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# RFID TECHNOLOGY IN PHARMACEUTICAL INVENTORY MANAGEMENT

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***Abstract-*** *Pharmaceutical industry is one of the major and sensitive industries that directly deal with the human health. Safety, quality, identification of the products are very important in such industries. Identification refers to tracking and tracing materials in the supply chain, the processes, machines etc. A pharmaceutical company handled 500-600 types of products that includes huge amount of raw materials movement, packaging and secondary packaging of the finished products. In Bangladesh, inventory control of the raw materials and finished products and tracing of the products are done by barcode and labeling. Conventional identification process requires manual intervention and manual data collection which is costly and time consuming. Moreover conventional process is unable to prevent any counterfeiting. To overcome these problems, a novel RFID technology is proposed in this paper to use in the pharmaceutical industry of Bangladesh.*

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**Keywords:** RFID, Inventory control, Middleware, Pharmaceutical product management.

## 1. INTRODUCTION

Pharmaceutical is one of the most sensitive and major industry that deals with human and animal life. Purity is highly deserved in this industry and there is no option of second chance. Quality, security, identity are the most important to maintain. So inventory management of the industry is a difficult job. A pharmaceutical company handled 500-600 types of products that includes huge amount of raw materials movement, packaging and secondary packaging of the finished products. In Bangladesh, inventory control of the raw materials and finished products and tracing of the products are done by barcode and labeling. By implementing Radio frequency identification (RFID) technology inventory control i.e. identification of raw materials, packaging of raw materials, quality assurance, finished products identification, control of material flow through the total supply chain can be done easily and more effectively than present conventional methods present in Bangladesh. RFID tags offer secure rewritable memory that can be used to improve visibility and security [1]. Loss of inventory during shipment will be minimized. It will enable accurate and real time inventory tracking.

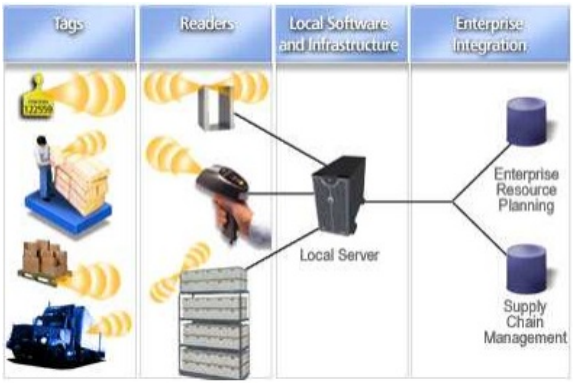


Fig.1: Overview of RFID system

RFID promises to save crores and radically change the way of supply chain works. Figure.1 shows the overview of a RFID system and working process. RFID has the potential to offer the following significant benefits, such as better tracking and tracing, reducing counterfeiting, increase the process efficiency, better temperature monitoring, better inventory management of both raw materials and finished products, reduction of inventory cycle time, reduction of administration error, etc.

## 2. RFID TECHNOLOGY

Radio frequency identification (RFID) is used to describe a system that transmits the identity in the form of a unique serial number of an object or person using radio waves. If any conductive materials are put into any electric or magnetic field, it can alter the field's characteristics. That occurs because the conductive material both absorbs and reflects the energy in the field. If the field is a radio frequency, or RF, the conducting material is capable of imparting a reflection of the source field radiation. RFID takes advantages of this characteristic by manipulating sequence and rate at which the reflection occur and it is called modulation. RFID tags are deliberately reflects the source RF in sequence that are interpreted as information in the form of digital data [2].

RFID enables identification from a distance, and unlike barcode technology, it doesn't require a line of sight. An RFID system includes three primary components: a transponder (tag), a transceiver (reader) and a data collection device.

RFID tags contain a microchip with some computation and storage capabilities, and a coupling element, such as an antenna coil for communication. There are three types of tags i.e. passive RFID tags, semi-passive RFID tags, and active RFID tags**.** Passive tags do not have an internal source of power. They harvest their power from the reader that sends out electromagnetic waves. They are restricted in their read/write range as they rely on RF electromagnetic energy from the reader for both power and communication. Semi-passive tags use a battery to run the microchip's circuitry but communicate by harvesting power from the reader signal. Active tags possess a power source that is used to run the microchip's circuitry and to broadcast a signal to the reader [3].

