

# Influence of Radio Frequency Identification Technology in Logistic, Inventory Control and Supply Chain Optimization

H. Amoozad-khalili, R. Tavakkoli-Moghaddam, N.Shahab-Dehkordi

**Abstract**—The main aim of Supply Chain Management (SCM) is to produce, distribute, logistics and deliver goods and equipment in right location, right time, right amount to satisfy costumers, with minimum time and cost waste. So implementing techniques that reduce project time and cost, and improve productivity and performance is very important. Emerging technologies such as the Radio Frequency Identification (RFID) are now making it possible to automate supply chains in a real time manner and making them more efficient than the simple supply chain of the past for tracing and monitoring goods and products and capturing data on movements of goods and other events. This paper considers concepts, components and RFID technology characteristics by concentration of warehouse and inventories management. Additionally, utilization of RFID in the role of improving information management in supply chain is discussed. Finally, the facts of installation and this technology's results in direction with warehouse and inventory management and business development will be presented.

**Keywords**—Logistics, Supply Chain Management, RFID Technology, Inventory Control.

## I. INTRODUCTION

SCIENCE introduces new identifier called RFID in business age. Determining item status and its movements tracking during logistic transactions, productivity, inventory accuracy, monitoring of items and timely response to inquiries are critical loop holes for any organization. the increase of the accessible amount of information with the aid of information technology development has made a flexible environment for the growth and development of decision support systems. This information has gained more strength with the use of sagacity and the use of smart systems or in other words making smart processes by the help of new methods and modern techniques has made smart business environment. Supply chain also by considering the importance and its key role in global contest arena is not an exception of this norm and it's making smart process with different looks and in its process of different aspects is always the center of attention. Supply chain is a

chain which contains all related activities of good flow and material conversion communication from the input to the product delivery to the consumer.

Supply chain management (SCM) refers to the management of activities that procure raw materials, transform those materials into intermediate goods and final products, and deliver the products through a distribution system to the end-user. There are numerous key factors that play an important role in the successful management of supply chains in today's dynamic environment. Among those are: paying utmost attention to the needs and desires of the end customer, designing flexibility into the supply chain for rapid response to changing conditions, utilizing the latest communication and logistics technologies, employing a sound measurement system for making the right decisions, and always communicating through the total supply chain.

## II. SUPPLY CHAIN OPTIMIZATION

The supply chain can be defined as an integrated system or network which synchronizes a series of inter-related business processes in order to:

1. Acquire raw materials.
2. Add value to the raw materials by transforming them into finished/semi-finished goods.
3. Distribute these products to distribution centers or sell to retailers or directly to the customers.
4. Facilitate the flow of raw materials/finished goods, cash and information among the various partners which include suppliers, manufacturers, retailers, distributors and third-party logistic providers.

Since the wide adoption of Internet technologies, all businesses can take advantage of Web-based software and Internet communications. Instant communication between vendors and customers allows for timely updates of information, which is key in management of the supply chain. Thus the main objective of the supply chain is to maximize the profitability of not just a single entity but rather all the entities taking part in the supply chain. This can only be done if all the entities wish to optimize performance of the supply chain as a whole (system optimization) and do not place their individual preferences (individual optimization) above that of the system. There must also be complete integration among all the entities so that information can be shared in real-time

F. H. Amoozad-Khalili is with the Industrial Engineering Department, Islamic Azad University, Nowshahr Branch, Nowshahr, P.O. Box 46516-46868, Iran (corresponding author; e-mail: Amoozad\_ie@yahoo.com).

S. R. Tavakkoli-Moghaddam is with the Industrial Engineering Department, College of Engineering, University of Tehran, Iran (e-mail: Tavakkoli@ut.ac.ir)

T. N. Shahab-Dehkordi is with the Information Technology Department, Islamic Azad University, South-Tehran Branch, Iran (e-mail: n.shahab22@yahoo.com).

in order to meet the highly fluctuating demand of the customers. The important issues driving the supply chain and governing its design are:

1. Inventory management
2. Transportation and logistics
3. Facilities location and layout
4. Flow of information

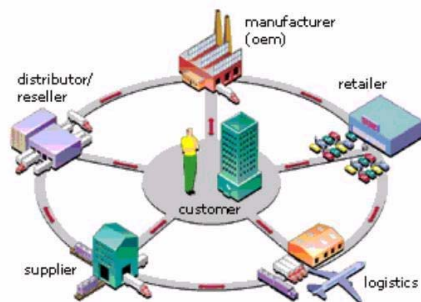


Fig. 1: Supply Chain

### III. GENERAL RFID BENEFITS FOR BUSINESSES

Radio Frequency Identification (RFID) technology has been used since the Second World War, recent years it is widely employed in many areas such as highway tolls, in tracking livestock movements, in tracking air freight, medical care, air cargo operations, and in motor car manufacturing. The effective implementation of RFID in Supply Chain can save the company millions. The reduced time in processing and labor are some of those factors.

