HOW WILL INTEGRATOR PERCEPTIONS AFFECT THE ADOPTION OF RADIO FREQUENCY IDENTIFICATION TECHNOLOGY

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ABSTRACT

Purpose - This study aims to assess the perceptions of leading Australian integrators within the RFID (radio frequency identification) Industry about the future of the industry and barriers to more widespread adoption of the technology.
Methodology/approach - Five leading Australian integrators presently working within the RFID Industry were interviewed.
Findings - We find that the interviewed managers were realistic and circumspect about the industry's future and potential supply chain savings, which can be contrasted with the "hype" evident in the commercial literature (for example, AIM-RFID Connections, 2003).
Research implications - Understanding integrators' current perceptions about the industry will help vendors and integrators to develop applications that will be more likely to gain widespread acceptance in the future.
Originality/value - This paper provides a unique insight into the perceptions of leading Australian RFID suppliers and integrators regarding the future of the industry and barriers to more widespread adoption of the technology.

KEYWORDS

Adoption, Barriers, Diffusion, Implementation, Radio Frequency Identification.

1.   INTRODUCTION

RFID (Radio frequency identification) can be thought of as Smart Labels or Silent Commerce. The demand for RFID has increased over the past few years. The hype in the industry (that "everything will be tracked") is fast becoming a reality.   At one end of the spectrum, RFID is viewed as a tracking and security device for enterprise application. At the other extreme, RFID is viewed as a true technological wonder that is going to transform the way that businesses will operate.

Customer perceptions of RFID have been studied extensively in the past. The main purpose of this study is to determine the perception of RFID among Australian Industry managers, and the role and importance of perceptions in the actual adoption process. Can marketing research companies and media publications on the RFID industry influence top managers?   This project identifies how managers' perceptions of the future of the industry impact upon present expectations of RFID technology.   An understanding of what managers think at this moment may help integrators and vendors create applications that will eventually secure more widespread acceptance.

This study was undertaken using qualitative data collection methods, that is, personal interviews with a sample of leading RFID Industry managers located in Australia.

2.   RELEVANT STUDIES

According to Thomas Ehrmann (Jones, 2003, p. 720), "value proposition" asks customers what value does the product have on the entire supply chain? This, in turn, focuses upon the business idea, economic role and the value that the product yields to the customer. The use of integration is another form of value, i.e., how successfully can the product integrate with new systems[1]?

Turban *et al*. (2002) suggests that companies may be "Market-Driven", waiting to observe what the competitors in their industry are doing. "When one or more competitors starts to use EC (electronic commerce), and it seems that they are doing well, it is time to follow suit" (Turban *et al*., 2002, p. 691)[2]. This can be linked to Everett Rogers' scientific theory of "Diffusion of Innovations", which suggests that, at an awareness stage, "the individual is exposed to the innovation but lacks complete information about it" (CIA Advertising, 1998). In order to evaluate the RFID industry in this study, the questions posed to interview respondents are interpreted within the context of the Ehrmann Business model, as well as Rogers' theory of Diffusion of Innovations.

According to Ehrmann (Jones, 2003, p. 720), the process of "innovation" is defined as reducing costs of producing or offering existing goods or services through a business channel. Innovation deals with cost savings, and the consequent advantages it bestows upon the innovating firm relative to its competitors. Innovation in the business model also considers production costs, and the market structures that are developed to support the product. This can be linked to Rogers's theory of Diffusion of Innovations which suggests that, at the interest or information stage, "the individual becomes interested in the new idea and seeks additional information about it" (CIA Advertising, 1998). Turban *et al*. (2002) look upon this as "Problem-driven", i.e., "Organizations have a problem such as inventory delays and deliveries. EC applications may be attempted in order to solve the problem" (Turban *et al*., 2002, p. 691).

Rogers' Diffusion of Innovations theory views "Early Adopters" as a group which comprises thirteen and a half percent of the total population. This group is comprised of highly educated and wealthy innovators, and is highly visible and respected among their peers. Early adopters play a key role in the adoption process for new technology, determining the times when an innovation will be adopted by others.

According to Ehrmann (Jones, 2003, p. 720), "content" in the appraisal of business models refers to the goods and information that are being exchanged. This business model looks upon the individual capabilities required to enable exchanges in the supply chain. Content evaluates the information that is being exchanged in the supply chain, and examines new products. We can also reference Turban *et al*.'s (2002) theory, where they state that "(t)echnology exists and the company is trying to use it. In doing so, the company may find problems that no one knew existed" (Turban *et al*., 2002, p. 691).