RFID readers are generally composed of an RF module, a control unit, and a coupling element to interrogate electronic tags via RF communication. RFID reader which reads and writes the data on the tags and finally, a backend database which is used to record the data collected by the tag readers [4] . The Authenticated RFID reader performs the following functions such as, authenticates tags that are presented using digital signature verification techniques, programs the chain-of-custody event marker to tags that are presented, creates a digital signature using the reader's private key, communicates relevant event information, including digital signatures and event markers to the local computer system.

A data collection device collects the data from the tags and stores. Figure .2 shows the RFID system components [5].

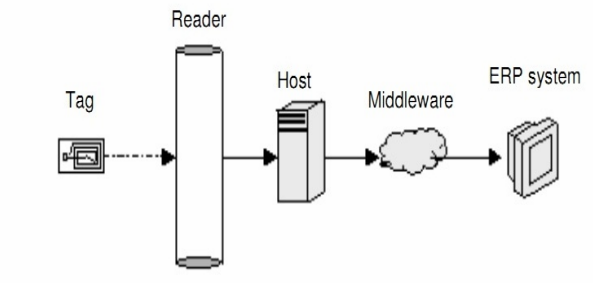


Fig.2: Components of an RFID system

EPC, the electronic product code, is a major issue when talking about RFID. It is actually a standard proposed by the Auto-ID center with two different types, a 64- and a 96 bit code and 96 bit chip would be the dominant data format for commercial RFID tags [6]. The 96-bit code gives a unique number to 268 million companies, with 16 million different object classes and 68 billion serial numbers in each class. The 64-bit version should be a compromise between the cost of a tag and the number of different codes. This version offers lower cost but fewer serial numbers. The EPC number is made up of a header and three sets of data. The header clarifies the EPC version used, as versions of different length and type might be used in the future. The second part represents the manufacturer's code. The third part identifies the type of product, usually the Stock Keeping Unit (SKU). The big difference to the bar code is the last part of the EPC, the serial number. It refers to one single item of this type of product and makes the EPC a unique code that only exists once, in contrast to the barcode which identifies to the type of product but not a difference in the single product. EPC was first developed by Auto-ID Center in MIT in 1999. This center developed the initial RFID standard and later transferred to EPC Global for commercialization in late 2003.

RFID middleware is an important part that creates link between reader and the ERP system. RFID middleware operates between RFID hardware and ERP system acting as a bridge between them. Due to the nature of RFID technology data must be captured in a intelligent manner, cleaned and distributed in the appropriate locations. RFID middleware [7], manages the readers and extracts data from the readers, followed by tag data filtering, aggregating, and counting, and finally sending the data to the database.

The frequency used for the communication between reader and tag is one of the leading factors, besides the choice between active and passive tags, affecting the read range for an RFID system. In addition to influencing the read range, the choice of frequency also has an effect on the data transfer rate that can be achieved between tag and reader. Frequency is

furthermore influencing the sensitivity to metals and fluids as well as the possible selection of sizes and shapes for the tags. Each of the frequency ranges thus becomes more or less suitable to certain applications. Figure.3 shows the working and data carrying process by RFID frequency.

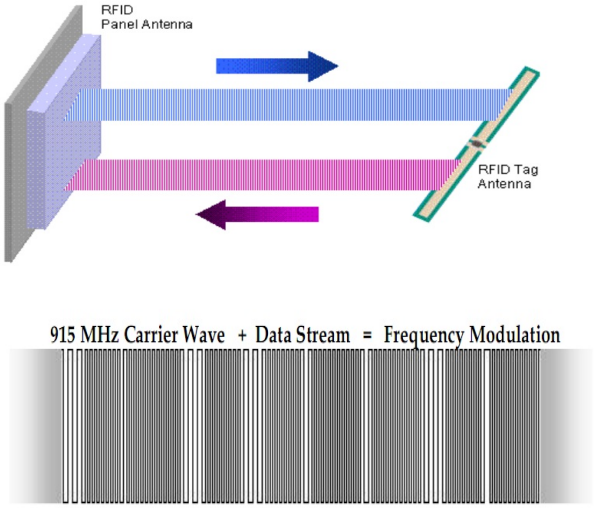


Fig.3: Working process of RFID frequency

There are two types of modulation, amplitude modulation (AM) and frequency modulation (FM). Amplitude modulation works by using the data stream to vary the signal strength of the carrier wave. On the other hand frequency modulation keeps the signal strength constant and instead works by varying slightly the frequency of the carrier wave.

