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## RFID System Adaptivity in Supply Chain Management for Bangladesh

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### ABSTRACT

At present, a gap exists between the genuine and potential estimations of RFID innovation in industry. Lately, scholastic analysts have perceived the significance of shutting this hole, yet the current investigations have not yet unequivocally managed intensity as the estimation of RFID. This paper gives knowledge into the vital estimation of RFID by building a hypothesis on how RFID utilized in store network the executives may make and continue an upper hand. Four recommendations are created dependent on a hypothesis of hierarchical learning and the hypothesis of first-mover favorable circumstances.

**Keywords:** RFID, Supply Chain Management, Industrial Management, Managerial Chain

### 1. INTRODUCTION

The market research firm IDC (Rockwell Automation, 2004) projects the spending on RFID in the US retail supply chain companies to exceed one billion US\$ by 2007. The increased use of this technology will have impacts on the supply management systems which must be accommodated to the new possibilities offered. New possibilities of RFID compared to the use

of bar code systems include the automation of the scanning processes, the possibility to track location of items, and the storage, transmission, and use of more data about the item than just an identification number, e.g. temperature history, best-before-date. The media are frequently bringing up the potential benefits users of RFID can reap. The adoption of the technology by the businesses has been recently stimulated by several factors including falling implementation costs, the establishment of key standards, retailer and government mandates and improved technology performance. Indeed, more and more businesses are considering investing or are investing in this fast-growing automatic data-collection technology in the purpose of improving convenience, accuracy, safety and security. This tracking and identification system basically consist of placing a radio frequency transponder containing a microchip on an item to be tracked. Then, whenever the item passes under a reader that interrogates it via radio waves, it will emit or reflect a signal to exchange its data and identity without human intervention.

Based on this elegant idea, this technology supports a wide range of applications not only in trade and retail, but also in public services, administration, research and development, and even in sports. Despite that, supply chain represents the most significant development potential for the use of RFID according to organizations. In fact, this is not surprising because RFID is exactly what companies are seeking to enhance supply chain management. By granting to everyday objects the ability to communicate without physical contact, RFID provides organizations with the capability of tracking, securing and managing items through their entire life cycle, thus considerably improving the efficiency of internal business processes and the visibility in the supply chain. For that matter, businesses place confidence in this technology to securely track the locations of their assets, shipments and inventory items. However, integrating an RFID infrastructure in its information system requires intense planning and testing not only because it represents a huge investment but also because it implies business processes reengineering, in addition to the fact that the technology is subject to changes. Misperceptions about what RFID is and what it can do can also stand in the way and discourage some companies from taking advantage of the technology.



**Fig. 1.** RFID systems in supply chain management.

Supply Chain Management (SCM) in simple words can be described as a network of facilities and distribution options. Wherein SCM involves functions such as material

procurement, transformation of the material into intermediate and finished products, and then distribution of the finished product to consumer. Supply chains are found to exist in both service and manufacturing sectors, although the complexity of the supply chain may vary vastly from industry to industry and firm to firm, however it represents a logical advance in our evolving understanding of business performance (Smith and Budress, 2005). Here RFID for the supply chain (RFID/SC) is an emerging technological trend that has attracted a lot of attention in the U.S., Europe, and Asia. The potential benefits that RFID is perceived to bring to businesses are what make retailers so fascinated with the technology and are a manifest of power among the supply chain members. RFID, as one of these innovations, is a system that provides easy, secure and quick data entry, storage and transmission. It is used in many places such as shops, stores, hospitals, pharmaceuticals companies, logistic services etc. where real time data should be used (Brown, 2007, Miles et al., 2008). Radio Frequency Identification (RFID) is a technology which provides appealing opportunities to improve the management of information flow within the supply chain and security. Implemented properly, RFID can save the firm money now-and make the company more competitive for years to come. Despite many useful applications, there are major impediments to RFID adoption in supply chain. In this study, the examiner on supply chain processes where RFID technology creates the most value, identify the opportunities and challenges facing RFID implementation in supply chains, and suggest a possible relationship between RFID system benefits and implementation success factors. RFID applications in supply chains of various industries and summarize empirical evidence of benefits gained. Retailers claim to have reduced stock-out and labor costs, improved inventory management, and achieved supply chain efficiency through greater visibility in their supply chains.

## **2. SIGNIFICANCE OF THE STUDY**

Even though RFID technology has initially been developed decades ago, the use of RFID in large-scale supply chain operations has until now been prohibited due to the relatively high costs compared to other Auto-ID solutions. Recent studies on the integration issues of the technology reveal that there are still several technical, as well as rather political, barriers to be solved before widespread RFID deployment in supply chain operations can take place. In this study will show the barriers are taking place in implementation of RFID technology in Supply Chain Management and what type of opportunities provided when it is used. According to this study it will also show how RFID technology is used in Bangladesh retail market and service product, what type of problems are facing by using this new technology and the benefit of using this technology and find out the possible recommendation for implementing RFID in supply chain management.

## **3. METHODOLOGY**

Since the use of RFID technology in supply chain operations is a rather new application. It became clear in the planning process that the research methodology must be suitable for the analysis of qualitative data. This study will follow the combination of exploratory and descriptive case study. Target population of this study are four major industries like 1) retail industry, 2) service industry, 3) apparel and 4) food industry in Bangladesh market (mostly

Dhaka based). In this study from these four sectors only 19 companies will be selected as sample and here convenient method has been followed. The data used in this study was gathered through three sources, namely a review of secondary sources, a survey and a semi-structured interview. Interview schedule has been applied in the study to get requires data and information through both open and closed ended questions. Secondary resources like books, articles, reports, journals, research paper etc. have been gathered to enrich the study. In the study, SPSS will use for descriptive data analysis.

#### **4. LITERATURE REVIEW**

To prepare this study, literature from the field of information systems in supply chain management as well as RFID-specific literature provide the basis which must be considered. Nevertheless, despite the topic's only recent popularity, there is already academic literature available which is also regarded in the light of this study. According to Bowersox and Daugherty (1995) and Currie (1993), benefits of supply chain management can be reached by the use of "information technology and the construction of integrated supply chain information systems" (Narasimhan & Kim, 2001). Concerning the use of information systems (IS) to integrate business processes across the supply chain, various studies have shown that an internal integration should precede the external integration with suppliers and customers (Narasimhan & Kim, 2001; Bowersox, 1989; Byrne & Markham, 1991; Hewitt, 1994). Stadler (2002) introduces the "House of SCM" in which the coordination of information in the supply chain is one of the building blocks. He states that information and communication technology is essential to efficiently automate processes and coordinate information flows along the supply chain. In the current digital economy, innovation is viewed by many scholars as a vital driver of business renovation and economic growth (Aizcorbe et al. 2009; Porter et al. 1985) and as a source of sustained competitive advantage for firms (Damanpour et al. 2006). In a literature review on Build-to-Order Supply Chain (BOSC) management, Gunasekaran and Ngai (2005) highlight RFID technology as one of the important information technologies for BOSC that increases efficiency and accuracy. They analyze qualitative and quantitative development of the knowledge in this area. Nemeth et al. (2006) present a state-of-the-art on RFID systems and the challenges and possibilities of the integration to supply chains.

