RFID in the Supply Chain and the Privacy Concerns

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1. Introduction

The Radio Frequency Identification Technology (RFID) is an emerging technology that has received considerable attention during its development. RFID dates back in 1948 when it was first used for military applications. Its commercial activities began later in 1960 when electronic article surveillance equipment was developed to counter theft and in 1970 when laboratories started working on RFID and companies started developing RFID. The 1980s became the decade for full implementation of the RFID technology and in the 1990s widespread use of the technology led to the creation of standards. From 2000 until today, RFID explosion continues and it is believed that over the next years it will experience wide implementation replacing the barcode technology which is widely used today.

RFID technology offers powerful benefits to its adopters and today is already being used in a variety of applications such as payment systems, access control and animal and human tracking. Among other applications, RFID is used for a wide variety of supply chain activities too and seems to be essential for successful supply chains since it plays a key role in order to gain a competitive advantage and differentiate from others.

This paper examines the impact of the RFID technology to the supply chain management. It explains how the technology can be used, the way it influences the management of the supply chain and what are the benefits gained at manufacturing, warehousing, distribution and retailing. Also, it presents the problems that are created specifically at the retail stage where the consumer is involved.

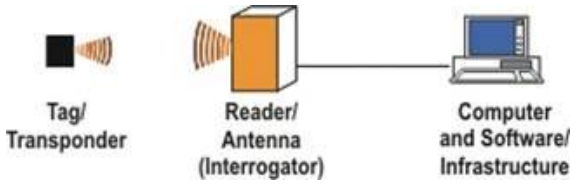
More attention is given to the privacy risks and the legal concerns that arise from the implementation of the RFID technology. While RFID offers great productivity benefits, it also addresses consumer privacy concerns which result from the lack of current data protection laws. So, in order to be able to see through the privacy concerns that arise from its implementation, it is primary to learn and understand the way the technology works.

In the next chapters an overview of the main components of the technology is given and the most popular applications are presented. Then we focus on its implementation to the supply chain and we discuss about the benefits and the barriers of its adoption. Also, we examine the way American consumers reacted when the RFID technology entered in their personal lives and we present the most recent proposed legislation in several states in the USA. We also discuss about the proposed guidelines in Japan and the activation of the European Union to protect the consumer privacy providing guidance to the Member States. Finally some legal proposals and recommendations are suggested.

2. An overview of the RFID technology

A basic RFID system consists of three main components: the RFID tag, the reader and the backend IT system. The tag is attached to the object and communicates with the reader using an antenna, which in turn communicates with the enterprise system (Figure 1). Furthermore, the tag is the most important component as it stores

specific information about the object in an analogue form and after the transportation from the tag to the reader using the antenna, the data are retrieved in a digital form from the backend IT system. Then, the backend IT system links to a database to obtain more information about that object. Thus, data can be stored both to the tag and the backend IT system to which the tag refers to and be cross-referenced and combined to find out the object's history.



Source: http://www.aimglobal.org/technologies/RFID/what_is_rfid.asp

Figure 1 A basic RFID system (31)

An RFID tag works as a transponder and consists of a microchip and an antenna. As mentioned before, the RFID tag communicates with the reader using an antenna and according to the way it communicates, the tag is categorized to passive or active tag. A passive tag has no power source and draws power from the reader which sends electromagnetic waves energizing the circuits in the tag. On the contrary, an active tag uses an internal power source, such as a battery, to perform all the functions.

Also, another common RFID tag type is the semi-passive tag (or battery-assisted, as referred by Roberti M., 2011) which is similar to the passive tag in that the signal is generated passively but it differs in that it uses an internal power source to complete other functions. For all these reasons, passive tags are smaller and cheaper but their signal strength is not so strong and they cannot emit radio waves in the range the active tags do (Wiebking L. et al., 2008). In conclusion, passive tags are suitable for mass single-use applications and active tags are suitable for manufacturing (Cavoukian A., 2004).

