RFID: Technology, issues, applications and growth

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Abstract

Radio Frequency IDentification (RFID) technology is an emerging technology which is being used in many areas like supply chain, healthcare, construction .etc. This technology was initially adopted by Wal – mart and DoD in the year 2005, because of its sound features later it was adopted in the various areas in order to overcome the various issues present in their application areas. In this paper the issues to be considered in various areas and the benefits with the current technology are mentioned. Also mentions the growth of this technology in those areas in the last decade. Finally the astragals for adopting this technology and the feature works has to be carried out in the area are discussed.

Key words: RFID, application areas, growth of RFID, value of RFID.

1. Introduction:

In gray market, in case of retail stores when the product size is less the billing person remembers the information pertaining to all the products and he will manage the total business. Due to increase in the product line and increase in the demand of the products it is not possible to manage all the information. So auto – ID techniques are adopted in the business operations to increase the efficiency, reduce the data entry error and to minimize the processing and waiting times. Many auto – ID techniques like bar codes, data matrix, PDF417 and RFID Techniques are emerged. Among these bar codes are widely adopting in the many business areas to access their activities[5]. The RFID technology provides many benefits that bar code system cannot, such as 1) Direct line of sight is not required 2) Ability to communicate with more number of items simultaneously (approximately 200 items) 3) Higher data information 4) more environmental durability in the presence of dirt, water, etc. 5) The ability to read and write 6) greater data security. A huge research and development project on RFID was initiated in 1999 and run by auto – ID centre managed by MIT in Boston, USA and Cambridge University, UK. This closed down in 2003 and the research results transferred to the organisation EPC global who has continued the standardisation work related to the retail industry world – wide. In 2003, with the aim of enabling pallet – level inventory tracking, Wal – Mart issued an RFID mandate to its top 100 suppliers to begin tagging of pallets and cases with RFID tags by January 2005 with Electronic Product Code (EPC) labels. In the same year Department of Defence (DoD) of USA suits and issued the same mandate to its suppliers[6] and 400 suppliers started tagging in 2005 and this number was increased to 45,000 suppliers in 2006[5]. In 2004, Tesco, Metro AG, Target, Albertson's, Carrefour, Best Buy and FDA (Food and Drug Administration) US companies also announced the recruitment of the RFID technology in their companies and started implementing in the years 2005 and 2006[5]. The strengths of this technology encourages in overcoming the issues present in the various areas. Due to this, the value of RFID in 2005 is $4.3 billion was increased to $5.56 billion in the year 2008 and ID tech analysed the sales of RFID will reaches $26.23 billion by the end of 2015. In this paper the elements of the RFID technology is mentioned in the second section and the application areas with the issue in it are mentioned in third section. The growth the research activities taken place is presented in the fourth section and growth of technology from 2003 onward is mentioned in fifth section. Finally in the sixth section, our feature works carried out in this area were presented.

2. Basic elements of RFID Technology:

Radio Frequency IDentification (RFID) is an automatic identification technology considered to be a better replacement for the existing bar code technology. Three basic components of the RFID technology are tag, reader and host computer (middleware). RFID Tag containing tiny

semiconductor chip and miniaturized antennas inside some form of packaging. They can be uniquely identified by the reader, when applied to an object or a person, that object or a person can tracked and identified wirelessly. RFID tags come in many forms like paper labels, wrist hands and incorporated into the wall of injection moulded plastic containers ...etc. RFID tags can hold much information about the objects to which they are attached like unique serial number, time stamps (manufactured and expired information), configuration instructions and much more. There are many types of RFID tags. Some includes miniature batteries that are used to power the tag, and these are referred as active tags. Those that don't include an on-board battery have power 'beamed' to them by the reader, are termed as passive tags. In addition of this some tags have memories that can be written to and erased, like a computer hard disk, while other have memories that can only be read like a CD-ROM. The cost and the performance of tags can vary widely depending on the features that are included in their design.

RFID readers are composed of an antenna and an electronics module. The antenna is used to communicating with RFID tags wirelessly. The electronic module is net worked to the host computer through cables and relays message between the host computer and all the tags within the antennas read range. The electronic module also performs a number of security functions like encryption/ decryption and user authentication and another critical function called anti – collision, which enables one reader to communicate with hundreds of tags simultaneously.