Chao et al. (2007) reviews the literature on trends and forecast of RFID technologies from 1991 to 2005 by a historical review method and bibliometric analyze. They focus on the RFID innovation, deployment by enterprises and market diffusion in supply chain management. Recently, Delaunay et al. (2007) presents a survey on the causes of inventory in accuracy in supply chain management. Dolgui and Proth (2008) also present a literature review on RFID technology in supply chain. They focus on the advantages of this technology in inventory management. They also analyze some problems and present perspectives dealing with privacy and authentication properties of it. The contribution of this technology to supply chains is not only in increasing the efficiency of systems but also in supporting the reorganization of the systems that become more efficient. RFID technologies offer several contributions to supply chain through their advanced properties such as unique identification of products, easiness of communication and real-time information (Michael & McCathie, 2005; Saygin, Sarangapani, & Grasman, 2007). The progress through RFID can be observed in different types of supply chains such as warehouse management, transportation management, production scheduling,

order management, inventory management and asset management systems (Banks, Hanny, Pachano, & Thompson, 2007). RFID can ameliorate the traceability of products and the visibility throughout the entire supply chain, and also can make reliable and speed up operational processes such as tracking, shipping, checkout and counting processes, leading to advanced inventory flows and more accurate information (Chow, Choy, Lee, & Lau, 2006; Sarac, Absi, & Dauzere-Peres, 2010; Tajima, 2007). Companies can achieve better supply chain planning and management by integrating and storing more accurate data obtained through RFID technologies in their information technology systems (Whitaker, Mithas, & Krishnan, 2007). There is thus a strong link between IT applications and RFID technologies. Bottani and Rizzi (2008) indicated that reengineering models increased possible benefits gained through RFID for all processes of distribution centers and retailers. Pigni and Ravarini (2008) analyzed the effects of RFID technologies in the fashion industry.

They showed that RFID technology integration improved the system business process and provided an inter-organizational information system that promoted the efficiency and effectiveness of the entire supply chain. Ferrer, Dew, and Apte (2010) studied 21 RFID applications across a wide variety of industries. Their conclusion was that there were four common benefits: replacement of labor through automation, cycle time reduction, enabling self-service, and loss of prevention. Through these numerous benefits, RFID technologies can provide cost reduction, increased revenue, process improvement, service quality, etc. Lee, Ho, Ho, and Lau (2011) discussed demand and supply chain management and examined how RFID technology can enhance the responsiveness of the logistics workflow. They concluded that the synergy of using a combination of advanced technologies to form an integrated system can help achieve lean and agile logistics workflow. Lao et al. (2012) proposed an RFID-based system to help a distribution center to facilitate the food safety control activities. A real-time food management system was developed that integrated RFID technology and case-based reasoning technique for the distribution center operators in launching a food safety plan. The study concluded that the real time data capturing nature of RFID technology further improved the efficiency and timeframe requested for the actions. An RFID-based system can provide real-time information to operators, manages, and supervisors in order to control actual situation in the supply chain. Therefore, they can manage customer demands and timely adjust the production plan to improve the whole supply chain efficiency and effectiveness (Cheung, Cheung, & Kwok, 2012; Ko, Kwak, Cho, & Kim, 2011; Poon et al., 2011).

## **5. THEORETICAL DISCUSSION**

### ***Scope of RFID implementation in Supply Chain Management in different sector***

During first commercial uses of data processing, material requirements planning (MRP) automated the processes of inventory and production planning in the early 1970s (Joshi, 2000). Because the used data is limited and the manufacturing system is not integrated with the firm's financial system, the concept of MRP was extended. MRP II, standing for manufacturing resource planning, additionally included the functions purchasing and capacity planning (Gronau, 2004; Wöhe, 2002). During the 1980s it became apparent that the information and information systems used within firms were much like the organizational structure, rather functional and disconnected. The need to integrate information across more units of the firm led to the appearance of enterprise resource planning (ERP) systems. And the integration of

internal systems and information drives increased competition resulting in the next development of enterprise information systems.

### ***RFID Devices***

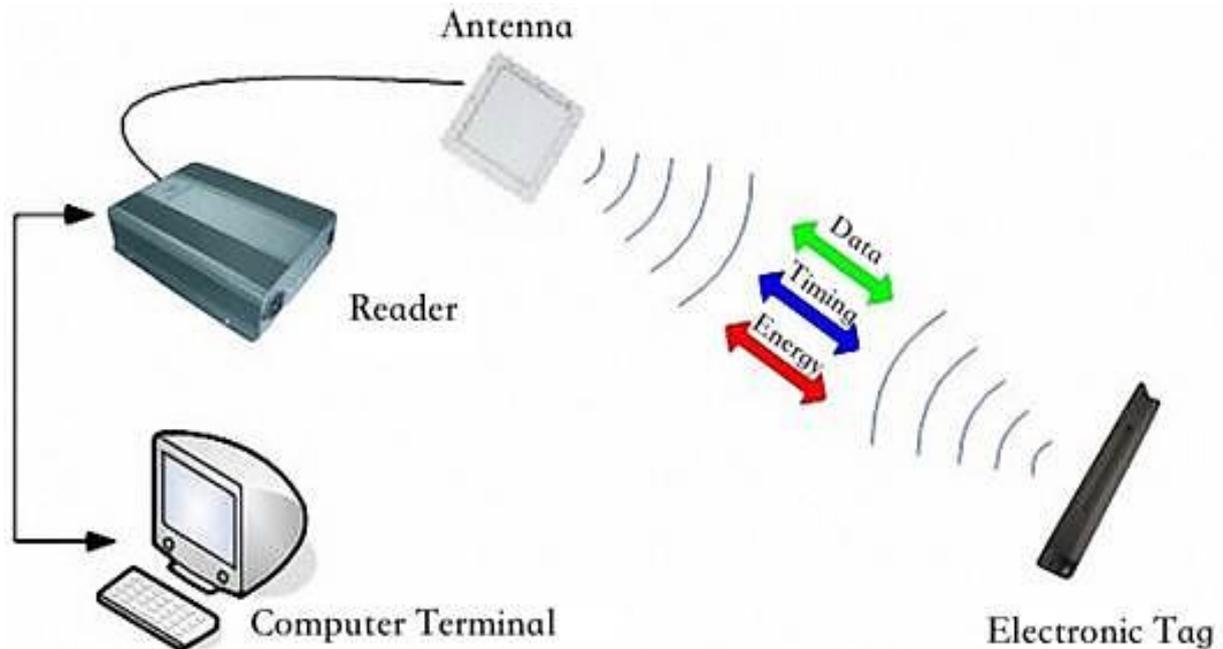
RFID architecture is composed by the following components (Roberts 2006; Aguzzi et al. 2011): (1) an RFID tag, which can be directly applied on the displacing good, (2) an interrogator (or antenna), as a device (i.e., the reader) that gathers information from the tag (ID or data stored), and (3) a database system used to store the information gained through the interrogation routines carried out by the antenna. An RFID interrogator (either defined by the synonymous “reader” or “antenna”) is a device that recognizes the ID information of the tag upon backscattered communication (see below). Readers can either be portable on handheld terminals or fixed as devices that can be positioned in different strategic places of the production/distribution chain or reading site. RFID tags, also known as transponders, are usually small pieces of material, typically comprising three components. An antenna, a microchip unit containing memory storage and an encapsulating material of different shapes (Fig. 2). Depending on their application, tags can be embedded in glass or epoxy resins or other materials. The tags have an identification code (i.e., the Electronic Product Code) commonly of 96 bits recorded at the time of manufacture. Tags can be classified in terms of data access in read-only or read–write tags. These terms refer to whether the information stored in the tag can be changed or erased. In a read-only tag the data cannot be modified or appended but it may be read multiple times and they are often used in simple tracking applications.