Active tags are also categorized to beacons and transponders. On the one hand, active beacons start the communication with the reader on their own emitting radio waves and when the reader picks up their signal the communication starts. On the other hand, active transponders wait for the readers' signal to start the communication and they don't broadcast on their own any signal. The transponders are used to the most applications but beacons are more useful for real time locating systems (OMNI-ID, 2009).

Finally, another important classification of RFID tags, according to the way they manage data, are read-only, write-once and read-write tags. A read-only tag contains pre-written data which can be read many times, a write-once tag gives the user the ability to write data only once and read them many times and a read-write tag allows the user to add new data any time he wants or even write over the original data and read them many times. Typically, read-only tags are passive tags and read-write tags are active tags (Roberts C.M., 2006).

At the table below (Table 1), you can see the types of RFID tags categorized by source of power, data management and way of activation, as discussed. RFID tags can also come in many forms and at different shapes and sizes depending on the reason for which they are created for. Therefore, it is important to study in detail about the application to which they will be implemented before the right type of RFID system is chosen for the particular application.

Types of RFID tags		
Source of Power	**Data Management**	**Way of Activation**
Active tags	Read/Write	Beacons
Passive tags	Read Only	Transponders
Semi-passive	Write Once	

Table 1 Types of RFID tags

3. RFID Applications

RFID technology offers powerful benefits to its adopters and today is already being used in a variety of applications. The key characteristic that differentiates one RFID application from another is the purpose of identifying the tagged items. At this chapter a small description of some of the most popular and common RFID applications is given.

Payment systems are one of the most popular applications of the RFID systems. Automated payment is used for highway toll collection, fare collection on public transit systems, parking in restricted area and quick service stores. In these cases, the purpose of tagged items is to complete financial transactions in a quick and contactless way. Therefore, cars and humans are equipped with semi-passive tags that are used as credit cards and they are charged automatically.

Security and physical access control system is an application which uses RFID to identify a person who accesses a facility and even track him wherever he goes. This system is used mostly to plants and big enterprises to check on the personnel and to public locations, such as the airport, to control the crowds of people that enter. In this case, the purpose of identifying the tagged persons is to authenticate and spot them.

Another very popular RFID application, especially in the USA, is animal tracking. According to Lockton V. and Rosenberg R.S. (2005), pet owners implant RFID chips in their pets in order to track and locate them whenever they are lost. For the same reason, animal tracking is useful to breeders to locate missing animals. Furthermore, exotic animals and animals that are about to extinct are equipped with RFID tags to control and save their species.

In European level there are laws that make animal tracking using RFID tags imperative and particularly for breeders when their goat and sheep population is more than six thousand in order to be able to check for animal epidemics. For more information refer to the Regulation 1760/2000/EC of the European Parliament and to the Council Regulation 644/2005/EC.

At this point, it is worth noting that after animal tracking, RFID chips were implanted to humans too. The first step has already been done and RFID chips were implanted to humans for medical reasons. For example, RFID chips were implanted to hospital patients to retrieve their medical history (Lockton V., Rosenberg R.S., 2005) and to patients with mental health problems and even to doctors and nurses to keep real-time track of their location. Likewise, trials were made to keep children safe on their way to and from school (Swedberg C., 2005b) and to track and log inmate movements during the day to prisons, as in the case of the Los Angeles County jail system that engaged in a pilot project to use RFID technology to track inmates at the Pitchess Detention Center in Castaic (Swedberg C., 2005a).

Also, RFID chips are already used on official documents like passports and identification documents and they store data about the person who owns it (Alexandropoulou E., Mavridis I., 2007). The International Civil Aviation Organization (ICAO) documented specifications and guidelines for machine readable

travel documents (Doc 9303, 2004, 1st Release) and then the Council of the European Union adopted a regulation on standards for security features and biometrics in passports and travel documents issued by Member States (No 2252/2004). The so called e-passports (Juels A. et al., 2005) until now are widely used in several member states of the European Union to authenticate the identity of the holder in a contactless way.