RFID system utilizes a variety of radio frequencies from 30 KHz to 5.8 GHz. Reading length and writing speed depend on frequency range. Lower the frequency, lower the read/write speed and lower the cost.

Low frequency (30 KHz-300 KHz) has small read range and slow data transfer rate. Read range varies from 1 to 90 cm. Low frequency tags can transmit through elements such as water, wood and aluminum. But in the environment with metal like iron, steel the transfer rate decreases.

High frequency (3MHz-30MHz) has high data transfer rate than low frequency tag. It can penetrate materials and has a read range from 1 to 75 cm. It works well in environments containing fluids. The high frequency tags are less sensitive to metals and sources of electronic noise than ultra high frequency tags.

Ultra high frequency (866MHz-960MHz) tag has high data transfer rate, it can store large amount of data and it can read up to 9m. Due to high frequency the transfer rate is also high. A disadvantage of ultra frequency tag is that it is highly sensitive to the presence of water and may not work properly if it is attached to materials with high content of water. Ultra frequency tags are unable to penetrate through wood or water. Microwave (2.4GHz-2.5GHz, 5.8GHz) has a read range from 0.3m to 0.9m and these types of tags are small in size compare to other tags. The characteristics of micro wave frequency are same to ultra wave frequency but the micro wave frequency can read very fast. [8]

## 3. BANGLADESHI PHARMACEUTICAL INDUSTRY AND ITS INVENTORY MANAGEMENT

In Bangladesh tracking, tracing, data collection, material collections are done manually. Supply chain visibility is not available and manual effort needs lots of time. So there is a huge scope for the implementation of this technology that can make the total system more effective and less time consuming. In Bangladesh RFID is not used in industry. RFID tags offer secure rewritable memory that can be used to improve visibility and security. It helps to identify various materials i.e. raw materials, packaging materials as well as the finished products in a very effective way that is a prime requirement for any pharmaceutical industry. RFID has the potential to offer the following significant benefits, such as better tracking and tracing, reducing counterfeiting, increase the process efficiency, better temperature monitoring, better inventory management of both raw materials and finished products, reduction of inventory cycle time, reduction of administration error, etc. The other major problem faced by the pharmaceutical industry is counterfeit drugs and drug diversion because of different pricing and taxation structures prevailing in the country.

## 4. APPLICATION OF RFID TECHNOLOGY IN PHARMACEUTICAL INDUSTRY

Companies are trying to protect themselves from possible disruptions to the supply chain, the lack of visibility for in-transit material are causing high buffers of inventory. Manufacturers have pursued practices such as lean production and Just in Time (JIT) to obtain the benefits of reduced inventory in production operations. With RFID companies can obtain a higher visibility through the supply chain and they can thereby reduce the buffers of inventory. Major applications of RFID technology in the pharmaceutical industry are discussed below.

RFID can easily identify the entry and exit products in a warehouse. If each arriving container has a RFID tag manufacturers' identity, product serial number, expiry date everything can be checked very easily and at the same time it would help to certify that the material has arrived from the approved vendor. RFID tags can help to validate the manufacturing and maintain quality control

and quality assurance by documenting that only approved materials as being used. Entry and exit of the products can be controlled. Not only products movement but also movement of employee can also be controlled and an automatic system would allow only the authorized person to enter the highly secured and restricted area.

Process validation is establishing documented evidence which provide a high degree of assurance that a specific process (such as the manufacture of pharmaceutical dosage forms) will consistently produce a product meeting its predetermined specifications and quality characteristics. All pharmaceutical processes are required to be validated before they are used to manufacture a specific product. Documentation contains product development data, product stability data, technical audit report, market complains etc. Documents like these and several others are required to be handled with utmost secrecy and confidentiality. RFID can be used for access control of these data.

By RFID technology product can easily be checked and it does not require human intervention or line of sight to read .RFID tagged items can be read even they are behind other items.