### ***Types of RFID used in various products***

RFID is a wireless automatic identification (Auto-ID) and data capturing technology that gives the opportunity to monitor objects by using a tag that carries information. In RFID systems, there are different software and hardware requirements for data gathering and management. One of the most important components of RFID systems is tag. A tag can be identified as a microchip that has an electronic circuit and antenna on it. For tracking the movement of goods, tags can be placed anywhere, such as containers, pallets, materials handling equipment, cases or even on individual products. Tags can be classified as passive (no battery), active (with battery) or semi-passive according to their power supply (Khan et al., 2009, Klaus, 2010). While active tags use an energy source that is integrated to a tag physically, passive tags obtain this energy from the readers in the communication field. Today, semi-passive tags that have some properties of both active and passive tags can be also used. The other component of RFID is reader which connects the tags to external world. Although readers can be classified as portable and mobile (Klaus, 2010), all of them consist of same components. In every reader, there are some parts that read tags, gather data and handle communication. While the reader antenna receives/sends the radio waves, it builds the signal and decrypts the signal which is sent from tags. There are eight main components for building RFID systems in a supply chain management: RFID Tag, Interrogator, Antenna, Sensors, Reader, Software System (ERP/MRP), Controller, Communication Infrastructure and Annunciator/Actuators.

Essentially, RFID is an automated identification tagging method for storing and retrieving data from a distance using RFID tags, which are attached to items and which contain a microchip and an antenna. Using an RFID reader, a remote device with one or more antennas, data on the microchip can be read at appropriate points in a business process via radio waves,

allowing the tagged item to be automatically identified without a direct line of sight. The information picked up by the reader is passed on to middleware and application software that validates and process the data, so that they can be used to create business value.



**Fig. 2.** Working principle of RFID

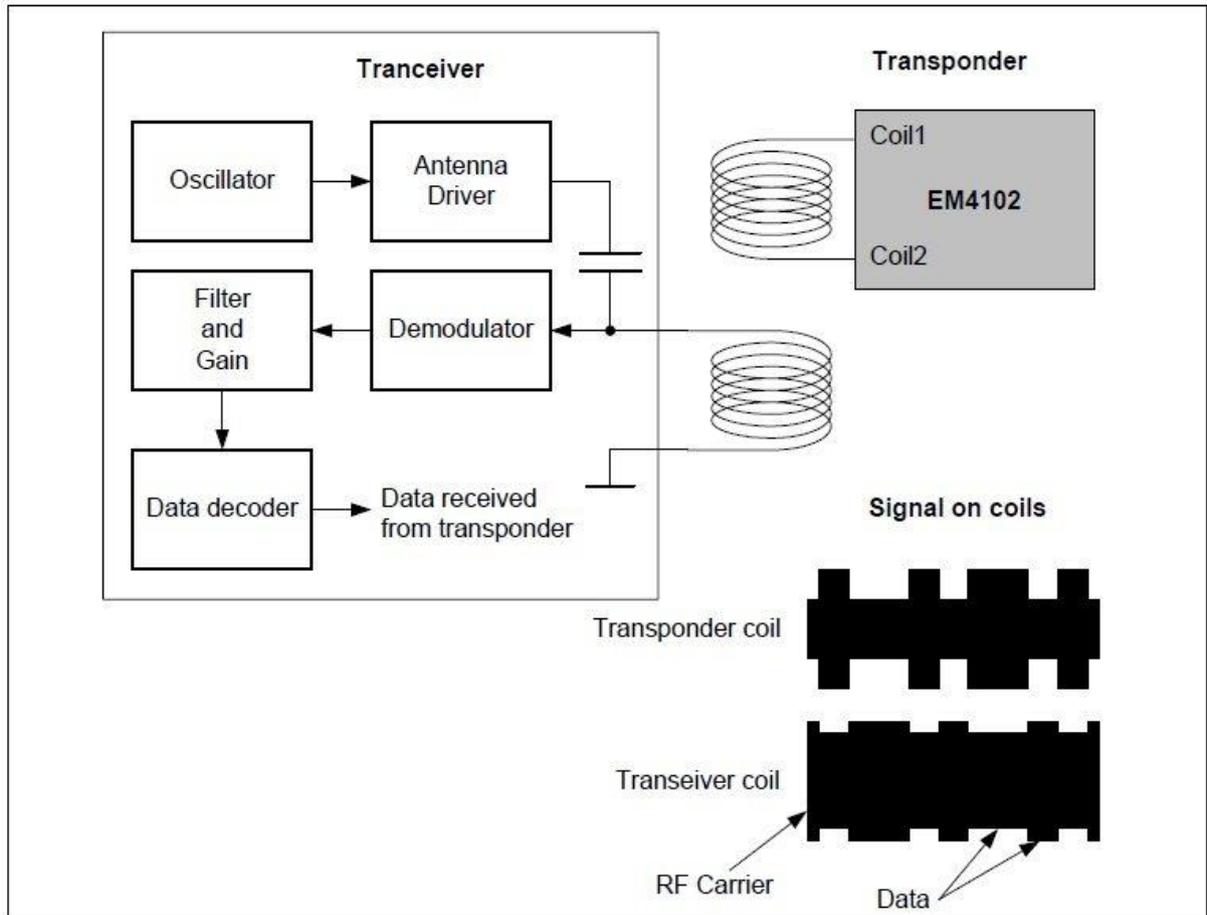
If multiple tags are present in the field, there is a chance of data collision. This can be the case for example in a shopping cart full of grocery items. In order to reduce the chance of two IDs being transmitted at the same time, more efficient RFID implementations have anti-collision algorithms, which determine the order of response so that each tag is read once and only once.

### ***RFID Data Model Used in a Supply Chain***

RFID data can be classified into two categories: the event data and the master data. The event data keeps real-time (or dynamic) information, which is about RFID tagged objects such as containers, pallets, materials handling equipment, cases, automobiles, textiles, animals, etc. The master data provides conditional information and verification about the event data. Fig. 3 shows an example of an RFID data model that contains 96-bit EPC code in a supply chain management and provides information about how RFID data is structured.

### ***Supply chain application standards***

ISO also currently develops several supply chain application standards shown in table 1: ISO supply chain application standards for RFID. However, the document containing general application requirements has been discarded.

