Deployment of printed RFID in Egyptian apparel retailing

Khalid M. Elsheikh
Lecturer, Apparel Design & Technology Department, Faculty of Applied Arts - Helwan University, Egypt
Mahmoud F. El Feky
Lecturer, Printing, Publishing and Packaging Department, Faculty of Applied Arts - Helwan University, Egypt

Abstract:
The purpose of this research is to investigate the printed RFID technology and its deployment in the Egyptian fashion retailing, discover the benefits and point out the barriers preventing the proper deployment of this technology in the Egyptian apparel retailing market. RFID stands for "Radio-Frequency identification", which is an innovative automatic identification technology, it identifies and gathers data without human intervention, or data entry, RFID systems consist of tags, readers and software. RFID is referred throughout the world as a replacement for electronic article surveillance (EAS) tags and are used to prevent shoplifting. Apparel retailers claim that EAS systems are cheap, the system installation cost is average, and the cost for securing each piece is near zero, the reason for that is that each key is used for almost unlimited number of times. However, the results show that using conventional EAS is not effective in securing store's goods, and it causes damage for about 0.05% of garments. Recently many technologies have been studied to overcome the cost barriers; one among them was "Printed RFID" technology. An innovation in conductive ink allowed RFID tag providers to print RFID antenna on tagging substrates, instead of using a conventional solid-copper antenna, which was more expensive and less flexible. The study used semi-structured interviews for data collection from apparel retailers and print houses managers in the Egyptian market, in order to overcome the research problem, which is the lack of studies investigated the deployment of RFID technology in the apparel retailing, precisely within the Egyptian industry. In addition to highlighting the benefits of printed RFID deployment as an alternate to EAS and etched RFID tags, because of printed RFID stability, reliability, cost-effectiveness, flexibility, and its low environmental impact compared to etching method. In addition to investigating the barriers limiting the deployment of RFID tags despite mentioned advantages, which is according to interviews analysis, resulted in a full ignorance of RFID technology itself among apparel retailers and Egyptian print houses, which require more research on the RFID marketing, and reduction of printed RFID tags' cost and the chips as well.

Keywords:
- ***RFID,***
- ***Radio Frequency Identification Systems, Printed RFID,***
- ***Fast fashion,***
- ***Supply chain management,***
- ***Apparel retailing***

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Introduction
RFID stands for "Radio-Frequency identification", which is an innovative automatic identification technology, as it identifies and gathers data without human intervention, or data entry. It is a wireless technology (Modrak et al., 2010).This technology has been widely adopted because of the huge potential it offers (Garrido Azevedo, and Carvalho, 2012). RFID uses transmitted radio signals to tag, recognize, track and trace the movement of an item wirelessly, two examples of today's RFID systems are theft protection systems in shops and systems for remote road toll management. Any RFID system typically consists of three basic components: tags (transponders), readers and Security programs (Hingley et al., 2007).

Tags are the key component and are placed on the entity (Wang & Hwang, 2011). It contains all needed information about the item it is attached to in its memory, this information is then transmitted to the reader. Tags can be classified as either active or passive (Pankaj, 2011). Active tags consist of a small battery, a microchip, and a small antenna built into them (Garrido Azevedo, and Carvalho, 2012). Active tags can be turned on by a suitable RF field from the reader, once turned on it communicates with the reader using pre-determined protocols (Pankaj, 2011). Passive tags are energized by the RF (radio frequency) field from the reader and transmit its identity to the

reader (Pankaj, 2011). Tags can reprogrammed on-the-fly (Kaur et al., 2011). With the ability to hold large amounts updateable information and is not limited by optical scanning.RFID technology has opened the door to a new era in Retail Management (McCathie, 2004).

The operating frequency of radio waves employed also varies; active tags have a greater read/write range than passive tags that are shorter range (Garrido Azevedo, and Carvalho, 2012). Low-frequency (LF) RFID tags operate at 125 to 134 kHz, for US and international use, high-frequency (HF)systems use 13.56 MHz, Frequencies of 866 to 960 MHz are used in UHF (ultra-high-frequency) systems, while microwave systems operate at 2.4 to 5.8 GHz (Dipert, 2004). Traditionally, the tag's antenna is manufactured using copper etching techniques or embedded copper wire on plastic base. Readers can read/write data on tags and transmit the data between readers and tags; and the software integrates an RFID system, which collect and store data.

