in the survey instrument to determine and analyse consumer behaviour. Each question was answered on the scale of 1 (Very Strongly Disagree) through 7 (Very Strongly Agree).

Table 3 Survey instrument, behaviour questions

Label	*Description*
Beh1	I would prefer to purchase products from retailers that use RFID.
Beh2	I would actively seek out products that use RFID.
Beh3	I would be more inclined to purchase products that use RFID if I could disable the RFID tag after my purchase.
Beh4	I would be more inclined to purchase products that use RFID if the retailer would automatically disable the RFID tag after my purchase.
Beh5	I would be willing to pay extra to disable RFID tags in the products I purchase.

Figure 2 (see Appendix B) demonstrates the visual differences between the three clusters.

5 Conclusions

As shown through the data analysis and cluster descriptions presented in this study, consumer behaviour regarding RFID adoption cannot be measured by demographic variables. When government and industry need to address consumers' concerns pertaining to residual RFID technologies, they are likely to have more success addressing these attitudinal variables as opposed to attempting to segment the market demographically. However, the study clearly indicates that respondents can be clustered based on attitudinal variables, which can be used to predict their behavioural intentions towards the technology. Generally half (*moderate majority*) are open to accepting this technology under the right conditions. A small proportion of the individuals (*untrusting sceptics*) will likely never fully accept the technology under any conditions. Another group comprised of the *concerned realists* are concerned about the risk but will be willing to accept the RFID technology if those risks are adequately addressed.

Consumers willing to adopt or reject RFID technologies may be found in every profession, in every age group, in the suburbs or in the cities, in schools or law firms. They may be technologically savvy or they may be computer illiterate.

None of the demographic variables we examined showed any significance in determining consumer behaviour. Rather, behaviour is determined by consumer attitude and innate personality. Throughout this study we examined consumer attitude towards RFID technologies through three factors: perceived usefulness, overall trust and risk likelihood. Future RFID adoption studies must address consumer attitude through these factors. Organisations planning to implement RFID technologies would do well to dispense with demographic evaluations and focus on attitudinal studies as a means for planning RFID adoption campaigns.

Managers can benefit from this research by understanding the different types of customers that they may deal with and how these groups line up with their core customers. For example, it may be that certain types of business, such as those dealing with a lot of technology, may have customers that are more willing to accept this technology. These companies might benefit from a broader use of residual RFID technologies. On the other hand, other companies might have a large contingent of customers made up of untrusting sceptics. These companies might need to proceed with caution to avoid the risk of alienating some of their customers. Companies might also benefit from education on the risks and benefits of this type of technology to alleviate potential customer concerns.

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Appendix A

Survey introduction

Many experts predict that in the future, nearly every product manufactured, bought and/or sold will have a tiny tag that can remotely and uniquely identify that individual item. Any person or business with a scanner may be able to know the item type, price, where it was made, sold, purchased and resold by reading a small RFID tag.

RFID tags are currently being deployed in the supply chains of many organisations. These tags have the potential to bring many benefits to organisations that use them. However, many of these tags can remain active after they leave the organisation, broadcasting their identities and histories to anyone with a scanner and link to the proper database. These left over tags, installed to help the supply chain, but not removed after the purchase, are referred to as residual RFIDS.

In the future, residual RFID tags have a tremendous amount of potential to both help and harm consumers. A few examples are listed below.

Possible benefits

Residual RFID tags may make it possible to return items without a receipt.

Residual RFID tags may make it easier to track and find stolen goods.

Residual RFID tags may make it easier to track and fulfil warranties and repairs.

Possible liabilities

Companies could scan for residual RFID tags in order to target marketing to individuals.

Thieves could scan for residual RFID tags in order to case out potential victims.

Residual RFID tags could give out a tremendous amount of private information about individuals.

Appendix B

Figure 1 Three-cluster plot

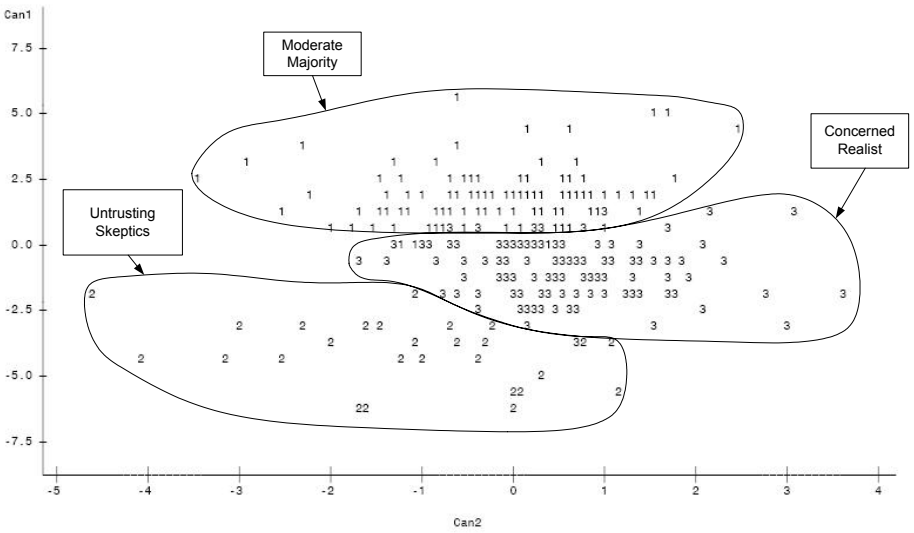

Figure 2 Visual of cluster differences (see online version for colours)