The RFID technology is available. The question is who is going to manage the information? This can also be interpreted within the context of Rogers' theory of Diffusion of Innovations, which labels this an "evaluation" stage. The "individual mentally applies the innovation to his present and anticipated future situation, and then decides whether or not to try it" (CIA Advertising, 1998).

According to Ehrmann (Jones, 2003, p. 720), "structure" refers to the actors that are linked in the value chain. The structure model analyses customers at both ends of the business. Structure refers to the underlying partners, and focuses on a specific network, rather than dealing with the entire value chain. This is similar to the Innovation model of Ehrmann, but it can also be interpreted within the context of Turban *et al*.'s (2002) theory.

Turban *et al*.'s (2002) theory states that companies are frequently "problem-driven". "Organizations have a problem such as inventory delays and deliveries. EC applications may be attempted in order to solve the problem" (Turban *et al*., 2002, p. 691). If the problem is to reduce inventory errors, then the advantage of RFID is in the accurate tracking of information. The cost to track information relates back to the partners in the value chain. Rogers' theory of Diffusion of Innovations suggests that adoption goes through a trial stage, as "the individual makes full use of the innovation" (CIA Advertising, 1998). Many companies are presently adopting RFID technology in the supply chain.

"Governance" deals with the way in which exchanges are executed. The model looks at property rights that are allocated between parties to the transaction. Also, governance deals with the set-up of market roles, operations and strategic tasks. The commercial literature has repeatedly viewed RFID in the context of consumer privacy issues. By contrast, Turban *et al*. (2002) focus on companies being either fear or greed driven. "Companies are either so scared that they are afraid that if they do not practice EC they will be big losers, or they think that they can make lots of money going EC" (Turban *et al*., 2002, p. 691). Rogers's theory of Diffusion of Innovations sees this as the adoption stage, where "the individual decides to continue the full use of the innovation" (CIA Advertising, 1998).

3.   STUDY APPROACH

At the early stage of the data collection process, initial e-mails were sent to ten (10) Australian corporate managers. Telephone follow up was used to clarify the questions. The initial ten (10) managers contacted either did not respond at all, or did not respond satisfactorily[3]. A second data collection attempt was made whereby one of the co-authors surveyed industry managers presently working for companies which are (at the time of writing) leading integrators of RFID technology within Australia. The response from this second group of selected managers was immediate, and the provided interviews generated sufficient material to allow for satisfactory conclusions to be drawn[4].

An unstructured interview approach was used as the data collection method. Interview questions were firstly e-mailed and then communicated over the telephone to respondents.   Answers were written down in point form. The approach was to gather the initial response. All interview responses were summarized.

One phone interview was organized ahead of time (by e-mail) with all respondents.   A comprehensive set of interview questions was sent to the five (5) managers selected.   The interviews consisted of 14 questions, which were designed to meet the following objectives:
  ➢ Understand the selected RFID industry manager's perception on each question using Ehrmann's Appraisal of Business model theory;
  ➢ Determine management expectations; and
  ➢ Evaluate responses within the context of the RFID commercial literature.

The five (5) companies surveyed were guaranteed strict confidentiality (other than brief bio data about themselves as presented below and their interview responses). They were also given the option to respond anonymously, although none of the respondents selected that option.

The objective in conducting phone interviews was to gain information about the perceptions of RFID technology held by key Industry managers, and the effects of these perceptions on the adoption process.

This study is based on the experience of real-world leading managers within the RFID Industry. All participants have given permission to present their details. The corresponding letter (A to E) below clearly identifies responses as belonging to each one of the following participants.
  A. Antony Edwards is an industry consultant for Symbol Technologies. His consulting company is The Enterprise Mobility Company. He wrote a paper "Radio Frequency Data Communications" dated April 1991.
  B. Duncan Goldsmith is a Business Analyst at Coles-Myer Limited specializing in in-store systems. At the time of the interview, he was a consultant at Synthesis PL. Duncan spent several years consulting at Australia Post, where amongst other projects, he was involved in trialing of both active and passive RFID. Duncan has extensive experience in numbering, bar coding, EDI and standards, as a result of his five year stint working for EAN Australia (now GSI Australia).
  C. Ken Laing is VP Technology at Magellan Technology, a Sydney-based RFID developer, which is partly owned by Siemens and Infineon. Ken also heads the Standards Australia Automated Data Capture Working Group.
  D. Anthony Mamo, of ElectroCom, is Marketing Engineer for a major distributor of Texas Instruments RFID and other TI products.
  E. Graeme Mears is Technical Director for Global RFID Systems Pty. Ltd, which represents Datanet Pty. Ltd as an "RFID Engineering Consultant". He has many years of experience in implementing RFID technology, as well as data collection and wireless systems within Australia.