RFID host is a "brain" of an RFID system and often it is in the form of a PC or a workstation. Most RFID networks are composed of many readers and tags. The readers (consequently tags also) are networked together by means of the central host. The information collected from the tags by the RFID readers in RFID system is processed by the host. The host is also responsible for shuttling data between the RFID network and larger enterprise IT systems, where supply chain management or asset management database may be operating.

3. Application areas & Issues:

RFID is an emerging technology which has been successfully applied in manufacturing, supply chain and logistics. The ranges of applications are extended far beyond these areas. Due to tremendous potential of this technology increasing numbers of companies have already started up pilot schemes and some are successfully used it in real world environments. RFID is likely to be among the most exciting and fastest – growing technologies in terms of scope and applications in the next generation intelligence[7]. RFID technology can be applied in the following areas.

- ➢ Animal detection
- ➢ Airport
- ➢ Building Management
- ➢ Cars & Vehicles
- ➢ Construction
- ➢ Food Industry
- ➢ Garments – apparels
- ➢ Healthcare Industry
- ➢ Library
- ➢ Manufacturing
- ➢ Pharmaceutical Industry
- ➢ Retail Stores
- ➢ Supply Chain Management & Logistics
- ➢ Transportation

With implementation of RFID technology the following benefits can be achieved. Reduces warehouse and distribution labour cost, reduces base stock inventory level, minimizes the shrinkage (theft, the losses due to theft are estimated to cost retailer over \$30 billion per year and are estimated conservatively at 1.5% of overall sales[8]), accuracy in forecasting and planning, reduces the out – of stock conditions, improves the customer satisfaction, better visibility, improve the shipping accuracy, reduces the cycle time, increases labour productivity, reduces the product obsolesces cost, better asset management and many.

3.1 Supply Chain Management:

As markets become mere global and competition intensifies, firms are beginning to realize that competition is not exclusively a firm versus firm domain but supply chain against supply chain phenomenon. Demand forecasting, sourcing of raw material, through to manufacture and dispatching are the critical to supply chain competition. Customers will no longer tolerate delay in response times and they expect information in minutes not hours. Consequently for this, supply chain networks must be most dynamic in nature, sound distribution

architecture and sophisticated leverage to the real time analytics. In this scenario information technology play a key role in supply chain competition. The information required to the technology is transmitted quickly by scanning the data which is printed on the pallets, cases and individual products in the form of bar codes. In this technology scanning of item require the line of sight of the bar code so time taken will be more for record the shipments, the transparency of objects is not possible, it cannot able to trace out the thefts.

RFID technology offers a potential solution and have a significant impact on every facet of supply chain management form the simple tasks, like moving goods through loading docks, to the complex such as managing terabytes of data as information about goods on hand is collected in real time. It has a potential to dramatically improve supply chain by reducing cost, inventory levels, lead times, stock outs, misplacement and shrinkage rates. Manufacturing flexibility, inventory visibility, inventory record accuracy, order accuracy, customer service and collaboration among supply chain members are possible with this technology. The automatic identification of products with RFID in the warehousing and distribution environments has a consequence of increased visibility and accuracy of the inventory. This increases the warehousing efficiency and order accuracy. At the same time it reduces shrinkage, stock outs and inventory levels. Consequently operation costs will be reduced which translates into increased profits and also a reduction in lead times. Reduction in the lead time increases the customer service as well as decreased inventories along the supply chain.

3.2 Retail Stores

The market share of the product can be increased only with the satisfaction of the customers. So retail stores is the place at which the customer will choose the product. If the items required to the customer is not available in the shelf even though the item data is there in the systems then also the goodwill of the stores will be lost. The difference between the system inventory and actual inventory present on the shelf may be due to employee theft, shoplifting, and collusion when a staff member collaborates with a customer to steal products or not billing the some of the items and grazing where items are consumed by the staff or customers[9]. Raman et al. (2001) reported that at the stores of one retailer, two thirds of the stock

keeping units had inaccurate inventory records upon physical audits. Such inaccuracies could have the potential of reducing profit by 10%. Fleisch and Tellkamp(2005) reported that shrinkage accounted for 2 – 4% of sales in the US retail industry in 2001. Alexander et al. (2002) at IBM reported that the amount of inventory shrinkage rates are around 1.75% of 2001 sales in the US, Europe and Australia. ECR Europe (2003) found that the shrinkage rates were 1.75% in for retailers and 0.56% for manufactures. De Horatius and Raman (2004) found that 65% of the inventory records at one retailer were inaccurate. Similarly, in 2005 Kang and Gershwin found that best performing store in their sample study only had 70 – 75% of its inventory record matching physical inventory during its annual inventory audit.