In this section we will examine the benefits of RFID for general businesses. These advantages are common for different types of business regardless of their level in the supply chain. RFID can deliver tangible benefits for many types of enterprise businesses:

#### A. Reduce Out-Of-Stock

When an item is out-of-stock, most of the time the customer either does not buy the item or buys a competitive product. For example in grocery stores, as much as 8.3% percent of revenue is lost each year due to out-of stock conditions.

#### B. Improve Inventory Management

Inventory accuracy is important to help improve visibility and insight into what specific raw materials have arrived, helping to assure the right materials are available and to better manage just-in-time production models, track work in process, and speed finished goods through the supply chain. The use of RFID improves these processes, and helps minimize costly inventory errors, reducing production delays and lowering production reconfiguration costs that often result from material or demand planning issues. Because it can be read

through packaging, without concern to orientation, without direct line of sight between object and reader and can withstand exposure to dirt, heat, moisture and contaminants that make bar codes unusable, RFID can remove blind spots from inventory and supply chain operations. Additionally, visibility can be improved into distribution and retail channels to more accurately and in real time track delivered goods and better manage and match demand. Accurate and real-time visibility throughout the supply chain helps to improve inventory forecasting, manage just-in-time workflow and eliminate excess inventory.

#### C. Reduce Shrinkage (loss and theft)

Losses due to theft are estimated to cost retailers over \$30B per year, and are estimated conservatively at 1.7% of overall sales. With RFID, pallets, cartons and individual products can be tracked through the supply chain to pinpoint product location and eliminate inventory errors that can cause shipments to go missing.

#### D. Reduce Supply Chain Errors

By replacing manual bar code scanning with automated RFID information capture, data entry errors can be eliminated, reducing not only inventory and tracking mistakes, but also the costly labor required to resolve such mistakes.

#### E. Improve Capital Asset Tracking and Management

In many businesses important assets such as shop equipment and containers are often difficult to track, maintain and secure.

#### F. Reduce or Eliminate Counterfeiting and Improve Security

In many industries, counterfeit or non-secure goods introduced into the supply chain cause large direct losses of revenue. RFID increases brand protection and helps mitigate safety, security, regulatory and liability risks.

#### G. Improve Accounts Receivable (AR)

With more accurate and real-time tracking of what has shipped, the accounts receivable process can become much more efficient, with shorter billing and payment cycles.

#### H. Meet Market Mandates and Protect Revenue Opportunities

Many industry leaders have set the stage by making RFID functionality and compliance a prerequisite for to participating in their ecosystem. RFID can help meet these mandatory requirements, or provide an advantage for those who proactively implement the technology over those that are struggling to meet these new market demands.

#### I. Regulatory Compliance

Companies that transport or process hazardous materials, food, pharmaceuticals and other regulated materials could record the time they received and transferred the material on

an RFID tag that travels with the material. Updating the tag with real-time handling data creates a chain- of-custody record that could be used to satisfy FDAi, DOTii, OSHAiii and other regulatory reporting requirements.

#### J. Returns & Recall Management

Companies could supplement the basic shipment identification information by writing the specific customer and time of shipment to the tag immediately prior to distribution. Producing and recording this information would provide several benefits.

#### K. Service and Warranty Authorizations

Authenticating the product and customer with proprietary information could also be used to authorize warranty and service work. This application ensures workers have necessary information if no database access is available, and eliminates the need and expense of making phone calls or wireless data inquiries to access records [6,7].

### IV. LOGISTICS IMPORTANCE

Logistics is the one important function in business today. No marketing, manufacturing or project execution can succeed without logistics support. For companies, 10 per cent to 35 per cent of gross sales are logistics cost, depending on business, geography and weight/value ratio.

Logistics is comparatively a new term, but not the operation. Logistics has existed since the beginning of civilization. Raw material and finished products had always to be moved, though on a small scale. Things began changing with the advance in transportation. Population began moving from rural to urban areas and to business centers. No longer did people live near production centers, nor did production take place near residence centers. The geographical distance between the production point and consumption point increased. And logistics gained importance.