4.   RESULTS FOR INTERVIEWS

The interview dialogues are presented below.   Questions were posed to each participant based upon Ehrmann's "Appraisal of Business model" theory. Respondents were asked to express their perceptions of the RFID Industry as it presently stands. The interview questionnaire gave a vignette to each participant. The vignette is as follows:

RFID (Radio frequency identification) can be thought of as Smart Labels or Silent Commerce. The demand for RFID has increased over the past few years. The hype in the industry (that "everything will be tracked") is fast becoming a reality.   At one end of the spectrum, RFID is viewed as a tracking and security device for

enterprise application. At the other extreme, RFID is viewed as a true technological wonder that is going to transform the way that businesses will operate.

Question: "What economic value will RFID Tags have on the business chain?"

Answers: (A): The economic value in the supply chain will amount to US$10 to US$100 million within 4 years.

(B): Assuming enough read ranges, goods can be moved within the logistics without line of sight.

(C): Should be cheaper in the long run. It will provide more information and visibility.

(D): It will be very good for the business chain. It will offer access control, niche markets. It is competing in bi markets.

(E): It will have a big value. It will stop fraud and authenticate drugs, perfume and electronic goods. Read and write tags will make it database independent. Therefore, the cost of goods should come down in the supply chain.

Question: "What economic value will Smart Labels have on the consumer?"

Answers: (A): In the supply chain 30% of the saving will pass on to the consumers. The rest will come from stocks and dividend profits which will be shared with consumers.

(B): Cost of goods could drop, which means retail price could drop for RFID tags

(C): More choices for consumers. Easier to shop and locate products in store setting. Provide authentication of genuine goods.

(D): The main advantage would be high security infrastructure, tracking the history of products.

(E): Ensure the customer gets the real product. Products are not copies and an authentication guarantee.

Question: "What is the RFID network size?"

Answers: (A): The network size is huge as tags will go to EPC and already the animal industry and the transport industry have use of the network.

(B): Small. Still in its infancy, mainly proprietary installation and pilot (tests)

(C): Everything we touch of a % of the GDP. Our lives will affect what we want to buy.

(D): It will be big. It will require updating systems, and purchases of reader and writers. Microsoft involvement in new software will bring changes across the industry.

(E): The RFID network size is huge. Areas of animal tracking and security will be big.

Three areas will be explained in appraising an EC business, based on Ehrmann's "value proposition" concept. These are: the economic value of RFID tags on the supply chain, economic value to consumers, and the RFID network size. Since this is an introductory study, only a few industry examples will used to illustrate the perceptions of the managers involved.

According to the World Watch Institute, 1.12 billion households, i.e., approximately three quarters of the world's population in 2002, owned at least one television set. This statistic, which demonstrates the widespread proliferation of technology in the present day, can be used as a basis for comparison with the economic value which RFID may create in the supply chain.

We can conclude that the RFID Industry managers interviewed had a realistic view of the impact of RFID on the supply chain, which can be compared to the more optimistic view (or "hype") which has been frequently expressed within the commercial literature. This is evident as manager (A) expresses his opinion that the supply chain savings will amount to US$10 to 100 million within four years. By contrast, AIM Industry analyst firms predict that RFID will be a US$3 billion market globally by 2008 (AIM –RFID, 2003).

The public as a whole has been led to believe, by the extant commercial literature, that the value proposition for RFID is captured most accurately by the recent public statements made by high profile retailers and government departments. For example, Ms. Linda Dillman, Wal-Mart's executive vice president and CIO (Chief Information Officer), has been quoted as saying that "(f)rom the supplier and the manufacturer, to the retailer and the consumer, we see this initiative (RFID technology) as a win for everyone. Benefits include better tracking and moving of inventory, faster receiving and shipping, improved quality inspection, fewer out-of-stock items resulting in improved shopper satisfaction, (and) greater predictability in product" (Mishra, 2004).

Public comments such as this have created the hype that big retailers are ready to fully embrace the technology, and that there will be widespread and substantial benefits for everybody involved along the supply chain. What value does RFID truly offer to the end consumer? A related question, that still remains largely unanswered, is whether consumers will actively push for RFID as an acceptable substitute for bar codes.

Top managers interviewed perceive the RFID network size to be "big", e.g., managers (A), (C), (D) and (E). Manager (E) mentions, "(i)t will have a big value. It will stop fraud and authenticate drugs, perfume and electronic goods." However, one manager (B) summarizes it as still being "small; in its infancy, mainly propriety installations and pilot tests". How can these conflicting viewpoints expressed at around the same date, be reconciled? One possible interpretation is that whilst the network size is potentially huge globally, in terms of actual realization the Industry remains in its infancy.