At present, a constraint for broader usage of RFID is the relatively high cost of the RFID tags. If the cost of the tags could equal the cost of EAS tags or printed bar codes, many new exiting applications of RFID could be conceived, one step towards lowering the manufacturing cost for such applications is to print the tag antenna using conductive paint.

RFID deployment in the fashion retailing business

Although commercial applications of RFID date back to the 1960s, the use of RFID in supply chain management is relatively new (Garrido Azevedo, and Carvalho, 2012). Companies ranging from fashion leaders to department stores are starting to deploy RFID technology in their business. *Marks and Spencer* started testing RFID on individual items of clothing in 2004, tagging all men's suits, shirts and ties at one of its stores (Collins, 2006).Inconsequence the suppliers and service providers were forced to keep up with them by taking steps towards adoption. This was an innovative, efficient and economical move (Moon and Ngai, 2008).

RFID is considered a substitute for Electronic Article Surveillance (EAS) tags. Today EAS tags are widely used to tag goods in retail theft prevention systems, the tags carry no data but simply respond to a reader that detects the presence of a tag. In a typical application an alarm would sound if an item tagged with an EAS tag is taken through a doorway (CoreRFID Ltd, 2012). However**,** RFID technology is not just about security, RFID offer a total new level of interaction retailing, the RFID technology has received considerable attention from academics and practitioners because of its potential for innovation in diverse processes such as manufacturing, transportation, distribution, information systems, store operations, and sales (Garrido Azevedo, and Carvalho, 2012). It could bring many benefits to firms through greater operational efficiency, better inventory visibility and more accurate data collection (*Chaoet al, 2007*).

Deploying RFID technology is valuable particularly in fashion retailing; this business is characterized by a wide assortment of products with short life cycles and complicated distribution and logistics operations. The apparel industry could experience great benefits from RFID deployment (Bottani, 2009).Especially with the fast fashion trend which is increasingly adopted model within the fashion and apparel retailing business. Fast fashion is about the ability to react to trends and improve response times (Krishnan et al., 2010).With RFID deployment, fast fashion retailers, such as *Zara* and *Prada* in Europe, enhance their ability to design, manufacture, and stock the latest fashion products that change very quickly, almost weekly by monitoring and responding to consumer preferences more effectively and promptly.

RFID Cost:

Retailers deployed RFID enjoy reduced labor costs, on the other side RFID technology involves substantial investment and the return is only recuperated in a long periods. The main obstacles identified by companies for not using this technology are the high costs. The RFID tag and system cost is high, but positive returns are obtained from the continuous material flow (Hingley et al., 2007). The cost of RFID systems, in particular the tag cost, must be reduced to a more acceptable level (Garrido Azevedo, and Carvalho, 2012).While passive RFID tags are steadily becoming cheaper, it has not yet reached affordable level that is acceptable to most fashion retailers for individual item level tagging (Bose and Pal, 2005).

RFID and customer satisfaction:

RFID supports apparel retailers in enhancing level of assistance offered to customers as it can help to faster locate misplaced fashion items and allows for better shelf replenishment (Pankaj, 2011).Another use of the RFID is the RFID-based customer cards, which enables retailers to record

how fashion shoppers shop, interact with products in addition to make purchase decisions. Subsequently, they can provide customized marketing programs for their loyal customers at an individual level (Moon and Ngai, 2008).

So and Sun (2010) state that the next step in RFID technology innovation in FSCM is to merge RFID tags with other pervasive computing technologies to achieve ambient intelligence (*AmI*) in real life. An example of this innovation is referred to as the "magic mirror", which has the ability to read an RFID tag in clothing in the fitting room and display associated information such as availability and advice on accessories (Soars, 2009). The salesperson can provide him/her tailor-made services and/or promotions, in addition, customers may see items of different colors and sizes in the same category, as well as the availability of the stock, from the RFID display screens (Moon and Ngai, 2008). This could help increase customer satisfaction, result in repeated purchases from loyal customers, and enhance marketing opportunities for retailers. Moreover, using the RFID technology to track customers' shopping behavior is provoking a range of privacy concerns among civil liberties groups in many countries.

Moreover the adoption of RFID technology in a retail store can faster sales transactions through the RFID reader at the cashier's counter, thus preventing long payment queues and enriching the shoppers' shopping experiences (Moon and Ngai, 2008).