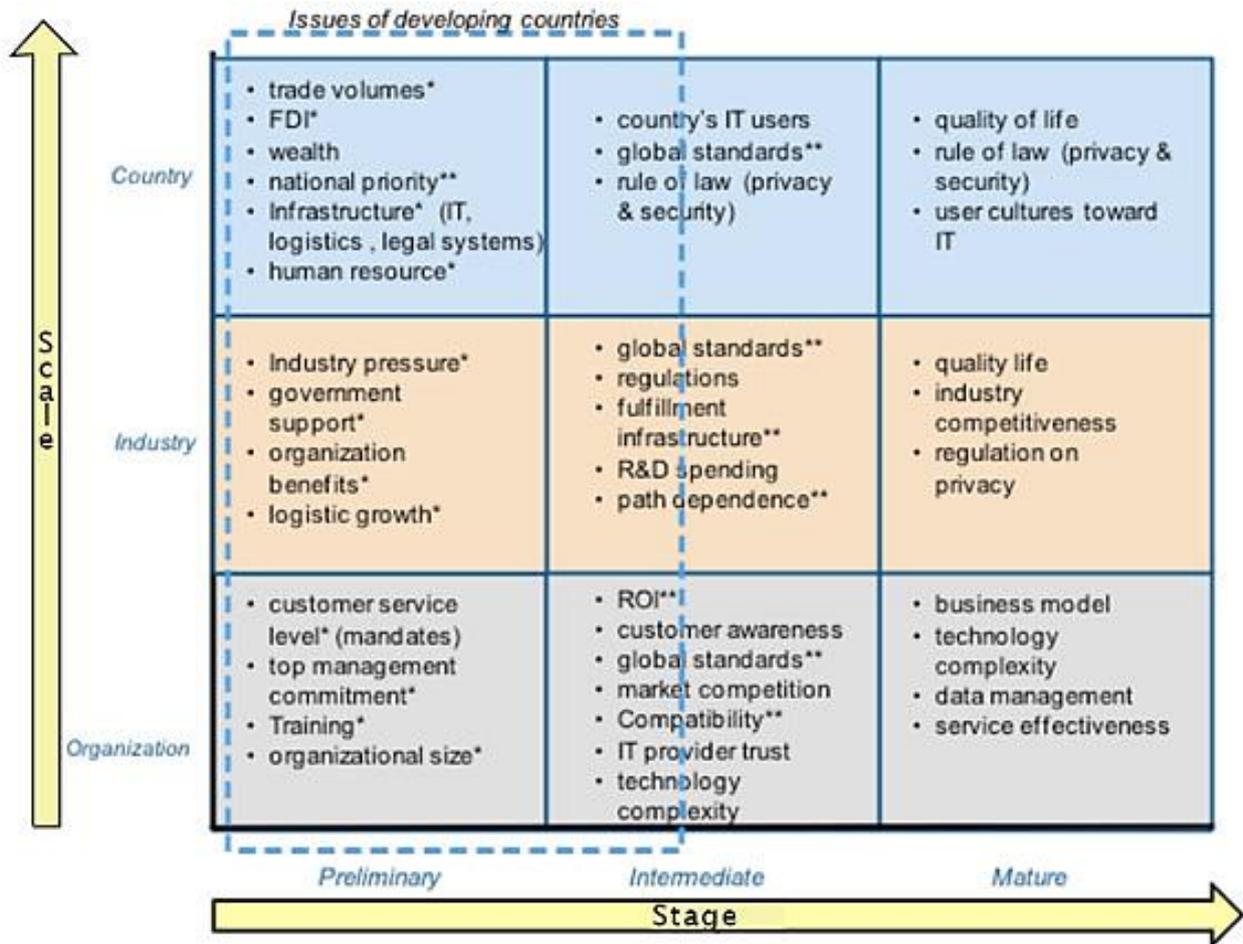


**Fig. 3.** RFID data module

**Table 1.** ISO supply chain application standards for RFID.

Notation	Supply Chain Application	Status of document
ISO 17358	General application requirements	Discarded
ISO 17363	Freight containers	Under development
ISO 17364	Transport units	Under development
ISO 17365	Returnable transport items	Under development
ISO 17366	Product packaging	Under development
ISO 17367	Product tagging	Under development

**Factors Influencing Adoption**



Notes: \*) specific issues of developing countries; \*\*) common issues with developed countries

**Fig. 4.** Factors Influencing RFID Adoption

Economic slowdown created major stress for many supply chains. Companies are challenged to keep critical products and supplies moving, manage inventory levels effectively, maintain productivity, improve safety and security, meet compliance requirements and keep emergency transportation costs in check. The inefficiency and lack of responsiveness of traditional SCM systems are highlighted by several empirical studies. According to a study by the Grocery Manufacturers Association, errors occur in 36 percent of consumer packaged goods orders which lead to inventory inaccuracy and are acknowledged as a multi-billion dollar problem (Zebra Technologies, 2011). Another recent study conducted by Efficient Foodservice Response identified more than \$800 million in savings available to the foodservice supply chain through more extensive use of technologies like RFID (Zebra Technologies, 2011). Data collection by RFID can help prevent errors in order picking and shipping that plague the foodservice industry. Despite unexpected events and a slowdown in the economy, companies

continue to initiate supply chain improvement initiatives based on the growing recognition that excellent supply chain performance has strategic value that can lead to:

- Rapid financial payback, often within months.
- Improvements in productivity and profits.
- Improvements in customer positioning and product quality.
- Improvements in safety and security.
- Meeting compliance requirements.
- Enhancements in long-term relationships with suppliers

There are tremendous cost savings that RFID technology can bring to supply chain operations. According to experts, it is not compliance driving RFID technology; it is the overall savings opportunity. For example, retailers using RFID technology can reduce the costs of receiving, inventory, and shrinkage by 11% to 18%, they can decrease the occurrence of out-of-stock merchandise by 9% to 14%, and they can cut logistical delays by up to 5% (Krivda, 2004). Another factor influencing adoption is mandates from powerhouses such as Wal-Mart, Target, and others that require the use of RFID-enabled tags for their largest suppliers. In addition, recent technological advances in RFID and a strong industry-wide commitment to standards and investment point to a bright future.

## **6. RFID REPORTED BENEFITS**

**Table 2.** Success Variable of using RFID in Supply Chain Management process

<b>Supply Chain Management Processes</b>	<b>RFID Benefits/Success Variables</b>
I. Demand Management	<ul style="list-style-type: none"> <li>• Speedy and accurate information retrieval</li> <li>• Better decisions</li> </ul>
II. Order Fulfillment	<ul style="list-style-type: none"> <li>• Enhanced visibility along the supply chain</li> <li>• Better-quality information</li> </ul>
III. Manufacturing Flow	<ul style="list-style-type: none"> <li>• Accurate asset tracking</li> <li>• Enhanced process automation</li> </ul>
IV. Reverse Logistics	<ul style="list-style-type: none"> <li>• Improved productivity</li> <li>• Improved quality and reliability</li> </ul>
V. Supplier Relationship Management	<ul style="list-style-type: none"> <li>• Reduced operating costs</li> <li>• Improved competitive position</li> </ul>

Several companies are actively involved in testing and adopting RFID technology in their SCM. The benefits of RFID technology in the supply chain are compelling. Organizations who take the time to understand the technology's capabilities and limitations can increase their inventory visibility while streamlining their operations. In addition, RFID can provide for more

information than bar-coding. This information can be used to improve inventory management at the retail store and along the supply chain. Several studies have investigated important benefits that businesses are able to obtain by embracing RFID technology in their supply chain management (Attaran 2007; Hou and Hung, 2006; Kern, 2004; Patton, 2005; Prater, Frazier, and Reyes, 2005; Reyes, Frazier, Prater, and Cannon 2007; Smith, 2005; Wasserman, 2007). Supply chain cost that includes receiving, inventory, shrinkage, distribution, logistical delays, and out-of-stock merchandise is often cited as a major factor influencing RFID adoption. Table 2 shows the success factor and benefits of using RFID technology in SCM is given below.