Question: "Do you think there is a demand for RFID Technology?"

Answers: (A): There is huge demand for RFID asset tracking, logistics tracking and proof of product delivery. By 2012 bar codes and RFID tags will equal each other in usage. The conversion from legacy systems in grand scale will happen. By 2020, 20% of the supply chain will be used by bar codes, which becomes a niche market.

(B): Only in niche industries at the moment, demand in retail will be led by large organizations such as Wal-Mart, CML (Coles-Myer Limited) here in Australia.

(C): There is demand for information. The process is not in place with RFID tags. The demand increased when governments controlled the export of animals and legislation. The Mad Cows Disease and September 11th increased demand. It took 20 years for bar codes to be accepted.

(D): The demand will depend upon the government, added security, fraud, and line of sight for identifying products. Also consumers are pushing the demand for cheaper and time saving retail experiences.

(E): Yes. RFID can be used with other technologies. With passive tags they can be dormant and are weather proof where barcodes, on the other hand, are not applicable.

Question: "Is the market structure established for RFID?"

Answers: (A): The market has been established but the privacy issue has given RFID a bad start. There seems to be some confusion in consumer perceptions.

(B): Not as yet, very proprietary, although some standards exist.

(C): The market is consumer driven. Distributors have established. RFID is not a commodity item.

(D): There is a structure for example the government control of animal tracking

(E): 40 million RFID are used in the Auto Industry tags each year.

Question: "Have other users in the industry caused interest in RFID?"

Answers: (A): Other retails have had a little influence but since 1995 I have been influenced by when Australia Post became interested in tracking mail.

(B): Certainly Wal-Mart's drive has created interest in the retail sector

(C): Wal-Mart and DOD (US Department of Defense) requiring mandates. Brazilian government use of RFID tags to track animals.

(D): Initially got fired up but did not care. The users are Gillette and Wal- Mart.

(E): Companies that have new technology interests.

Three areas will be explained that relate to appraising an EC business, based on the Diffusion of Innovation theoretical framework which was first presented in Section 2. These are the demand for RFID, market structure establishment and commercial influence.

Is there a demand for RFID? According to the managers interviewed, demand will depend upon government, added security due to "911" (and, of course, the more recent London bombings of 2005 which took place after the interviews were conducted), prevention of fraud and the potential for weatherproof bar codes.

One manager (B) did mention that giant retailers like Wal-Mart, and Coles-Myer Limited in Australia, might take the implementation lead[5]. RFID research articles mention that meeting demand will cost US$200,000, plus the cost of the RFID labels. This amounts to 10 million cases and RFID labels which cost US$20 cents each. This would amount to US$2 million per year in recurring costs. Also, it should be noted that the world's biggest buyers of RFID, which are, presently, the US Department of Defense, Wal-Mart, Target, and international retailers, require that their suppliers place RFID tags on their packaging, or products, as a condition for doing business. The interview results show that RFID Industry managers presently perceive that the demand for RFID by government and big retailers will be enormous.

The interviewed managers clearly view the RFID market structure as being "established" in some way. The perception of those interviewed is that animal tagging has been around for many years, and governments have structures in place. Manager (E) explains that 40 million tags are used in the Auto (parts) Industry each year, and this is an actual, present figure, not an estimate applying to the future. It is clear that distributors have already established the viability of tags in the Auto (parts) Industry. Importantly, because the end product is not a commodity item, the opinions of end consumers have been effectively excluded from the integration process within this application.

The commercial literature argues that manufacturers are producing tags, but the readers have not been implemented in industry applications. For example, different tags may require different and specific read ranges for a reader. Frequency availabilities of 13.56 MHz and 2.45 GHz are both worldwide standards. Proper read ranges and speeds on tags operate close to 915 MHz[6].

Rogers's Diffusion of Innovations theory classifies "Early Adopters" as a group that comprises thirteen and a half percent of the total population. This group is highly educated and is composed of wealthy innovators, who are highly visible and respected among their peers. Early Adopters play a key role in the adoption process for new technology, determining the times when an innovation will be adopted by others.

The interviewed managers did appear to be influenced by the fact that Wal-Mart, Gillette and the US Department of Defense have taken active steps to adopt the technology, a point that has also been widely documented in the extant commercial literature. Some managers know that the technology will be huge, and this had an impact on them pursuing RFID markets[7].

Question: "How and who will manage the information of RFID Technology?"

Answers: (A): It is not inclusive to one industry. Everyone will own the information. Likewise all are shareholders. Different shareholders will have a different stake in the management of the data.