RFID and Supply chain management:

The advantages of RFID deployment result mainly from the innovation in processes, (Garrido Azevedo, and Carvalho, 2012). Since warehouse operators do not have to manipulate an optical reader to collect data about the products that are being loaded or unloaded (Garrido Azevedo, and Carvalho, 2012). it is particularly visible in Fashion Supply Chains (FSCs), due to the fashion business unique character. RFID provides the capability to track and trace items, it can improve the efficiency of many activities along the supply chain (Moon and Ngai, 2008).

RFID deployment by fashion retailers will have positive impacts on all drivers of marketing value chain such as product, price, place, promotion, physical evidence, process and people (Pankaj, 2011).RFID deployment decreases situations of product stock outs and increases availability of desired products, by allowing retailers to easily and efficiently track products using its identity code, showing its type, size, and color, without the need to check them the traditional way. Thus, the system can identify the stock levels of each items quickly and correctly.

RFID Infrastructure:

Once the cost barriers are overcame, and the retailers are aware of the RFID benefits, there will be another issue, which is compatibility. Lack of global standard is a major barrier in the deployment of RFID (Erickson and Kelly, 2007).Some international/national supply chain members do not have compatible network infrastructure in place (Lorchirachoonkul and Mo, 2010).The deployment of RFID must overcome the barrier of integration with existing systems(Garrido Azevedo, and Carvalho, 2012). As well as increasing the levels of trust and alliances among supply chain members, so that they can share information effectively. Another problem is the enormous data volume that could render RFID event-driven supply chains (Ilic et al., 2010).

Printed RFID

At the moment, many technologies have been studied to overcome the cost barriers. One step towards lowering the RFID tag cost is to print the antenna instead of etching it. Currently copper is the most commonly used conductor in tag antennas and the etching is the most widely used manufacturing technique to produce the conductive patterns (Björninenet al, 2009). These etched antennas are only acceptable for low volume production and in situations where cost is not a premium concern. (Sure, et al., 2005), However, the cost of antennas is a crucial factor in the mass production of antennas and there is an increasing need to develop new manufacturing techniques to enable the manufacturing of RFID tags on complicated curved surfaces at economically competitive cost. This can be achieved by applying new economical manufacturing methods to produce the antenna structures. Printing techniques may provide a new and fast way to do this (Björninenet al, 2009).

An innovation in conductive ink allowed RFID tag providers to print RFID antenna on tagging substrates, such as a label, instead of using a conventional, solid-copper antenna which was more expensive and less flexible. The method of printing has been used for many products such as clothing and printed circuit boards. The flexibility of printing allows it to be applied to almost any surface or material. Printing can have a great potential for RFID antenna fabrications. Compared to the traditional method of fabrication (etching), screen printing for example is more stable, reliable, cost-effective, flexible, and has a

low environmental impact compared to etching. The use of printing allows for intricate and minute details to be fabricated while still maintaining conductivity throughout the entire design. Even the amount of raw materials used for printing can be reduced since the layers of conductive ink can vary in thickness. Due to the consumption of fewer raw materials, its application in mass production provides the best cost per development ratio, allowing a company to sell at the lowest price. Printing can be used to fabricate a RFID antenna on almost any substrate or material such as metal, paper, and plastic (Elsherbeni, T. et al., 2010).

January 2004, Dan Lawrence, director of Technology and Commercialization, Precisia, presented that the printed antenna had 93-96% of the radiation efficiency of a copper antenna (depending on the design), while it cost only 24-44%. He also introduced the concept of RFID integrated by printing it directly on substrates and attaching microchips in-line. Ideally, RFID integration would significantly reduce the cost of RFID implementation in mass production because it would eliminate the needs for labels and the manual "slapping" (attaching) process (Lawrence, et al., 2004).

The simplest passive RFID tags have microchips that contain a single bit. These tags are referred throughout the world as electronic article surveillance (EAS) tags and are used to prevent shoplifting. In terms of cost, passive RFID tags range from $0.25 up to $10.00, depending on functionality, packaging, and application. The prices of passive RFID tags are highly dependent on the volume of tags ordered, lower volumes will generally lead to much higher per tag prices (Smart Border Alliance). Tag's cost need to be lowered, and production must reach extremely high volumes (Tens of Millions) (RFID Technology Roadmap).