By attaching RFID tags to reusable assets, such as vehicles, containers, racks and other load carriers, these will be allowed to be uniquely identified. No extra time slowing down the movement of the asset will be needed since the reading operation will be automatic as the reusable asset passes check points or detection areas.

RFID technology can offer smart shelving and searching solutions. To do this all shelves in a warehouse should be first uniquely identified; this can be done using RFID tags. Each unique shelf location could then be used to associate it with a palette. Hence, whenever a new consignment arrives at the warehouse, the RFID system can direct the consignment to the most appropriate location within the warehouse. Since the RFID system is capable to keep track of all the empty shelf space in the warehouse, the whole process can be automated. The whole warehouse can thus be operated from a remote location.

As RFID offer better tracking, tracing and product visibility it ensures smart security and protection against thief. Counterfeiting is a major problem in pharmaceutical industry. Every year pharmaceutical industries losses more than 750 corers because of counterfeiting. The World Health organization defines counterfeiting as "A medicine that is deliberately and fraudulently mislabeled with respect to identity and/or source. Counterfeiting can apply to both branded and generic products and counterfeit products may include products with the correct ingredients or with wrong ingredients without active ingredients, with insufficient or with fake packaging" [9]

There are various advantages of using RFID technology over barcode. They are: no line of sight needed, scanning from a distance, greater capacity for information, possibility to write and therefore update information, ability of enabling triggered activities, identification of discrete items, improved data collection accuracy.RFID tags can be placedinside the packaging or even in the product itself,the readability of barcodes can be impaired by dirt, moisture, abrasion, or pack aging contours. RFID tags are not affected by those conditions.

## 5. CONCLUSION

This paper is concerned with the application of RFID technology in pharmaceutical industry. There are three major benefits of this technology, such as, automation, visibility and flexibility. These three things are again interrelated. Flexibility is achieved by high visibility, accurate data providing by the tags provide visibility to supply chain. So automation, flexibility and visibility can provide huge benefits for the industry but his technology requires time to implement. There is a huge scope for the implementation of this technology for the development and modernization of pharmaceuticals industry in Bangladesh. At present, the initial costing may seems big. Case, pallet or item tagging or combination of all can be done and it may prove beneficial if proper planning and time is given for the implementation. Actually it requires time and if it becomes popular in pharmaceuticals industry it may prove highly beneficial in a long run.

## 6. REFERENCES


[1] M. Johansson, *"Identification of the main factors influencing an RFID implementation in the automotive and pharmaceutical industries"*, Master's Thesis, Department of Science and Technology, Linköping University, Sweden, 2005.

[2] G. Avoine. "*Cryptography in Radio Frequency Identification and Fair Exchange Protocols*", PhD thesis, Ecole Polytechnique F´ed´erale de Lausanne (EPFL), Lausanne, Switzerland, December 2005.

[3] M. Bumbak, "*Analysis of potential RFID security problems in supply chains and ways to avoid them*", Master's Thesis, Rotterdam Business School, May 2005.

[4] S. A. Weis, S. E. Sarma, R. L. Rivest, D. W. Engels, "*Security and Privacy Aspects of Low-cost Radio Frequency Identification Systems*", LNCS 2802, pp. 201-212, 2004.

[5] P. P.Lopez, *"Lightweight Cryptography in Radio Frequency Identification (RFID) Systems"*, Ph.D. Thesis, Universidad Carlos III de Madrid, 2008.

[6] C. Floerkemeier and M. Lampe, "*RFID middleware design-addressing application requirements and RFID constraints*". Institute for Pervasive Computing, Department of Computer Science, ETH Zurich, Switzerland.

[7] A.B. Fasth, Y. Johansson, I.M. Karlsoon, "*Application of RFID in the production Industry- a field study at Volvo Trucks in Umeå*", Master's Thesis, Chalmers University of Technology and Gothenburg University, Sweden, 2005.

[8] K. Finkenzeller, *"RFID Handbook. Fundamentals and Applications and in Contactless Smart Cards and Identification"* Second Edition, Chichester: JohnWiley & Sons Ltd. ISBN: 0470844027, 2003.

[9] http://www.who.int/medicines/organization/qsm/activities/qualityassurance/counterfeit/faq_counterfeit.doc (05/07/2010)