(B): Writers and readers of the data, some organizations like EAN (now GSI) for numbering.

(C): IT managers within the company will manage the information for goods entering the company, same as bar code item numbering systems. Proprietorship of information on the tag will be allowed by the manufacturer, e.g., authentication of a refrigerator for the disposal of product.

(D): Instruments. The retail industry will not be able to write tags.

(E): Presently for livestock the NLS (National Livestock Stream) and the Automotive Industry database.

Question: "What goods and information will be exchanged in the RFID tag?"

Answers: (A): There will be a release for privacy of information released by the Australian Retail Association by Christmas time.

(B): This is application dependent.

(C): Its up to the user to determine. The user would be the manufacturer.

(D): Universal Identifier, no write-able bits and factory program. This all depends on the size of memory of the tag.

(E): RFID will provide for the maintenance history of machinery to be recorded on the tag for the services industry.

Two areas will be analyzed with a view to appraising an E-commerce business based on content. These are: the management of information in the market and the type of information exchanged.

Managers' first impressions about ownership of information were that it should not be exclusive to one industry. All managers of Information Technology will own the content for each good. The commercial literature explains that an Object Name Service (ONS), such as UPC (companies will need to maintain ONS servers locally), will store information for quick retrieval. The ONS will keep track of data for every EPC-labeled object (Shankland, 2002).

Large volumes of information will be stored in the RFID tag, and retrieved when required. The intellectual property belongs to the universities where the research is being conducted[8]. The intellectual property will be freely available to any company that wants to use it. Therefore, the suppliers and retailers using RFID tags in the supply chain will manage the information on the tag.

The managers interviewed mention that the information on the tag will specify the manufacturer, factory program, maintenance for service and personal information of the product. This view is similar to viewpoints expressed in the commercial literature which states that the RFID tags will let you trace a particular unit of product through its life-cycle. Product recalls can trace a suspect unit right to the point of delivery. The data will have business intelligence, such as inventory reduction and total asset visibility (Rossi et.al., 2003). This raises the related issues of data integrity and privacy.

The commercial literature raises the concern of privacy, which relates to how the product information can be used once the product has left the store. There are no local laws specifically covering accumulation and compilation of anonymous data. In addition to this, RFID chips embedded in clothing and other consumer products, which allow for the tracking of a person's location and shopping habits, may not be covered presently by Australia's privacy laws (Dearne, 2003, p. 1).

Another important issue is that the speeds of the networks for retrieving tag identifiers have not been tested for large volumes. Will the information be reliable and accurate? Interestingly, none of the managers discuss these concerns in their statements. Overall, the commercial literature does emphasize this concern and has hyped both the privacy issue and the large volume of retail tag usage issue.

Question: "What price do you expect RFID tags to cost in the coming years?"

Answers: (A): Price of tags will go down due to economies of scale. The more users that implement RFID the less the tag/label cost per unit. Tag prices will definitely go down to a few cents US when RFID equals bar codes share.

(B): Passive-cents, Active – still will cost more.

(C): Tag dependent. Read only near Aust. 1 cent but Read/Write up to Aust. 35 cents in a couple of years. This factor is dependent on the antenna cost and packaging. 2004 prepare market, 2005 first role out, 2006 -100 million tags volume.

(D): Retail tag- now is A$1, landed- 0.40 cents Aus. Label tag from A$0.20 to A$0.25 in a few years. Packaging will add cost to the item.

(E): 13.56 KHZ when it reaches billions the tag price may drop to .1 cents Aust. Presently it is at 10 cents Aust for large orders.

Question: "What value is RFID technology to the entire supply chain?"

Answers: (A): The value is over US$100 million.

(B): Removes the need for line of sight scanning, transmission of EDI message.

(C): RFID can save 100 millions of dollars of lost inventory. Lost cost reduction method. It will be able to manage large amounts of information.

(D): Billion – US and 100 million - Australia

(E): The value will be worth billions in the supply chain

Two areas will be focused upon in the appraisal of an EC business based on structure. These are: price of tags in the coming years, and the value of RFID to the entire supply chain.

All five managers interviewed mention that the tags will go from dollars to cents within a couple of years. Manager (D) mentions that the retail tag is A$1 landed, and could go down to 40 cents. They all note that packing will be the costly item.

The commercial literature states that tag costs in volume now (2004) "could be in the range of (US) 18 to 35 cents each. However, those costs depend on the type of product the tag is applied to and the kind of adhesive used to secure it to a package" (Brewin, 2004). We conclude that the surveyed managers perceive the tag pricing similarly to the commercial literature.