Where all reports agree that as RFID technology evolves with ongoing advancements made and production volume increasing, the price will inevitably drop, eventually justifying the business case for tagging all items when tags reach the utopian price of about 1 to 5 cents. Even over the last several years, the cost of tags has fallen significantly, with a tag that cost US$2.35 four years ago, now costing as little as 15 cents (Luke McCathie, et al., 2004).

Printed RFID Materials:

Among all available printed materials including metals, carbon, and intrinsically conductive polymers, silver is considered as the most promising one, due to its high electrical conductivity (6.2 x 105 S/cm, which is the highest among all metals), relatively low material cost, and excellent reliability in long-term uses without the concern of electrochemical etches(Yang, et al., 2008).

Also, Paper substrates offer many advantages for printing RFID antennas, not only is paper widely available and affordable, it is lightweight, biodegradable and can be rolled or folded into 3D configurations (Bose, et al., 2005). In addition, there are many aspects of paper that make it an excellent candidate for an extremely low-cost substrate for RFID and other RF applications. Paper; an organic-based substrate, is widely available. The high demand and the mass production of paper make it the cheapest material ever made. From a manufacturing point of view, paper is well suited for reel-to-reel processing (Amin, et al., 2012).

Modern manufacturing methods of electronics such as screen and inkjet printing are making their way into mass production of low-cost electronics. The applicability of these methods has already been validated in manufacturing of radio frequency identification RFID tags in. Furthermore, these modern additive processes posses the capabilities to lower the cost of a single RFID tag. This cost reduction could help the RFID systems to supersede traditional bar code systems(Virtanen, et al., 2010).

RFID Printing Techniques:

The selection of a printing process for the fabrication of printed RFID antennas is important because it directly affects the requirements of ink, performance and productivity of RFID antennas. Some key requirements of the printing process for RFID antennas are:

1- It is suitable for mass production.
2- It needs to be employable to produce RFID antennas for various frequencies such as 13.56 MHz, 860 to 960 MHz and 2.45 GHz not constrained to one specific model.
3- Job changes among printed RFID models must be easy and quick.
4- Printing as an additive process should consume a less material than conventional etching techniques as a subtractive process to achieve a low cost
5- The infrastructure of the printing process must be will developed.
6- The cost of owner ship needs to be considered.
7- It must be easy to use and maintain.
8- Operators can solve problems on site, if

possible. and,

9- It must meet the rheological characteristics of conductive ink (ISO/IEC 18000).

Screen-printing is an additive process – as opposed to the subtractive process of etching into a copper layer – and is more cost-effective and environmentally friendly, since an additive process consumes fewer raw materials, and limits waste products. Furthermore, a silver ink antenna on paper withstands twisting and bending better than common copper antennas: the silver ink antenna is screen printed directly onto the paper so that the conductive ink penetrates into the fibers of the paper providing greatly enhanced flexibility. To be most effective, RFID antenna production should be a rapid and stable process that delivers a robust, reliable product. Silk screen printing is a well-tested industrial process, compatible with high speed reel-to-reel manufacturing, which can easily be scaled to meet any production requirements (Sure, et al., 2005).Also, only Ink-jet technologies allowing printing multiple thin conductive layers and with relatively low edge roughness would be able to compete with screen-printing technologies for RFID tag antenna manufacturing.

By using Ink-jets designed to use conducting ink, very cheap and easily manufactured antennas could be produced. These printers commonly provide a conductor thickness in the order of 1μm (Koptioug, A, et al, 2011), and high printing definition, at least 600 dpi. Some Ink-jet technologies allow repetitive printing of the same pattern after each layer is cured, bringing the overall conductor thickness up to about 1 mm(Fuller et al, 2002).

Finally, RFID technology deployment is valuable particularly in fashion retailing, on one hand this business is characterized by a wide assortment of products with short life cycles and complicated distribution and logistics operations. On the other hand, RFID intend to enhance level of assistance offered to customers as it can help to faster locate misplaced fashion items and allows for better shelf replenishment (Pankaj, 2011). However, although the relative advantages of adopting RFID technology have been adequately substantiated in the literature, it has become increasingly apparent that the actual adoption rate of RFID is not growing as fast as expected and falls behind the optimistic expectations of the early years (Sulaiman et al, 2012).There are still a number of issues for RFID deployment like technology, standards, infrastructure, cost and privacy.