## **7. RFID BENEFITS IN SUPPLY CHAIN MANAGEMENT PROCESSES**

In general, RFID technology could generate business value at three levels for any SCM: Immediate: RFID readers can read multiple tags simultaneously, without requiring line of sight or human involvement. This can cut checkout, inventory control, and loss prevention costs.

Short-Term: RFID can improve supply chain performance through asset tracking, product origin tracing, and product recall.

Long-Term: Collaborative use of RFID information can help supply chain partners put the right item in the right place at the right time and for the right price. And demand-driven, product fulfillment systems can link consumer behavior back into inventory planning, and logistics. (Intel Corporation, 2004a, b).

Sabbaghi and Ganesh 2008, explored the effectiveness and efficiency of RFID applications and identified four key processes where RFID creates the most value in the management of the supply chain. Considering the ever-increasing value of sharing historical data and forecasts among supply chain partners, a fifth process, "Supplier Relationship Management," has been added to this list. These five processes along with the benefits gained from RFID technology implementation are discussed below:

**1. Demand Management** - One of the challenges in demand planning is a lack of accurate, timely, and reliable data. RFID can produce accurate and timely information related to the inventory of work-in-process, in-transit, and finished goods. Timely data regarding market demand provides support for accurate forecasts and assists in the development of better strategies in production, distribution and marketing. An accurate forecast provides the input to match supply with demand and produce profitable aggregate planning.

**2. Order Fulfillment** – RFID enables automation of processes such as picking, shelving, and cross-docking. These operations are consolidated and the costly logistics mistake of not dispatching the right item to the right customer at the right time is reduced with the use of RFID. RFID technology provides enhanced visibility along supply chains enabling suppliers to accurately determine the location of a pallet and to track its journey through the supply chain.

**3. Manufacturing Flow Management** – RFID streamlines assembly line operations by enhancing process automation resulting in a reduction in cycle times and an increase in production throughput. Tracking capabilities, enabled by RFID, improve the velocity and visibility of products along the supply chain. Furthermore, RFID technology can be useful to manufacturers with just-in-time (JIT) assembly lines.

**4. Reverse Logistics and Return/Recalls Management** – RFID can facilitate the return of defective products and product recall, also known as reverse logistics. RFID technology facilitates return management by matching a product to a sale. Enhanced traceability and tracking capabilities, enabled by RFID, allows manufacturers to eliminate fraudulent products being returned to retailers. Moreover, RFID makes lot-level traceability available throughout the supply chain limiting the logistics of handling costs and administrative burden, so recalls can be resolved, and unaffected products can be redistributed quickly. The enhanced traceability also limits liability exposure and prevents lawsuits from unaffected individuals. Enhancement of the reverse logistics process will ultimately lead to sustained competitive advantage and will permit firms to actively monitor productivity improvements.

**5. Supplier Relationship Management** – Collaboration among supply chain partners and good relationships with suppliers are essential for a supply chain to be competitive. Collaborative Planning, Forecasting and Replenishment (CPFR) is an initiative that facilitates the reengineering of the replenishment between trading partners. CPFR was developed and evolved from an industry wide, efficient consumer response concept. An important promise of CPFR is that the accuracy of a forecast (demand, order, sales) will improve by having the customer and supplier participate in the forecast. While the CPFR process does not fundamentally depend upon technology, it does advocate using common tools and processes to improve supply-chain planning through accurate and timely information flow. A specialized technology such as RFID can integrate with the CPFR process providing more scalability. The major purpose of RFID deployment is identification, authentication, and automatic data acquisition. The processes affected by the implementation of RFID provide enhanced visibility along the supply chain and facilitate the sharing of historical data and forecasts among supply chain partners. Therefore, RFID is positively related to CPFR adoption.

### ***Challenges of implementation of RFID in SCM***

RFID technology faces numerous implementation challenges. The major challenges include technological maturity, global standardization, government regulations, and cost as summarized in Table 3.

**1. Fundamental** – The business benefits that RFID technology offers will not arrive with a big bang. From a supply-chain, manufacturing, or warehouse standpoint, RFID technology has limited applications. There is also a question regarding the “drivers” for adaptation. There must be incentive for retailers and manufacturers to adopt the technology. A return on investment (ROI) is not always a straightforward calculation. Ultimately, a desire on the part of buyers and suppliers to collaborate is necessary to promote the use of RFID.

**2. Technical** – Among the technical problems of implementation are imperfect read-rates, unproven systems, and conflicting problems with assembling low-cost tags. RFID is more expensive than bar codes, and problems can occur when using the tags on metal objects. To reduce tag cost the size of the chip needs to be reduced. However, reductions in the size of the chip make assembly of the tags more expensive. Further, technology vendors do not have a clear idea of what RFID middleware should do. Finally, companies often lack in-house experts with the knowledge to implement RFID technology and hiring outside experts can be difficult and expensive.

**3. Security** – RFID is a wireless technology and, as such, poses some potential security concerns to users regarding the compromise of data during wireless transmission, storage of data, and security of storage sites. Some of the security issues have been addressed by RFID vendors by employing varying querying protocols, jamming and other techniques.

**4. Privacy Issues and Government Regulations** – The use of RFID could have profound social implications. Without safeguards in place, RFID technology has the potential to compromise consumer privacy and threaten civil liberties. Consumer groups have expressed concern over the privacy invasion that might result with widespread application of RFID tags. Governments around the world regulate the use of the frequency spectrum. There is virtually no part of this spectrum that is available everywhere in the world for use by RFID. This means that a RFID tag may not work in all countries. This ultimately hinders the use of RFID tags in a global environment.