Managers of integrating RFID systems have expressed their perceptions that tag prices will go down. We interpret this as a very similar occurrence to events within the entertainment industry where DVDs and digital televisions have now reached (at date of writing) an equilibrium price level which is cost effective for consumers. As the number of adopters increases, the marginal ability to pay for the good increases, due to network externalities (Varian, 2003, p. 32).

Managers' revealed perceptions concerning the value of RFID to the entire supply chain are over US$100 million. Manager (C) mentions that it will reduce lost inventory, and will be able to accurately handle large volumes of information. By contrast, Industry analyst firms are predicting that RFID will become a US$3 billion market globally by 2008. For example, Michael Liard, senior RFID analyst at VDC, predicts that shipments of transmitters and readers will grow from US$703 million in 2002 to nearly US$2 billion by 2007, according to his firm (Liard, 2001; Stackpole, 2003). This suggests that the commercial literature has over exaggerated the supply chain value. Leading technology managers (such as those interviewed in this study) see the real picture of the value of RFID, and maintain a positive, yet realistic, attitude toward large-scale applications of the technology. At this moment, their view is that it will commence primarily in niche applications. Industry analysts, however, view it as a "killer" application, which will explode in popularity as early as 2006.

Question: "Are you concerned with the privacy issues posed by RFID technology?"

Answers: (A): There has been bad publicity of RFID when it comes to privacy. As business integrators its does not matter, as all technologies have some negatives. Privacy will not pose an issue because consumers will be educated on the plan and usage of the product.

(B): Personally no at this stage, again depends on the application.

(C): No Problem. The technology does not exist that privacy issues have on consumers (sic). Items do not get attached to the person (i.e., physically) so the retailer does not know who purchased the item.

(D): Not concerned. It will be impossible to read.

(E): Not concerned. This is all hype to slow the progress of information. 'Big Brother and Mark of the Beast' scenario. The future will be biometrics.

Question: "Who controls the RFID industry?"

Answers: (A): One identity does not control RFID. New standards are being created for global compatibility. This includes hardware and software. Governments control the frequency of each country. Therefore, there is a lack of standards. Top chip manufacturers and universities are trying to create a standard.

(B): Standards to some extent will be set by the major users who, when they implement, will drive their suppliers, e.g. Wal-Mart.

(C): System integrators control the RFID industry. There is no one entity that will control this industry.

(D): EPC and government control this industry

(E): Sokymat is the largest RFID tag manufacturer. EPC Global and ISO control the RFID Industry.

Question: "Who are the main players in the RFID industry?"

Answers: (A): Texas Instruments and Philips.

(B): Too early to tell, many manufacturers of the product, but will be led by major users when they emerge.

(C): Hardware- Philips, Texas Instruments; Software- IMB, Accenture, PWC, Unisys.

(D): Texas Instruments, Philips, Matrix and Alien Technology who are US based manufacturers.

(E): Sokymat and Texas Instruments.

Question: "What products names can identify RFID in the industry?"

Answers: (A): Low frequency: Texas Instruments, Tagis and Philip; Active tags: Indentex and Savy Technologies.

(B): Respected Brand Names as users and manufacturers, both national and multinational.

(C): There is not a real brand name. RFID will be application driven, e.g., beer barrels.

(D): Texas Instruments, Mayfair and Philips that produce readers and tags.

(E): Sokymat and Texas Instruments.

Three areas will be discussed in appraising an EC business based on governance, which are the privacy issue, and stakeholders and product players.

Interestingly, each manager has a different perception concerning RFID industry control. The majority perceives that the government has control (managers A and D), or in fact they did not really know until the question was presented. Some believe that the leading retailers will take the lead (manager B), and others deem the EPC Global to be precedent (managers D and E). RFID control and standards (or the lack thereof) has become the leading obstacle in the adoption of RFID. This is evident in the confusion of standards with domination. For example, all frequency bands are subject to licensing regulations that are drawn up by standards institutes, both national and international[9].

Commercial articles have emphasized that there is a perception among privacy groups that RFID is a real threat to patron privacy. We feel that this outlook is based upon two clear misconceptions: (1) that the tags contain patron information, and (2) that, as managers C and D make clear, they can be read after the patron has taken the product back to home or office (Boss, 2004).

For example, the recent announcement by Benetton of its planned adoption of RFID led to an immediate call by the US based Consumers against Super-market Privacy Invasion and Numbering (CASPIN) organization for a worldwide boycott of Benetton stores. The impact of this boycott caused the implementation of low-cost RFID systems in the retail market to be re-considered by some within the sector. By contrast, the interviewed managers' perceptions were that, as business integrators, privacy issues do not concern them, and/or the privacy issues are not perceived as being insurmountable.