There is a lack of studies focusing on the deployment of RFID technology in the apparel retailing especially in Egypt. There are few companies aware of the various applications of RFID technology that can bring significant benefits to their organizations. Therefore, it is essential that more effort should be made to understand the concepts of RFID adoption and to identify and analyze factors affecting the RFID adoption decision, in this line, (Ngai et al., (2008). Considered that the barriers and critical success factors of RFID adoption are important issues that should be addressed in future studies. (Curtin et al. (2007) also propose a RFID research agenda stressing the need of more studies on the following areas; developing, adopting and implementing RFID; using, supporting and evolving RFID; and RFID impact.

Methodology

The literature showed that RFID is a promising innovative technology with many benefits and improvements for retailing, FSCM and even for apparel manufactures. First, the deployment of RFID technology requires more researches on the reduction of tags' microchip cost, because it is the most expensive part of the entire RFID system, which contributes about 30% to 70% of the total cost of a tag. and this could be done by developing new innovative design or changing the materials used, however this direction is away from the subject of this paper. The second direction is reducing the antenna's cost, which can be achieved by replacing etched antenna with printed one, the printed antennas cost is continually drops, and expected to be very affordable for the Egyptian retailers soon. For development of this research, this paper will focus on two more direction of RFID deployment course, which are:

- Investigating the apparel retailers awareness of RFID technology, compare the benefits of the RFID technology into current similar systems.
- Investigating the printing houses awareness too of RFID technology, specially the printed one, and their capabilities to print these RFID antennas, in case of high volume production.

A total number of 30 retailers were selected in random from well-known Egyptian apparel retailers, working in men clothes outerwear. The selected retailers were interviewed personally in face-to-face sessions arranged by the researchers themselves. The interviews were semi-structured, to allow space for the participants questions and to give the interviewer a deeper understand of the business requirement as well. The interviews were held in Arabic to assure maximum understanding and accurate response of the participants, the

questions and the results were then translated by the researchers themselves into English.

The interviewee were asked first about the security system they use in their own stores, and Secondly if they have any knowledge about RFID, *Table (1),* so that the interviewee who have no prior knowledge on RFID were then omitted from the following steps for improved research results.

Table (1); security system used by Egyptian apparel retailers:

Question	Answer
1. What is the used security system in your store(s)?	EAS: 28, RFID: 2
2. Do you have any knowledge about RFID?	Yes: 11, No: 19

Table (2); interview Questions for apparel retailers using EAS:

Question	No.	Mean	SD
1. What is the average of garment defects caused by EAS tags in percent?	28	0.050	0.94
2. As EAS is used for security purpose, what is the average loss of garments in percent?	28	0.049	0.98
3. What is the average cost garment sold in your store(s)?	28	248	33.73
4. How much does the cost of an RFID system base preventing you from deploying it?	28	4.04	0.63
5. How much does the lack of trained employee of a RFID system preventing you from deploying it?	28	4.46	0.88
6. How much does the cost of an RFID tag preventing you from deploying a RFID system?	28	4.29	0.86

The results show a massive usage of electronic article surveillance (EAS) system compared to RFID, 28 out of 30 participants are using EAS system, and only two of them are using RFID. With average knowledge of RFID technology, some of the participants could not identify the technology, however they claimed that they used it couple of times, most of this times were during travels offshore, few of them were within Egypt.

The interviews were continued with retailers using EAS technology (number of interviewee: 28), a total number of 6 points were discussed, a checklist with the discussion points were developed to record the interviews' results. The results were recorded by selecting the appropriate level on a scale from one to five where the grade (five) indicates the highest effect, while the grade (one) means little to no effect. Table (2), shows the questions discussed during the interviews along with the results' mean and standard deviation (SD).

EAS system consist of a *key* which is two plastic parts fixed to the garments by a metallic pin, an *unlock tool* used to unlock the sold garments, and a *gate* which rise alarm when a garment with the EAS components are passing through. Apparel retailers claim that EAS systems are cheap, the system installation cost is average, and the cost for securing each piece is almost zero, the reason behind this claim is that each key is used for almost unlimited number of times.