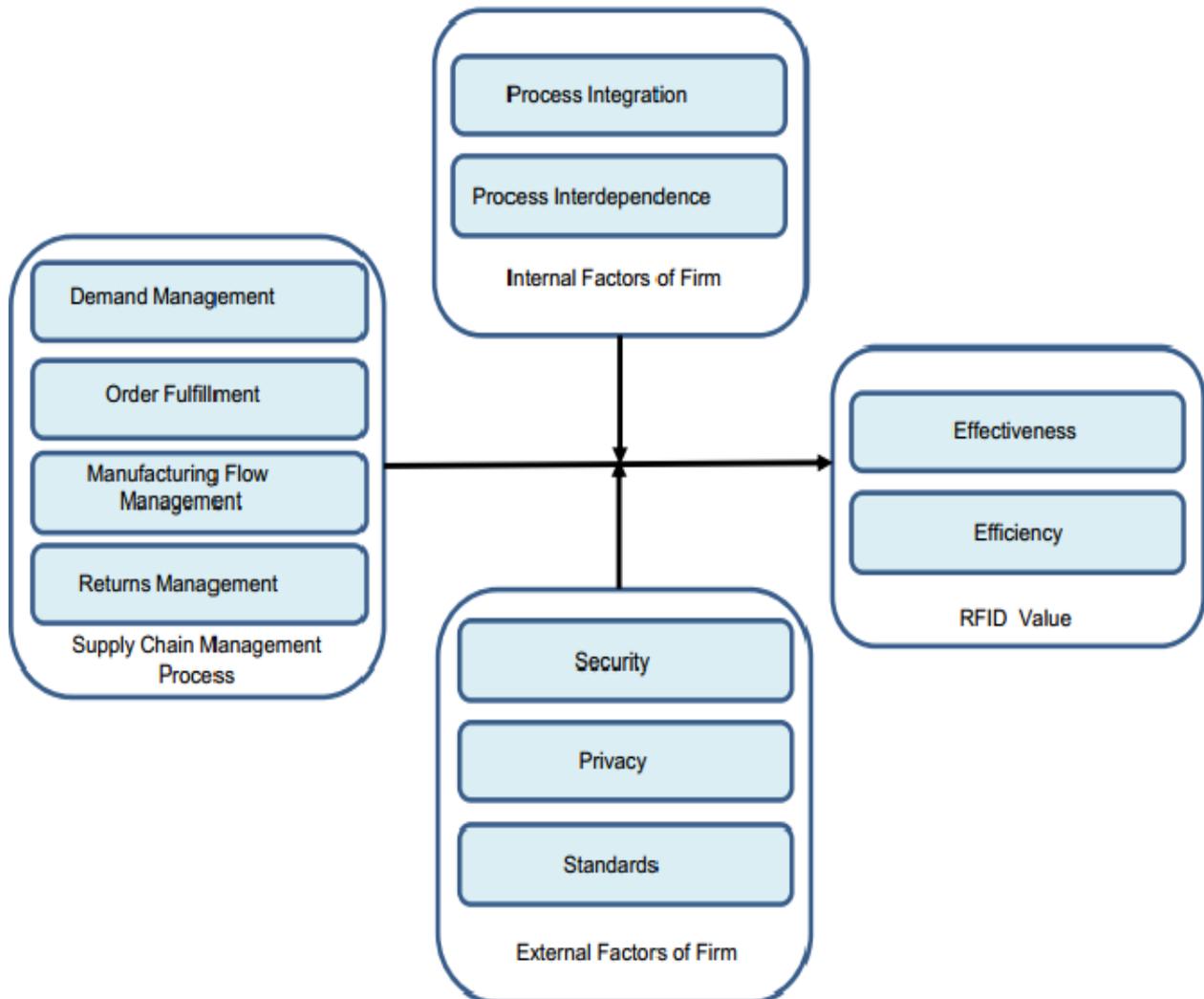
**Table 3.** Challenges of implementing of RFID in SCM

Levels	Challenges
Fundamental	<ul style="list-style-type: none"> <li>◆ High capital costs</li> <li>◆ Challenges in finding the ROI</li> <li>◆ Challenges in finding the “drivers” for adoption</li> </ul>
Technical	<ul style="list-style-type: none"> <li>◆ Imperfect read-rates</li> <li>◆ Unproven systems</li> <li>◆ Problems with assembling low-cost tags</li> <li>◆ Uncertainty about the role of the middleware</li> <li>◆ Lack of in-house experts to implement RFID</li> </ul>
Security	<ul style="list-style-type: none"> <li>◆ Concerns regarding the compromise of data during wireless transmission</li> <li>◆ Uncertainty around security of data storage and physical security of storage site</li> </ul>
Privacy Issues/ Government Regulations	<ul style="list-style-type: none"> <li>◆ Privacy concerns and the potential for legislation</li> <li>◆ Uncertainty around standards</li> </ul>

***RFID Implementation Success Factors***

Several studies have identified factors that contribute to the success or failure of a large system development project. For example, Vatanasombut and Gary (1999) identified 51 success factors that contribute to the success/failure of data warehousing projects. Sammon and Finnegan (2000) recommend ten-commandments of data warehousing success. DeLone and

McLean have reviewed the definitions and classified six major categories of an information systems success and the corresponding measures. A multidimensional measuring model was used to distinguish between the different successes categories (DeLone & McLean 1992, 2003). Other researchers have provided lists of critical success factors (Watson and Haley, 1997; Wixon and Watson, 2001). Ten critical implementation factors have been chosen to represent the prominent influences of RFID adoption by companies (Attaran, 2011a; Angeles, 2005; Reyes, Frazier, and Prater, 2007; Visich, Li, Khumawala, and Reyes 2009; Waters and Rahman, 2007).



**Fig. 5.** RFID Benefits and Challenges in Supply Chain Management

## **8. SCOPE OF USING RFID TECHNOLOGY IN BANGLADESH**

**Shipping and Distribution** – In this industry, RFID technology enables suppliers to accurately determine the location of a pallet, to track its journey through the supply chain, and to make instantaneous routing decisions. At the service center, the tag automatically determines what

loading/unloading activities are needed and assigns an appropriate crew to service the truck (Intermec, 2004).

**Retail Industry** – RFID technology offers a very significant advantage over bar-coding. In Bangladesh, Arong and Sailor’s initiative and move in using the technology was the most important technology development for retailers since the bar code. RFID tags continually gather information as products move from shelves to the checkout counter. The technology not only helps the retailer to reduce labor and manual costs, it also curbs shoplifting and boosts store productivity (Gogoi, 2005). The tags already help Arong and Sailor with reordering, stocking, and keeping track of purchases.

**Manufacturing Sector** – This sector has been finding different ways to derive value out of this technology. For example, manufacturers can use RFID product tracking mechanisms to ensure accuracy. Parts can be individually tagged and tracked throughout the manufacturing process while on the production line. When parts received from the production plant, can be tracked throughout the assembly process. This would certainly help manufacturers with their carefully scheduled Just-In-Time (JIT) assembly lines. Tags containing equipment specifications can be attached to enable easy upgrading. Similarly, tags can be used to keep track of usage, availability, location, and maintenance of material handling equipment. RFID tags will be used to keep track of vehicles as they leave the assembly line for testing and refinement. The technology will help to reduce the labor costs involved in looking for “lost” vehicles, decreased inventory carrying expenses, and assured faster order-to-cash cycles.

**Apparel Industry** - In this industry, RFID technology can address critical challenges of how to gain greater control of merchandise flow. The technology will help apparel industry to improve turnover and increase the brand profitability. Using RFID, will enables apparel manufacturers and retailers to realize fewer operational errors throughout the supply chain, to accurately determine what stock is in the store, and to enjoy automatic replenishment that include stolen items. Some of the most important benefits that the apparel industry is able to gain by embracing RFID technology include, enhanced visibility into customer needs, accurate and timely asset tracking, reduction in inventory costs including stock-out and holding costs, and improved product quality and reliability including traceability. The system can assists staff members in improving inventory management and security.

**Agriculture, Cattle and Food Production** –In the U.S. and mandate from the European Union (EU) are using RFID technology for tightening traceability requirements beginning in 2005. This technology used for trace poison, bacteria and unwanted particle in food and food products. RFID can help these traceability requirements at a reasonable cost. The technology is proving more useful and is playing a broader strategic role in this industry. So, it is also an important scope for food sector in Bangladesh to improve this sector as well.

**Health Care** –RFID technology is increasingly being used in health-care industries to improve quality and reliability of health-care service delivery. RFID tags are used to identify and track individuals in health-care contexts. Examples are employee identification cards, patient identification cards, ankle and wrist identification bracelets, and implantable RFID chips. RFID tags, embedded in wristbands, are used to identify patients and update their status automatically. RFID tags are also used to match blood samples to patients. Medical Centers are using RFID technology to track and manage assets, such as medical devices, wheelchairs, and surgical

equipment. Moreover, the technology is used to monitor specimens and laboratory results. So, it can be helpful if it is used perfectly in hospital management in Bangladesh.