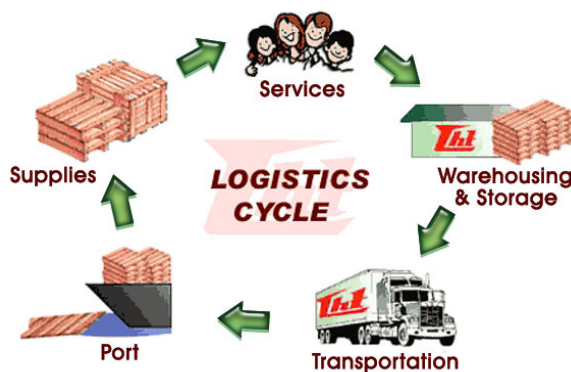


Fig. 2: Logistics Cycle

### V. RFID IN LOGISTIC AND SUPPLY CHAIN MANAGEMENT

We mentioned supply chain management is defined as “all management functions related to the flow of materials from an organization's suppliers to its customers”, with often the main objective being the maximization of customer satisfaction at the lowest possible cost. Bose and Pal contend that auto-ID technologies such as RFID “are likely to affect every aspect of SCM, helping to improve demand management, customization, and automatic replenishment of out-of-stock goods while reducing inventory and distribution costs, as well as counterfeit versions of name-brand items”. Tagging every item in a supply chain promises to help send the right product to the right destination at the right time, reducing the cost of operations and transportation and minimizing distribution lead times [2].

Twist contends that “although there are many obstacles, RFID proposition is large and the technology will gain significant traction in the next three to five years and gain widespread use in the next five to ten years”. It is suggested that the deployment of RFID will result in greater efficiency in operations and supply chain management. In turn it is argued that RFID should result in further pay-offs in terms of value creation in marketing because of better responsiveness and relationship to customers and efficiency in financial performance because of reduced working capital. Manufacturers, retailers, logistics providers and government agencies are making unprecedented use of RFID technology to track, secure and manage items from the time they are raw materials through the entire life of the product. Manufacturers can especially benefit from RFID because the technology can make internal processes more efficient and improve supply chain responsiveness [3]. It must also be noted however that aside from the financial implications that RFID incurs, the organization will also be faced with an enormous inflow of data, which to succeed (they) must turn into information and thus knowledge.

RFID technology is going to generate mountains of data about the location of pallets, cases and cartons. It is going to produce oceans of information about when and where merchandise is manufactured, picked and shipped. It is going to create rivers of numbers, which will have to be stored, transmitted in real-time and shared with warehouse management and others. In other words this means not only doing things better but also doing things differently.

Ever since Wal-Mart adopted and mandated the use of RFID tags for its suppliers, there has been a growing interest in the use of RFID in the supply chain.

But not all is well in the RFID world. There have been conflicting statements about the value derived from RFID. Industry Week reported that manufacturers have been finding the financial justification for implementing RFID rather difficult, and are unable to make a good business case. Many seem to be limiting their projects to the bare-minimum needed to comply with these demands. These facts have cost apprehensions as to whether RFID will become a cost-

reducing panacea for supply chains, or instead a cost-producing machine [4].

A key determinant of the success of a firm's RFID implementation will be the degree to which its business processes can be changed to leverage RFID technology most effectively. To derive benefit from any technology, firms need to redesign their business processes or to identify innovative uses that the said technology can be put to. Clarke have emphasized that RFID should be used less as a glorified barcode and more as a tool to leverage business intelligence for strategic planning. They suggest that RFID could be used to plug information black holes in the supply chain, helping to reduce stock outs and improve fill rates.

RFID technology as a key component of an enterprise mobility solution, combined with appropriate business process improvements, can result in clear benefits in the following key areas:

- Automation - reducing manual processes through automated scanning and data entry improves productivity, allowing resources to be reallocated to higher value activities.
- Integrity - improving the integrity of real-time supply chain information with increased authentication and security and tracking capabilities reducing errors, shrinkage, and counterfeiting while improving customer satisfaction — information is only valuable if it is correct.
- Velocity - reducing workflow issues by minimizing the time spent finding and tracking needed assets, in turn increasing product flow and handling speeds.
- Insight - providing the real-time information needed to make faster, better and more informed decisions and the ability to be more responsive to the customer.
- Capability - providing new applications and quality to meet supply chain partner demands and enhance customer experiences.