Most of them were concern of the RFID system cost, the lack of trained employee, and the cost of a RFID tags, On the other hand the interview results show that most of retailers using EAS are facing some monetary problems too; The EAS tools are not unique, any EAS unlock tool can be used to unlock almost any EAS key, thus it is not effective in securing store's goods causing garments loss. Moreover, EAS' tags causes damage of about 0.05% of garments, the shortage of using EAS are as follow:

- The cost of fixing and removing the EAS unit is hard to calculate, however, the labor involved in this work do cost some money obviously, beside the loss of valuable time at cashier.
- About 0.05% percent of garments got defected while fixing and removing the EAS components,
- Garments loss is about 0.05, store managers believed that EAS unlock tools which is not unique can be part of the problem.

Despite the labor cost, the true average cost of EAS deployment should be equal the loss of one garment out of 1000, while the average garment price is 248, this mean about 0.25 LE/piece.

The printed RFID tags is not cheaper, however the prices are dropping continuously, that is why it is expected that the adoption of printed RFID tags in the retail sector will increase rapidly. Beside the cost, deployment of RFID technology benefits do extend the cost to wider areas like; improved company image, faster and better shopping experience for customer, better management of stock and supply chain, and more other benefits as mentioned earlier in the literature.

Finally the interviews were continued with retailers aware of RFID technology (number of interviewee: 11), a total number of 10 points were discussed, a checklist with the discussion points were developed to record the interviews' results. The results were recorded by selecting the

appropriate level on a scale from one to five, where the grade (five) indicates the highest effect, while the grade (one) means little to no effect. Table (3), shows the questions discussed during the interviews along with the results' mean and standard deviation (SD).

Table (3); interview Questions for retailers with knowledge about RFID systems:

Question	No.	Mean	SD
1. Would RFID deployment improve stock management?	11	4.64	0.48
2. Would RFID deployment improve retail operation workflow?	11	4.36	0.48
3. Would RFID deployment improve data collection about customer preferences?	11	4.27	0.45
4. How much important for retailers to collect data about their customer preferences?	11	3.91	0.51
5. Would RFID deployment improve responding to consumer preferences?	11	4.18	0.57
6. Would RFID deployment reduce security costs?	11	4.45	0.50
7. Would RFID deployment support brand image?	11	4.27	0.45
8. Would RFID deployment effect customer privacy?	11	4.64	0.48
9. To what extent is it hard to integrate RFID with existing systems?	11	1.91	0.53

The results given for questions from one to seven indicate that selected retailers are aware of the benefits, with results' mean ranging from 3.91 to 4.64 which is considered high, and standard deviation ranging from 0.45 to 0.57. However the fourth question result's mean, which is 3.91, indicate low valuation of the customer preferences data collection, which is one of the RFID deployment advantages. The integration of RFID system with existing ones was not an issue according the interview results, the ninth question result's mean was 1.91, which is below average, and the standard deviation was 0.53, which indicate acceptance among the participants. They claimed that RFID system would easily replace barcode and EAS systems.

The last point discussed with participants was the reason they do not use RFID systems in their business, as nine of them was aware of the technology, but only two of them did deploy it. The reason was the lack of trained employee beside the cost of the system installation and operation, which was expected to be high.

The global market demand for high quality and low cost electronic components requires innovative fabrication techniques that are both faster and cheaper compared to traditional production methods (Hudd, 2010).Currently, the cost of chip is still the major part of the overall cost of a tag, which contributes about 30% to 70% of the total cost of a tag. The rest part is the sum of the materials cost including the antenna, substrate, and that for integrating them together. Since the cost of the chip keeps dropping due to the technical development, the need for reducing the other parts now is more urgent than ever (Yang et al, 2008).

Reducing the RFID tag's price can be achieved by reducing the cost of antenna, which is extremely high within the Egyptian market, the reason behind antenna's high prices is that all of RFID tags and systems as well are imported overseas, no systems or tags are manufactured in Egypt at all. Printing RFID tags in the Egyptian printing houses would help reducing its cost, using the advantage of Egyptian low labor costs, and high labor skills and experiences.