Many manufacturers suggest that RFID creates new benefits in their factory operations too. RFID is being used in manufacturing plants to track assets and tools, increase throughput and productivity, reduce defects and manage the production line. Then, at distribution centers RFID is also useful because tags store data about the pallets that arrive and can be updated to show anytime their location. And at last, in retail stores RFID tags assist in shelf replenishment and in provision for the consumer's habits and make sure that consumers can find the right products to the right place and at the right time. So, as concluded, RFID improves store's efficiency and is beneficial for both retailers and consumers.

Finally, supply chain management is the most common application of RFID for tracking items and automate parts which involves all the processes a raw material has to go through to become a product and end up to the shelves of the stores and finally to consumers. The supply chain management contains a lot of the above applications such as manufacturing, distribution and retailing and further detailed discussion will take place in the next chapter.

4. Use of RFID in the field of the Supply Chain Management

This chapter explains the impact of RFID in the supply chain. At first a comparison between RFID and barcoding is made because nowadays barcodes are widely used throughout the supply chain. Then, the levels of tagging are presented and finally the applications of RFID in the supply chain and its barriers to adoption are discussed.

4.1. A comparison of Barcoding and RFID technology

RFID is often compared to barcoding because they are both used for auto identification (Table 2). Tags in the first case and labels in the other case contain data and they both rely on a backend IT system that cross-references to a database (Gaukler G., Seifert R.W., 2007). Many experts argue that RFID is an extension of barcode data collection systems. However, there are significant differences that make them appropriate to different applications and for different reasons with the RFID to be more efficient (Holloway S., 2006).

According to Katina M. and McCathie L. (2005) the most important difference and simultaneously the most attractive advantage of the RFID technology is that it doesn't require line of sight to read the tags and multiple parallel reads are possible without human involvement. For example, when a pallet arrives to a warehouse and passes through an RFID reader portal, all the products are scanned simultaneously and in milliseconds. On the contrary, in the case of barcodes, a worker would have to open the pallet and all the boxes in the pallet and scan each item individually, because line of sight is required and the read distance must be small. This is both a laborious and time-consuming task.

Another significant difference is the amount of data they contain. RFID tags have bigger data capacity and contain more information than barcodes do and they can even store the movement of the tagged items. Also, some RFID tags offer the capability to the user to update and add new information any time he wants

(read/write tags). For example, whenever the tagged items move from one task to another, their tags can be updated with the time and date they started and finished each task. On the contrary, barcodes cannot be overwritten and the data they contain is set only the moment the label is printed.

Furthermore, RFID tags have sensor capability and except from the movement of the tagged items they can also record the environmental conditions that they are stored, such as the temperature and the pressure. This capability is useful especially for sensitive cargo, such as food (Psion Teklogix, 2004). In addition, RFID can perform in environments where barcodes can't. In particular, RFID can cope with harsh, dirty and oily environments but barcodes cannot be read if they are damaged, torn or dirty and they cannot be protected against the environment because they need to be exposed to achieve line of sight.

Barcode	RFID
Line of sight required	Non- line of sight
Individual reads	Multiple parallel reads
Update is not possible	Real-time information, read/write ability
Limited memory	Large memory
Cannot be read if damaged or dirty	Can cope with harsh environments
	Sensor capability

Table 2 RFID Advantages versus Barcoding

However, RFID has also its own sensitivities (Hofman S.L., 2005). Liquids and metal influence its capability to read tags from a distance and problems occur when the environment is electronically noisy. So, in these cases careful study must be done before the positioning of the RFID readers.

To conclude, RFID and barcodes now co-exist. Barcode technology is still widely used because its implementation cost is lower, the technology is more mature and people trust it more. However, it is believed that it is only a matter of time until RFID technology spreads and takes the place of barcode technology, at the beginning locally and then widely. For this to happen, it is suggested that it is obligatory to create and enforce laws not only locally, but nationally too because products containing RFID tags are exported to other countries and the consumers all over the world should be informed about it and protected.