## VI. RFID IN MANUFACTURING

Manufacturers are evolving to confront new challenges and opportunities, such as implementing and managing a lean supply chain, adapting to expanding globalization, and dealing with increasing competition, labor costs and compliance requirements.

To help meet these challenges, manufacturers are looking to implement RFID solutions to reduce costs, improve asset utilization, and improve business quality, flexibility and scalability. RFID can specifically help manufacturers advance from current barcode systems (or fragmented solutions) to help drive lower costs, improve decision-making, and streamline processing and tracking of raw materials, work in process, and finished goods throughout the just-in-time supply chain[6,7]. RFID implemented throughout the manufacturing environment can help streamline the processing of raw materials, work in process and finished goods, resulting in improvements in many business areas. We discussed some of

these improvements in the previous section and here we will bring specific advantages for manufacturers in supply chain:

### *A. Receiving of raw materials*

RFID Portals at dock doors and points of ingress allow instant verification of the entire contents of a shipment by reading an RFID-tagged case, container or pallet.

### *B. Tracking Work-In-Process*

RFID-tagged raw material and sub-assembly parts are routed and tracked throughout work stations along the assembly line and the entire production process.

### *C. Tracking History*

RFID can track the history of the production and finished goods which are important information for shipping and possible recalls.

### *D. Shipping*

RFID tags on outgoing pallets and containers can associate vast amounts of information with the finished goods being shipped.

### *E. Inventory and Net Fixed Asset Optimization*

Increased knowledge of raw materials, work in process and finished goods, as well as increased visibility into manufacturing assets used to transport and produce these goods, can help to improve scheduling, better manage inventory, reduce carrying costs and improve net fixed asset utilization.

### *F. Counterfeit Prevention*

In many industries it is vital to track goods in order to prevent the insertion of counterfeit goods into the supply chain.

### *G. Visibility*

Real-time information collected throughout the manufacturing process can help improve accuracy and visibility, enabling the accurate measurements of key performance indicators, optimized performance and improved production and inventory planning [7,8].

RFID solutions can ultimately help manufacturers reduce operating expenses and improve margins by:

- i. Reducing labor costs and improving productivity via automation of current manual inventory tracking tasks and reducing handling errors. Bar coding is very common in today's manufacturing environment.
- ii. Improving product quality as line-sequencing and parts verification applications are improved. Also reducing the number of production reconfigurations by assuring the right inventory is available to meet production and shipment schedules and demands.
- iii. Lowering required inventory levels (working capital

savings) and associated carry cost expenses by optimizing inventory levels and reducing safety stock. Manufacturers can reduce obsolete inventory write-downs through better planning and visibility and lower inventory shrinkage by keeping better track of goods helping to eliminate losses and theft.

- iv. Improving production asset visibility helping to track their location and reduce maintenance issues. Reducing claims and returns by assuring the right goods are sent where they should be.
- v. Improving revenue opportunities, reducing out-of-stocks and improving promotional execution by having the right inventory available to match demand. Meeting new customer mandates and regulatory compliance.

#### VII. RFID IN INVENTORY CONTROL

The goal of inventory management is the store level keeping in possible minimum amount without facing with shortage. In this issue, RFID technology can present trusty information in the relation with useable parts and the amount of store in each place with high speed and almost without human interface.

The use of RFID technology in inventory control in industry can answer the questions below:

- Where are the goods or the properties of companies?
- What do the properties of the company consist of?
- What is the best way of keeping the company's properties?
- What has been the company's property?
- What has been the company's property in the recent six months?
- On which part of the production cycle have we missed the company's properties?
- Which parts of the production cycle need to raise and lower the limit of accuracy?

In an example, we can refer to a supply chain of a factory in which RFID is connected to pallets to be able to understand quickly where the parts have come from and in which parts of the chain are placed now.

This technology makes the possibility or the possibilities in way of easing and automatic management of goods in warehouse and asset and arranging in warehouse. RFID's labels will be put on each goods and can consist of more information of different goods such as: first material or tools or fixed equipment and keeping and or any needed information of the collection properties are definite based on similar characteristics with tags collection and by means of user's needed definition. This system benefits the preservation of vain and unnecessary purchasing costs by attention to this point that all entries and emersions of the goods from warehouse will be controlled and stored so in case of not inscription of the permissive emersion of a good the alarm system will make noise and will prevent the emersions

without justification [5]. This system is able to produce various reports such as:

- consume cases
- The number of consume and ordering points.
- The pursuits of goods and properties
- The amount of consuming a good the situation of good in warehouse.
- Consuming date
- Depreciation report
- Present inventory
- Guarantee control and their report of left time of goods guarantee
- The insurance value of goods

decrease of certainty store level the prevention of material unwilld accuracy and high speed of material flow the decrease of high costs related to emergency order it is not needed to search missed part (in case of using Real - time locating system) automatic control of inputs and outputs protecting of Vendor managed inventory system.