We conclude that privacy all depends on the specific application. The interviewed managers' (consensus) viewpoint as to privacy concerns are diametrically opposed to the viewpoints expressed in the commercial literature. The early adopters of the technology, e.g., Wal-Mart and Gillette, also do not appear to be overly concerned about privacy issues.

5.   CONCLUSION

The interviewed managers view the economic value proposition of RFID technology as "big". However, one manager considers it to be still "small". The commercial literature mentions that the demand for RFID by government and big retailers will be enormous. The difference in outlook can be explained by the technology being "small" at present, being focused as it is within niche applications e.g., the auto-industry, but "huge" in terms of potential future application, once certain implementation problems have been ironed out.

The interviewed managers look upon the RFID market structure as being already "established" in some way. The commercial literature argues that manufacturers are producing tags, but that the readers have not been implemented in industry applications.

The interviewed managers appear to have been strongly influenced and impacted by the recent decisions of Wal-Mart, Gillette and the US Department of Defense to adopt the technology, and this has also been documented extensively in the commercial literature. This appears to be an area where the perceptions of the commercial literature and the interviewed industry managers are in substantial agreement. According to the Diffusion of Innovations theory, Wal-Mart, Gillette and the Department of Defense can be regarded as widely respected "Early Adopters", who are likely to create a wave of subsequent adoption by more conservative organizations[10].

The heavy reliance upon the Wal-Mart example may reflect the managers' perceptions that Wal-Mart has been a successful and early adopter of other technologies and advanced processes in the past 15-20 years, e.g., the "cross-docking" warehousing technique[11]. Many commentators feel that this eager embrace of new technology has been a major contributor to Wal-Mart's ascendancy to the position of Number One retailer in North America and the globe, over-taking its industry rival K-Mart.

The interviewed managers' first impressions as to ownership of information are that it is not inclusive to any one industry. All managers of Information Technology will own the content for each good. The commercial literature argues that the intellectual property will be freely available to any company that wants to use it. The suppliers and retailers using RFID tags in the supply chain will "manage" the information on the tag.

Managers mention that the information on the tag will determine the manufacturer, factory program, maintenance for service and personal information of the product. Consistent with the interviewed managers' (consensus) perception, this view is similar to the view expressed in the commercial literature that the RFID tags will trace a particular unit of product throughout the duration of its life cycle.

All managers interviewed mention that the price of tags will decline from dollars at the time of the interviews (the second half of calendar year 2004) to cents within a couple of years. The commercial literature maintains that tag costs in volume now (2004) "could be in the range of (US) 18 to 35 cents each".

The interviewed managers' perception of the value of RFID for the entire supply chain is over US$100 million. By contrast, industry analyst firms predict that RFID will become a US$3 billion market globally by 2008. Some confusion may exist between global and local markets.

Each interviewed manager expresses a different perception about RFID industry control. According to the commercial literature, the main organization reforming RFID standards is EPC Global, originally known as the MIT Auto-ID Center. We can conclude that the interviewed managers confuse standards with domination.

Managers' viewpoints relating to privacy concerns are diametrically opposed to viewpoints that have been expressed in the commercial literature. The commercial articles emphasize that there is a perception among privacy groups, such as Consumers against Super-market Privacy Invasion and Numbering (CASPIN), that RFID is a threat to patron privacy. However, the interviewed Industry managers perceive that privacy is not a major issue, and is based upon two misconceptions.

We conclude that integrators' perceptions can affect the adoption process. Managers' perceptions, based in part upon future predictions contained in the commercial literature, can act upon present expectations of RFID technology. The study has provided an informal view that marketing research companies have invaded the consumer market by predicting million-dollar investment and unrealistic expectations for today. The commercial marketing researchers have also caused attention to focus upon consumer privacy concerns, and this has reduced the speed of adoption of the technology. Managers of large companies must block out the hype and exploit the technology for its ability to increase return on investment in the supply chain.

Some over-expectations for the RFID industry held by industry analysts can also be explained according to Roger's model of Technology Diffusion. Rogers' theory warns that a technology may be rejected during any stage of the adoption process. Rogers defines "rejection" as a decision not to adopt an innovation. The over-expectations appear to lie in the areas of lack of systems integration expertise, the promise of smaller and cheaper tags for tomorrow (which remains a clouded issue), the lack of penetration acceptance, and the cost of integration, tags and readers.

The main implication of Ehrmann's Appraisal of Business model theory is that top Managers in the RFID industry are required to, and do, compromise between the hype of the commercial literature and the practical reality of actually implementing scientific advancements in the real world. Through economies of scale, RFID products will be forced to adapt, by the way of unique applications that will ultimately benefit the consumer. Unresolved privacy concerns mean that RFID is more likely to receive widespread acceptance (at least in its early stages) in those parts of the supply chain where the end consumer is not directly involved, such as in the automotive industry.