4.2. Levels of RFID tagging

There are three levels of RFID tagging: the pallet level, the case level and the item level. In pallet level the tag is attached to the pallet and can be cross-referenced to a database to retrieve information about it. The benefits of pallet level tagging are mostly the labor time that is saved because pallets are identified automatically and the reduction of the misplaced pallets in a warehouse optimizing the storage.

In case level the tag is attached to the case and, as in pallet level, it can be cross-referenced to a database to retrieve inventory information. The most important difference between pallet level and case level tagging is that at case level more detailed product traceability and inventory visibility is achieved (Gauckler G.M., Seifert R.W., 2007). Furthermore, manual checks at the retail store and labor time are saved because the need to check the number of cases on a pallet is reduced, product

recalls can be managed more efficiently and product returns are handled better since the cases being returned can be identified automatically.

In item level tagging a tag is placed to every product either on the product itself or on its package. In this case, the benefits are even more crucial especially for the retailer because higher product visibility and better inventory control is achieved. In particular, readers can be placed to shelves so as to control the stock all the time and inform the personnel when a product is going to run out. Also, according to Katina M. and McCathie (2005) the personnel can be informed when products are going to expire and need to be removed immediately from these smart shelves, when the environmental conditions are inappropriate for storage and when product re-ordering is necessary. Item level tagging can be easily used as an anti-theft measure too by positioning a reader at every exit of the store.

4.3. Applications of RFID in the supply chain

The main objective of a supply chain is to meet customer needs and as a consequence to gain more profits. General thinking, supply chain's activities start with customer orders and end when the customer finally buys the product and is satisfied. With RFID all raw materials and finally shipments can be identified, verified and sorted at different points in the supply chain.

A variety of stages are involved until the product ends to retail stores to fill customer requests. In particular, the stages involved are product manufacturing, warehousing, distribution and retailing and the parties concerned are manufacturers, suppliers, distributors, retailers and finally customers (Chalasani S., Boppana R.V., 2007). Zebra Technologies Corporation (http://www.zebra.com/) is an RFID provider with more than 30 years of success in developing supply chain solutions and according to its experience below is given a short description of how the RFID technology can be used to the supply chain applications and what are the benefits of its implementation (Figure 2).

At first, raw materials are equipped with RFID chips so when they arrive to the manufacturer they are checked for counterfeiting to ensure that only authorized materials enter the supply chain. After this quick check, they are directed for inventory or directly to the production line or for return back to suppliers if they are defective. If the RFID tags are read/write type, while they are driven for inventory they are updated with location data and stored in the warehouse. In this case, RFID can provide more accurate real time information about inventory levels reducing transaction errors, processing time and labor, minimizing the inventory inaccuracy problem (Lee Y. et al., 2004).

When raw materials are moved from the warehouse to the production line, the system is updated again in order to control stocks. To the production line encoders write data about each task, monitor the work-in-process and check the quality of the end product. Then, the finished products are stored into pallets in the warehouse and wait to be distributed to the retail stores.

Until now two major benefits for the manufacturer are observed. The first one is the production tracking that enables products to move faster through the production line and minimizes the cost, because the stopping points are removed and production continuity is achieved. Another benefit, just as important, is the increased visibility through the whole supply chain. Moreover, inventory accuracy and generally data accuracy is improved and better management decisions are taken because they depend on real time information.

Since the production is completed, the finished products are packed into pallets and enter the distribution channel. The shipment is recorded again from the distributor for counterfeit and during the distribution the environmental conditions are monitored too. Many times distributors collect different shipments for different destinations and with the use of RFID the mistakes are minimized because product identification is easier. So, the most significant benefits resulting are fewer delays, better shipment handling, controlled environmental conditions and less delivery mistakes.

Finally, shipments arrive to retail stores and readers check the pallets that have just been received for counterfeit protection and the conditions which they were stored during the distribution. The retailer in his turn either stores the products to his storeroom, or places them directly to the shelves. When a customer removes a product from a shelf (called smart shelf), the storeroom is notified so as to control the stock levels, replenish the shelves when necessary and make a new order before a product runs out (Gaukler G.M., Seifert R.W., 2007).