For investigation of the Egyptian printing houses capability to print RFID antennas, the researchers arranged interviews with number of top printing houses managers working within the Egyptian market. A total number of 20 print houses were selected, this print houses were known for their attempt to adopt new technologies, those print houses are supposed to be the first ones to buy RFID materials and print machines in order to produce RFID tags within the Egyptian market. The selected print houses managers were interviewed personally in face-to-face sessions by the researchers themselves. The interviews were semi-structured, to allow space for the participants questions and to give the interviewer a deeper understand of the business requirement as well. The interviews were held in Arabic to assure maximum understanding and accurate response of the participants, the questions and the results was then translated into English by researchers themselves.

A total number of 5 points were discussed, a checklist with the first four discussion points were developed to record the interviews' results. The results were recorded by selecting the appropriate answer (Yes or No), the fifth discussion point

result was developed to be an essay answer, table (4), shows the questions discussed during the interviews.

Table (4); printing houses interviews questions and results:

Question	Yes	No
1. Do you know what does the term of RFID refer to?	1	19
2. Do you know that RFID tags can be printed by various printing techniques?	1	19
3. Do you print RFID tags?	0	20
4. Do you know any print-houses that prints RFID tags in Egypt?	0	20
5. If you have all materials like paper, Conductive inks, etc., how much does 1.000.000 antennas cost?	Unknown	

The interview results indicate an ignorance of RFID technology and its applications, among the participants, they were not sure if tag's antenna can be printed or not, only one of all participants knows what is RFID and it's applications. This participant who has knowledge about RFID, was aware of the various applications of this technology, he mentioned the following ones: access Control, supply chain management, retail, and other identification usages.

This participant was aware that tag's antenna could be printed by various printing techniques. However, his print house is not printing it, and he does not know any other houses that print RFID tag's antenna within Egypt, moreover, This participant supposed that there is no Egyptian print house are printing RFID tags at all.

Therefore, this participant's answer on the last question was that it is not possible to provide a list of every element because there is a huge variety of the components depending on their size, the frequency, memory capacity, design and dimensions of the antenna, battery, packaging around and materials. Therefore, since antenna's designs and specifications are different, costs vary widely too.

It is worth mentioning, that the only print house manager with knowledge about RFID technology, has shown fully readiness to print RFID tags if it will make suitable revenue if there is enough demand in the Egyptian market, and if there is a feasibility study made on it. Especially when the interviewers explain that he can print high volumes (tens of millions) of tag's antennas to reduce the total cost of the tags, and it can be personalized individually for any application will be used in, provided that it works in the application demands like size, frequency and range.

Results

RFID is an innovative automatic identification technology, RFID antenna printing is known for stability, reliability, cost-effectiveness, flexibility, and its low environmental impact compared to etching method. RFID is considered as a replacement for electronic article surveillance (EAS) tags and are used to prevent shoplifting, however RFID extend the EAS usage and enables better management of items, and improved customer shopping experience.

According to interviews analysis, there is a lack of studies focusing on the deployment of RFID technology in the apparel retailing, and on the benefits of using printed RFID instead of conventional one especially in Egypt. RFID deployment is valuable particularly in fashion retailing business, due to its characteristic, however there is unjustified concern of the system implementation and running cost, deployment of RFID technology help reducing labor costs, however it involves substantial investment and the return is only recuperated in a long periods, furthermore the benefits of the system deployment is beyond the cost.

RFID technology enhances the level of assistance offered to customers, faster locate misplaced fashion items and allows for better shelf replenishment. A further step in RFID technology innovation is to merge RFID tags with other pervasive computing technologies to achieve ambient intelligence (*AmI*) and the “magic mirror” in real life, by reading an RFID tag in clothes and display associated information such as colors and sizes availability combined with advices on accessories too. Resulting in increased customer satisfaction, faster sales transactions, plus improving marketing value chain such as product, price, place, promotion, physical evidence, process and people.

Printing RFID antenna is a great opportunity for Egyptian printing houses, it is very profitable business, the process require minor to none modification to be applied to printing machinery, however some marketing efforts supposed to be made too, Furthermore, the printing houses certainly need to be aware of their own opportunities.

Therefore the researchers recommend that deployment of RFID technology should be directed in three parallel routes:

- Reducing the antenna's cost, by replacing etched antenna with printed one, which can be

printed in Egypt too, for further reduce its cost.
- Highlight the benefits of RFID technology deployment for apparel retailers.
- Highlight the opportunities available for Egyptian printing houses by printing RFID antennas for apparel retailers and other retailing business within Egypt and offshore too.

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