Based on the results of the study, additional research is required which will provide accurate recommendations for change. Future research will explore and develop further issues raised in this research, including whether RFID follows, and is expected to follow, the adoption processes of other technologies in the 20th and 21st centuries. Will RFID remain a niche application, due to privacy or other concerns, or will it ultimately revolutionize commerce, and become an acceptable substitute for bar codes? It is envisaged that this continued work will improve our understanding of the complicated network of relationships that exist between technology, perceptions, ethical and privacy issues and successful practice.

Notes

1. Thomas Ehrmann, 'Appraisal of a business model' theory evaluates the (1) value proposition, (2) innovation, (3) content, (4) structure, and (5) governance.
2. Turban *et al.*'s theory explains that companies use a systematic approach to adopting Electronic Commerce initiatives to launch the idea to dominate a market. Successful implementers use a systematic approach, which is either problem-driven, technology driven, market driven or fear and greed driven (Turban *et al*., 2002, p. 691).
3. Unfortunately those managers chosen initially explained that they did not understand the questions. Some of this group did not respond at all. The poor response was due to the fact that the managers

chosen were generally working at companies which did not (at that time) purchase or integrate RFID technology. Another potential reason for the initial poor response is that these managers did not want to commit, as they were not sufficiently confident about the depth and extent of their industry knowledge.

4. The second attempt (with a different group of managers) was successful due to this second group of managers having industry expertise.

5. In Australia, in contrast to the US, the major retailers have not so far been the Early Adopters of RFID (Mills, 2005; Walters, 2005). A Woolworths spokesperson has said that RFID adoption is not an immediate priority, and that other projects with a "more certain" pattern of perceived benefits will be pursued more vigorously than RFID adoption. As at 20 April 2005, Coles Myer had undertaken RFID pilot tests but had generally viewed the technology as too expensive when compared to barcodes (Walters, 2005).

6. Mills (2005) notes that the Australian Communications and Media Authority (ACMA) has recently (in July 2005) permitted the regulatory body GSI Australia to issue licences for 4W readers. 4W readers can read RFID tags from twice the distance at which tags can be read by 1W readers. The accuracy of the reading process also improves. Since July 2005 it has been illegal to use 4W readers without a licence, and a database is maintained by GSI Australia of each company and each site licensed to use 4W readers. A major concern is that use of readers does not interfere with other UHF frequency users such as Vodafone. The band of 920-926 MHZ is used for the 4W readers. The Australian retail price for a new Epson reader was approximately A\$800 in March of 2006.

7. The hype about the retail industry's usage of RFID products is obvious to all. For example, the Yankee Group mentions that suppliers to Wal-Mart and Department of Defense will need to spend between US\$3 million and \$35 million on EPC RFID in 2004 (Ebizq, 2004).

8. For example, Auto-ID Center is a unique partnership between industry and academia.

9. So, who really controls the RFID industry? According to the commercial literature, the main organization reforming RFID standards is the EPC Global, originally known as the MIT Auto-ID Center. The EPC Global is made up of the world's largest retailers, in partnership with a broad spectrum of technology providers. EPC has successfully transformed itself, in more recent times, into a not-for-profit (NP) organization with links to the Uniform Code Council (UCC) and EAN (now GSI) International (Melling, 2004).

10. Con Colovos, Chief Information Officer (CIO) of the Australian Early RFID Adopter Moraitas Fresh, has been reported as saying that as a result of Wal-Mart's decision to require its Top 100 suppliers to use RFID by January 2005 that widespread adoption of RFID in Australia "is inevitable" (Walters, 2005). Colovos is also the current chairman (as at April 2005) of the Victorian Government funded industry body RFID Action Australia.

11. "Cross-docking" is a process whereby warehouses are used as inventory co-ordination locations rather than inventory storage locations (Simchi-Levi *et al*., 2000, pp. 113-114). Goods remain in the warehouse for fewer than 12 hours on average before being transferred to the retailer as quickly as possible. Wal-Mart uses Point of Sale (POS) technology to instantly transmit sales data to its suppliers (thus reducing the "bull-whip effect") and has some 2000 trucks on hand to transport full truckloads of goods rapidly to stores. Wal-Mart manages 85% of its goods using cross-docking, as compared to only 50% for K-Mart (Stalk *et a*l., 1992; Simchi-Levi *et al*., 2000, p. 114). Kurnia and Johnston (2001) analyse cross-docking within the context of an Australian supply chain.

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