Although advanced inventory control polices have been developed still occurrence of out of stock is a significant issue in the retail supply chain. This may occur because of the replenishment process from the backroom to the shelf of the retail stores, keeping them in the wrong shelf and misplaced by the customer during his visit to the stores, hence once a better product than earlier picked one appears customer drops the old one there itself. So for the next customer the item won't appear in the right shelf. The surveys conducted by Gruen 2002, out of shelf rate falls in the range of 5 – 10 % and also mentioned that out of stock rate is about 8.3% leading 4% of loss of sales for a typical retailer. Berger (2003) also reported that out of stock between 10 and 15% are not unusual in most of European countries.

With the application of RFID technology the misplaced items can be traced out with a minimal cost in short time period and for this the line of sight of the item is not required. Shrinkage will also be reduced and Lee and Ozer (2005) reported that between 10 to 66% of the original shrinkage observed is reduced after implementing RFID technology.

3.3 Hospitals:

The global healthcare industry is facing several challenges such as spiralling healthcare cost, chronic labour shortages, huge loss including medical errors due to medication faults and loss of expensive equipment. In this scenario by implementing the RFID technology in healthcare organizations these challenges can be easily tackled and also operational efficiency will increase. Apart from these enhanced

patients safety and improved business processes can be achieved.

RFID system is used to track patients, doctors and expansive equipment in hospitals. RFID tags can be attached to the ID bracelets of the patients to monitor the location and also store information about medical allergies, medical data and other health history. A system of attaching a passive RFID tags with unique EPC code on the covers of the patients documents like address, medical bills, prescriptions, clinical reports, pathological test certificates, name of the attending doctors, insurance company details for an outgoing patients can be easily track able form the store room cabinets containing millions of patient files. This system will reduce handling, human errors which will lead reduction of manpower. The following benefits can be obtained with implementation of the RFID system in the hospitals.

➢ Continuously track each patient's location
➢ Real time tracking of the location of doctors, nurses and other employees in the hospital
➢ Track location of expensive and critical instruments and equipment
➢ Patient's RFID tag is used to access patient information for review and update through hand held computer
➢ Restricts the access of drugs, paediatrics and high threat areas to authorized staff
➢ Monitor and track unauthorized persons who are loitering around high threat areas, patients during medical emergencies, epidemics, terrorist threats and also when demands could threaten the hospital's ability to effectively deliver services

3.4 Pharmaceutical industry:

One of the major problems that the pharmaceutical companies are facing in the world is infiltration of counterfeiters with fake drugs that look identical to the legitimate drugs. The majority of such fake drugs have little or no medicinal value and which can lead to fatal deterioration of health. Some of these drugs are life saving drugs which are used for severely ill patients to stay alive. The US Food and Drug Administration (FDA) estimated that 7% percents of all medications in the international pharmaceutical supply chain are counterfeit. In some countries the problem is endemic and patients are more likely receiving fake drugs than real. FDA reported that rise in the drug counterfeiting cases are more in the recent years. The average numbers of counterfeit drugs are increased for 5 in through the year 1990 to 20 in 2000. One such cases, in 2003, over 2,00,000 bottles of counterfeit Lipitor found their way into U.S. market.

Another one is tampered to misrepresent of the product's potency or extend the expiration date. Pedigree enables that each year $ billon worth pharmaceutical products are returned with 1,300 or more recalls in each year. Lack of shelf-life information and inventory visibility makes inventory management less accurate, often resulting in excessive expired product and increased cost.

So a mandate require to pharmaceutical companies to use auto – identification technology, such as RFID to enable the electronic pedigree of the drugs to prevent fake or counterfeit drugs seeping into the supply chain as well as safe product remains available to the patients and the industry saves on recall costs. And some of the other key benefits obtained with the adoption of the RFID are,

➢ The ability to identify drugs at the individual and container level.
➢ Assurance that the ID on the bottle has not been forged or mislabelled.
➢ The ability to track exported drugs being re-imported and resold in the markets at lower costs.
➢ Minimized line-of-sight requirements to read product information.
➢ Remote tracking of product movement and location.
➢ Increased potential for reducing clinical trial times by reducing errors and improving delivery accuracy.

Kalorama information reported that, adoption of RFID "ensures a good return on investment for pharmaceutical manufactures as well as distributors". And it calculates that Large manufactures can save $17 – 55million and major distributors up to $10 million per year by implementing the technology[10].