#### VIII. RFID IN RETAIL

Stocking the right products in the right quantity at the right time is a key to ensuring that the customer enjoys a superior shopping experience. Customers are increasingly demanding that merchandise and offerings be tailored and customized to their needs, forcing stores to more quickly react to unique aspects of each market and consumer base. As a result, almost all retailers are struggling with the ability to deliver superior customer service while keeping rising operating expenses under control — particularly labor, the largest operating cost contributor.

Retailers have experience with the benefits of bar code technologies, and RFID can complement and extend these benefits. RFID is an important evolution in data capture and management, providing the ability to further increase visibility, automation, and integrity, while opening the door for a host of new customer service improvements and applications. The initial move to RFID tagging makes the most sense in areas where additional tracking and automation can provide added value to retail businesses.

#### IX. CONCLUSION AND FUTURE SEARCH

In case of warehousing RFID can change many of available processes from manual situation to automatic one and need to many number of staff will be decreased more over the use of RFID in warehouse management causes a cost related to human and time to be less and less and increase accuracy in this issue of producing and consumers order. Today many of warehouses and distributions center in world are using RFID system and confess that their capital backing is developing. However many of the companies don't have clear understanding of using this technology and use it only in parts which have some serious problems in rate and etc. if RFID system is started with a flexible subsystem and we use all its

advantages and disadvantages the capital backing will be more efficient by deleting time-consuming and extra process.

The goal of using RFID in container depots is to enhance efficiency, thus providing better customer services while lowering the cost of operations.

1) With the RFID-based system, the drivers can access the system anywhere inside the container depot via handheld devices. Information on the containers will be updated and sent to the system via a wireless system to the backend computer system. This reduces human errors, and drivers no longer have to wait for the system computer operator in the depot control office to become available.

2) The system can determine where to put the containers based on developed algorithms and prescheduled orders. The system can inform workers where to put and get the containers. The time needed to train new staff is shortened. Dependence on the experience of staff to pick up and deal with the containers is greatly reduced.

3) All of the containers are identified by RFID tags. Workers can access detailed information about the containers easily via their handheld devices. The system can inform the workers where the containers of the customers are located. In case mismatch containers are found, an alert can be sent to the operators.

#### REFERENCES

- [1] BitKom., "RFID White Paper, Technology, Systems and Applications", German Association for Information Technology & Telecommunication and New Media e.v., (2005), pp. 13-17.
- [2] I. Bose and R. Pal, "Auto-ID: Managing Anything, Anywhere, Anytime in the Supply Chain", Communications of the ACM, Vol.48, No.8, (2005).
- [3] R. Angeles, "RFID Technologies; Supply-Chain Applications and Implementation Issues", Information Systems Management, Vol.22, Issue 1,(2005), Pg.51-61.
- [4] D.C. Twist, "The impact of radio frequency identification on supply chain facilities", Journal of Facilities Management, Vol.3, Issue 3,(2005), Pg.226-236.
- [5] T. Coyle, "Market trends: material control RFID and the mainstream supply chain", Material Handling Management, Vol. 58 No. 9,(2003), pp. 47-50.
- [6] M. Karkkainen., "Increasing efficiency in the supply chain for short life goods using RFID tagging", International Journal of Retail & Distribution Management 31 (10),(2003).
- [7] S. Li and J.K. Visich, "Radio frequency identification: supply chain impact and implementation challenges", International Journal of Integrated Supply Management, Vol. 2 No. 4,(2006), pp. 407-24.
- [8] J.D. Porter, Billo, R.E. and Mickle, M.H., "A standard test protocol for evaluation of radio frequency identification systems for supply chain applications", Journal of Manufacturing Systems, Vol. 23 No. 1,(2004), pp. 46-55.
- [9] Hanns-Christian L.Hanebeck, "Process Management and RFID: Implications and Considerations for Process Management", WP Globe Ranger,(2004), pp. 3-5.

- 
- i . Food and Drug Association
  - ii . Department of Transportation
  - iii . Occupational Safety and Health Administration