## 9. ANALYSIS

This study is carried out in four different industries such as 1) retail super shop 2) food manufacturing 3) apparel outlet 4) Hospitals (service) with different objectives. Therefore, the motivation which led to RFID technology introduction varied. In this chapter, the underlying variables and factors of the anticipated variations are inspected in the light of the research questions. Consequently, the first part of the chapter focuses on the current use of RFID and the second part investigates the resulting impacts on supply chain management systems in frequency distribution table using SPSS statistical program function.

**Table 4.** RFID technology used in organization

SL	Organization Name	Industry	Level of RFID use
1	Shopnow	Retail Super shop	No use
2	Meena bazar	Retail Super shop	No use
3	Agora	Retail Super shop	No use
4	Prince bazar (Dhaka based)	Retail Super shop	No use
5	ACI food Ltd.	Food Industry	No use in SCM
6	Pran agro Ltd.	Food Industry	No use in SCM
7	CP Bangladesh	Food Industry	Have use in firm (production) management
8	Bangle meat	Food Industry	Have use in firm and cattle handling
9	Squire consumer Ltd.	Food Industry	No use in SCM
10	Aarong Bangladesh	Apparel Industry	Strong use in inventory, SCM and retail outlet
11	Sailor	Apparel Industry	Strong use in inventory ,SCM and retail outlet
12	Vuge by Prince	Apparel Industry	Strongly use in inventory, retail outlet.
13	Yellow	Apparel Industry	Use in retail outlet
14	Le reve	Apparel Industry	Use in retail outlet

15	Extacy	Apparel Industry	Use in retail outlet
16	Lab Aid Hospital, Dhaka	Service Industry (hospital)	No use
17	Ibnsina Hospital	Service Industry (hospital)	No use
18	Ad-din Hospital	Service Industry (hospital)	No use
19	Islami Bank Hospital	Service Industry (hospital)	No use

For my study, I choose total 19 organizations (Table 4) which are serving at different industries like first four are in retail industry, five-eight this four are in food industry, next seven are in apparel industry and last four are include in service industry. In Table 4 shows the current use of RFID technology in their organization in supply chain management, inventory control and so on.

**Frequency distribution of Type of industry**

**Table 5.** Frequency distribution of types of industry survey

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	retail industry	4	21.1	21.1	21.1
	food industry	5	26.3	26.3	47.4
	apparel industry	6	31.6	31.6	78.9
	service industry, hospital	4	21.1	21.1	100.0
	Total	19	100.0	100.0	

Above in Table 5 shows the individual percentages value. Where retail industry has the 21.1%, food industry has 26.3%, apparel industry has 31.6%, and service industry (hospital) has 21.1% in overall 100%.

**Frequency distribution of Level of RFID use**

Table 6 shows the ratio percentage of RFID technology use and non-use organization. Here eleven organizations (57.9%) are not using this technology but other eight organizations are using this technology which stand for 42.1%.

**Table 6.** Ratio of RFID technology use in selected organization

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	No use	11	57.9	57.9	57.9
	strongly use	8	42.1	42.1	100.0
	Total	19	100.0	100.0	

***Frequency distribution (data analysis) based on survey questioner.***

In this study some open-ended questions were asked to the responsible employee about opportunities and barrier of using RFID technology based on semi structured questioner.

**Q.1. Have key business environment risks been identified in the organization's decision to implement RFID, including payback, supply chain capability, and customer capability**

**Table 7.** Have business risk using RFID technology

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	5	26.3	26.3	26.3
	average	9	47.4	47.4	73.7
	agree	5	26.3	26.3	100.0
	Total	19	100.0	100.0	

Table 7 shows the five organizations were disagree on about there is risk of using RFID technology in the business policy, which is 26.3%. Nine organization were think there are average risk of using RFID in business and this percentage is about 47.4% and rest five were agree that business environment has risk of using RFID in their Supply chain management and inventory control, payback and customer service, which is 26.3%.

**Q.2. Have key risks regarding network security**

***Frequency distribution of Network risks***

In Table 8, it describes is there any network security risks in using RFID technology, as it is think a big challenge for RFID implementation in any organization. Only two organizations

think there is no risk in networking process as if they control it in strong security management and the percentage is only 10.5%. Other six organization think it has average risk in use RFID which is about 31.6%, nine organization think there are some networking security risks in using RFID technology which stands for 47.4% and rest two are strongly agree on there is huge networking security risks in using RFID technology which is about 10.5%.

**Table 8.** Frequency distribution of networking risks

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	2	10.5	10.5	10.5
	average	6	31.6	31.6	42.1
	agree	9	47.4	47.4	89.5
	strongly agree	2	10.5	10.5	100.0
	Total	19	100.0	100.0	

**Q.3. Have risks regarding data management and integrity**

**Table 9.** Frequency distribution of Management risks

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	3	15.8	15.8	15.8
	average	7	36.8	36.8	52.6
	agree	8	42.1	42.1	94.7
	strongly agree	1	5.3	5.3	100.0
	Total	19	100.0	100.0	

In Table 9 and 10, it describes about managerial risks in using RFID technology, as it is also a big challenge for RFID implementation in any organization. Only three organizations are thinking there is no risk in management process as if they can organize it with the help of strong management team and regulation, and the percentage is only 15.8%. Other seven organizations think it has average risk in use RFID which is about 36.8%, eight organization think there are

some management risks in using RFID technology which stands for 42.1% and rest one is strongly agree on there are managerial risks in using RFID technology which is about 5.3%.

**Q.4. Business processes been identified and positioned for backup or exception process purposes**

**Table 10.** Frequency distribution of business purpose

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	5	26.3	26.3	26.3
	average	7	36.8	36.8	63.2
	agree	7	36.8	36.8	100.0
	Total	19	100.0	100.0	

Table 10 shows the five organizations were disagree about the statement, which is 26.3%. Seven organization were thinking average and this percentage is about 36.8% and rest seven are agree on the statement of using RFID which is 36.8%.

**Q.5. Highly additional costs need to be in place for processing transactions directly to ledgers from networks or tags**

**Table 11.** Frequency distribution of highly additional cost

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	average	1	5.3	5.3	5.3
	agree	13	68.4	68.4	73.7
	strongly agree	5	26.3	26.3	100.0
	Total	19	100.0	100.0	

Table 9-11 shows only one organization think using RFID technology added average additional cost, which is only 5.3% but other thirteen organization are agree on the statement that using RFID is costlier than using barcode and this percentage is about 68.4% and rest five

are strongly agree on the statement of using RFID is costlier than other technology and its added initial cost as well, which is 26.3%.

**Q.6. Implementing or using RFID technology need additional training on it**

**Table 12.** Frequency distribution of possible training need

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	average	4	21.1	21.1	21.1
	agree	12	63.2	63.2	84.2
	strongly agree	3	15.8	15.8	100.0
	Total	19	100.0	100.0	

Above Table 12 shows the data where only four organizations comment average about the statement which is 21.1% but other twelve organizations are agree on the statement that it is needed additional training about RFID technology before implementing in Supply chain and inventory control, this percentage is about 63.2% and rest three are strongly agree on the statement, which is 15.8%.