3.5 Garments - Apparel Industry:

Incorporating RFID tags into garment labels or even into the garment itself can be a valuable tool for brand owners. A tag inserted at the garment manufacturing plant can identify its source. By using the tag's unique identification number, the garment can be certified as authentic, which enables the

identification and control of counterfeits. Grey market imports can be controlled through the use of source identity. The tags enable inventory visibility throughout the supply chain, reducing shrinkage and out-of-stocks, and the EAS function can reduce in-store theft. Finally, where warranty information is needed for after-sales service, the tag can be written to at the point of sale.

3.6 other application areas:

Logistics and transportation are major areas of implementation of RFID technology. Yard management, shipping and freight and distribution centre are some of the examples where RFID tracking technology is used. The North American railroad industry operates an automatic equipment identification system based on RFID. Aerospace applications that incorporate RFID technology are being incorporated into network centric product support architecture. This technology serves to facilitate more efficient logistic support for system maintenance on-board commercial aircraft. In hong kong international airport, for improving efficiency and reduces misplaced items, the bag gages which are passing through it are individually tagged with 'HAIK' RFID tags. These are navigated by the airport's baggage handling system[11].

The oldest application of RFID technology is animal husbandry. Earlier, plastic tags were used for tracking the animals. These plastic tags easily worn out after a few weeks. These have been soon replaced by the RFID tags. The RFID tags provide easy tracking of the animals. Injectable RFID tags are also available these days. The injectable RFID tags can be used for tracking the animals easily. These tags have the information about the age of the animal, medical history and vaccinations. Any other system doesn't provide the facility of the maintaining all the information in addition to keeping track of the animal. RFID technology has made many tasks in animal husbandry very easy[12]. The Australian National Livestock Identification System (NLIS) is the first and the largest implementation of RFID for animal tracking in the world. A Texas instrument is using low frequency RFID technology to identify millions of livestock animals around the world. These systems track meat and dairy animals, valuable breeding stock and laboratory animals involved in lengthy and expansive research projects.

Construction and Building managing organizations are worried about protecting, tracking and managing the tools, equipment and supplies. The inventory that is often porn to theft, loss, hoarding, stock-outs, maintenance slips, and even improper sage by an employee without the necessary certifications to operate particular tools. National Insurance Crime Bureau estimated that the industry loses $1 billion annually from equipment and tool theft and increasing on average 20 percent annually. The worst part is that organizations don't even know something has been stolen until weeks or months have passed, making it almost impossible to recover. Statistics like this prove how important it is to provide the necessary protection and tracking of the valuable inventory.

4. Growth of RFID:

Apart from the above advantages many organizations are not come forward for implementing this technology hence it required high investment for implementation, lack of globally accepted standards, lack of better middleware and strain in the IT infrastructure by overwhelming information systems as real-time scans move between multiple applications. The downfall of RFID implementation cost and the technology benefits are encourages the organizations to implanting this technology. The total sales of the RFID tags in the past five years also seems that it is going to be occupies the place of the barcodes in the near feature. The number of RFID tags sold is increased to 2.35 billion in 2009 form 1.02 billon in the year 2005. According to the market research carried out by the ID TechEX sales of the tags in the years 2006, 2007 and 2008 are 1.74, 1.91and 1.97 respectively. Also the tag costs are reduced from $1.10 to $0.40 in the last decade. The total value of the RFID technology including tag cost, readers cost and hardware installations are reached to $5.56 billion in the year of 2009 which is having the worth of $2.8 billion for the year of 2006.

5. Conclusions:

Apart from its many advantages most of the industries are not looking into this technology because it is a costly technology, which requires high initial cost for building the infrastructure, installing the readers and maintenance cost associated with the tags, and lack of standardization. Every industry before taking a decision regarding the introduction of any new technology which requires addition of cost then

comparison of the benefits associated with the technology will comes into the picture, if the monitory value of the benefits is more than the expenditure then it is economical to implement that technology otherwise it is not economically feasible to implement. In case of service sector customer satisfaction or service levels are considered as measuring yard and in case supply chain reduction in the processing time, minimizing the workforce, provides the protection to the products from theft and misplacement are considered for comparison. So much research work has to be required in this area for breaking the barrier between the academics and industries for getting the conclusion regarding that it is economically feasible or not and at the same time if it is feasible then the information regarding how much time it will take to enjoy the benefits of this technology.

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