**Q.7. It is needed extra labor for handling and attaching RFID device on the product and it is also time consuming**

**Table 13.** Frequency distribution of additional labor need

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	average	7	36.8	36.8	36.8
	agree	8	42.1	42.1	78.9
	strongly agree	4	21.1	21.1	100.0
	Total	19	100.0	100.0	

Table 13 shows the data about using RFID technology needed additional labor for installing RFID tags or chip on the products where seven organizations comments as it is average which is 36.8% but other eight organization are agree on the statement and this percentage is about 42.1% and rest four are strongly agree on the statement which is 21.1%.

**Q.8. By using RFID total profit can be increase**

**Table 14.** Frequency distribution of increase profit

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	average	8	42.1	42.1	42.1
	agree	6	31.6	31.6	73.7
	strongly agree	5	26.3	26.3	100.0
	Total	19	100.0	100.0	

In Table 14, it shows data that using RFID technology can increase profit margin. Eight organization are thinking it can increase average profit within this technology use and the percentage is only 42.1%. Other six organization are agree on the statement which is about 31.6%, rest five organization are strongly agree that using RFID in their Supply chain and inventory control can increase profit margin which stands for 26.3%.

**Q.9. Using RFID technology ease product tracking and manage inventory**

**Table 15.** Frequency distribution of Easy tracking manage inventory

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	2	10.5	10.5	10.5
	average	7	36.8	36.8	47.4
	agree	5	26.3	26.3	73.7
	strongly agree	5	26.3	26.3	100.0
	Total	19	100.0	100.0	

In Table 15, it shows data that using RFID technology supply chain process can make easy to handling and tracking inventory than other technology use for supply chain management but there are two organization are disagree with this statement and the percentage is only 10.5%. Other seven organization comments on the statement as it is average which is about 36.8%,

other five organization are agreed, which stands for 26.3% and rest five are strongly agree with it is 26.3%.

**Q.10. Using RFID technology also make easy to manage its supply chain process over other technology is used currently**

**Table 16.** Frequency distribution of Smoothing Supply chain management

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	disagree	2	10.5	10.5	10.5
	average	8	42.1	42.1	52.6
	agree	2	10.5	10.5	63.2
	strongly agree	7	36.8	36.8	100.0
	Total	19	100.0	100.0	

In Table 16, it shows data that using RFID technology supply chain process can be smoother than other technology use for supply chain management but there are two organization who disagree with this statement and the percentage is only 10.5%. Other eight organization comments on the statement as it is average which is about 42.1%, other two organization are agree which stands for 10.5% and rest seven are strongly agree with it is 36.8%.

**10. DISCUSSION**

As Bangladesh is a developing country that has not strong position in Global market, again both the private and public sectors are trying to overcome the obstacles and become strong market players despite the circumstances. RFID technology has already been adopted by a few organizations and over time will show improved results. Future promotions will become efficient and maximize organizations’ profits. Customers will enjoy products and services through the supply chain. Organizations need and want to follow technology and innovations. There is shortage of knowledge about this new technology among the employee as well as owner of the organization but who are already understand the goodness of this technology, they are enjoying the benefit of it. Mostly in Bangladesh RFID is use in apparel industries because they leveled up their business along with globalization and according to demand of new technology use. Again some food industry are trying to get this technology because now a days Bangladesh has increase amount of food export in other countries where it can make value of their business and also in national level.

Concerning the barriers of widespread RFID technology integration, the participants mentioned different themes. Some stated that the technology is not mature enough and made reference to problems with bulk reading procedures, one of the main benefits which accelerates warehousing and loading processes. But also, the costs of the transponders and reading devices compared to barcode solutions are seen as a hindrance for fast large-scale RFID applications. The participants also stated that the inconsistencies in the RFID standards both in frequencies and protocols, were posing problems because global standards would be needed. But the participants also see other hindrances, for instance that current systems do not reflect RFID processes, and that there is lack of professional knowledge in the companies which could deploy RFID technology. Also, the participants are aware that privacy issues with private end-consumers need to be addressed by government regulations before open loop RFID systems can be securely deployed in retail stores. The cost of RFID technology implementation is high. Organizations need to know the return on investment (ROI) to organize their operations and strategies. The economic crisis will not help organizations to grow. Users and all the participants need training and to know how to use competency. Technological revolutions will help the growth of organizations. Integration systems will help the implementation of RFID. Some people believe that traditional ways of doing things are better. Suppliers could not afford the cost of implementation and training. The result will be that small organizations will go out of business.

## **11. CONCLUSIONS**

RFID is the general name of the systems that use radio waves in automatic object identification. It transmits the identification information of objects as a numerical serial number dynamically. These wireless systems give the opportunity to read without contact and being visibility. This property provides simplicity in difficult environments, as compared to conventional technologies such as barcode. Today, RFID technology with its different applications provides many advantages in the industry. Invention of new technologies decreases the operational costs of firms and companies and increases the efficiency and profitability. By using RFID technology, the changes in the working process can be analyzed and planned. The RFID system can set with the most suitable tag design and be started to be managed. In this study, it is examined supply chain processes affected by RFID technology. Using information from published secondary data, have identified a consolidated list of RFID benefits or success variables and also list of challenges. By identifying influencing factors and the benefits gained, this paper presents areas in need of further empirical research to understand the significance and strength of each influencing factor. Moreover, this paper examined the interrelationship between RFID benefits and implementation success factors as well as the challenges in supply chains. Since different organizations have different objectives in implementing RFID technology, this study is useful in identifying and prioritizing factors needing attention. In short, results of this study provide a suggested list of critical success factors that can be tailored to suit the needs of individual companies. This study was conducted to provide information on the current use of RFID technology in supply chain operations and its impacts on supply chain management systems in Bangladesh prospective. As RFID technology can provide important business benefits, the results of this research deliver a better understanding of current problems

and issues in RFID technology introduction and show which factors influence the level of success in various industries.

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**APPENDIX**

Questioner on RFID technology use

Organization name: \_\_\_\_\_

Date: \_\_\_\_\_

Here are some questions about using RFID technology. I want to collect data for fulfillment my thesis paper as I am a MBA student of Bangladesh University of Professionals (BUP). Here I provide the following questions that can help me to collect data for my study. I hope you will help me as well.

Q.1. Have key business environment risks been identified in the organization's decision to implement RFID, including payback, supply chain capability, and customer capability

Q.2. Having key risks regarding network security.

Q.3. Have risks regarding data management and integrity.

Q.4. The business processes been identified and positioned for backup or exception process purposes.

Q.5. Additional financial controls need to be in place for processing transactions directly to ledgers from networks or tag.

Q.6. Implementing or using RFID technology need additional training on it.

Q.7. It is need extra labor for handling and attaching RFID device on the product and it is also time consuming.

Q.8. By using RFID total profit can be increase.

Q.9. Using RFID technology ease product tracking and manage inventory.

Q.10. Using RFID technology also make easy to manage its supply chain process over other technology is used currently.

\*\* Here likert scale is used. Where 1 = strongly disagree, 2 = disagree, 3 = average, 4 = agree, 5 = strongly agree scale is used. \*\*