The benefits at this stage are also of great importance and the most remarkable benefit is the customer's satisfaction. In particular, improved in-store experience and better customer service is succeeded in several ways. Smart shelves never run out of products, the waiting time at the check out is reduced because payment is automated and after sales service is improved too since warranty data and sales information are saved. Also, as Tajina M. suggests (2007) reduced stock outs and subsequently reduced lost sales allow retailers pay more attention and invest to other problems, such as store management and new product introduction.

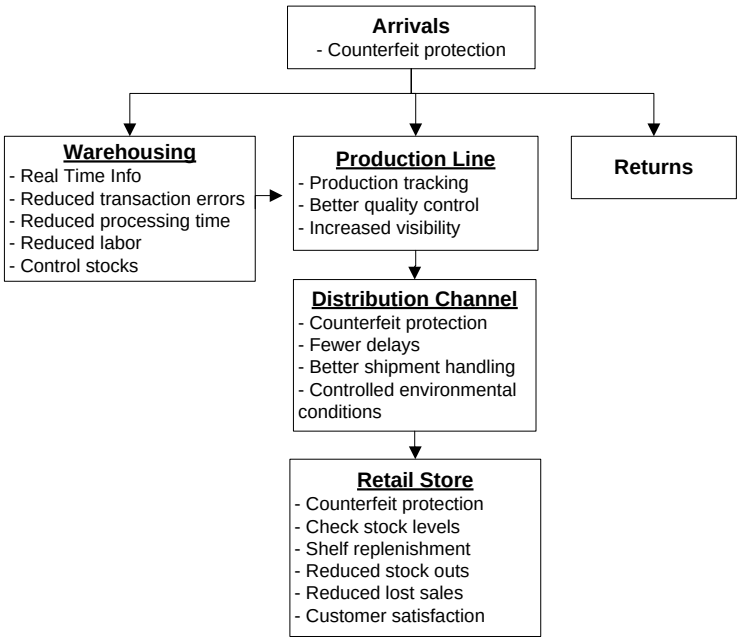


Figure 2 Advantages of the implementation of the RFID at each stage of the supply chain

To summarize, with the use of RFID in the supply chain, all the applications are automated, product flow is uninterrupted and customers find the right products to the right place, at the right time and in the most cost effective manner. So, shop experience is improved, customer needs are satisfied, competitive advantage is gained, profits are increased and consequently everyone benefits.

4.4. Barriers to RFID adoption in the supply chain

There are many challenges and barriers that keep down the evolution of RFID in the supply chain. Huber N. et al. (2007), after a research to industries found that these barriers to adoption are mainly the cost, the lack of awareness and the consumer privacy concerns.

The cost of various RFID components is one of the most significant barriers to its adoption. RFID tags in a supply chain, even used at pallet level or at item level, are the most costly components because they need to be replaced constantly. Also, RFID readers and the backend IT system cost too, but only at the installation phase and then they only require maintenance. Further, it is estimated that when RFID tags reach large implementation and be produced on a larger scale, their production cost will be diminished and their cost will not be considerable.

Simultaneously, there are considerable gaps in the awareness of the RFID technology. This lack of awareness requires information sources to be directed at manufacturers and retailers too (Huber N. et al., 2007). Therefore, it is believed that knowledge about the implementation of the technology, its benefits in the retail supply chain environment and its vulnerabilities should be given from consultants. An effective awareness effort can ensure successful integration of the technology in the supply chain.

Finally, a major barrier to RFID adoption in the supply chain is the consumer privacy concerns that arise and the lack of legal regulations. With the implementation of the RFID in the supply chain, data protection and privacy became one of the major challenges and many concerns about the security and privacy of personal information arose. More details about the technology's effect to privacy and the legal efforts adopted will be discussed in the next chapter.

5. Privacy Risks and Legal Concerns over RFID data collection

As inferred, RFID technology not only has benefits but raises serious legal concerns too, especially for consumers. The fact that the content of RFID tags can be accessible by third parties without the consent of the person who carries it, serious legal problems on privacy are raised. The aim of this chapter is to present the most significant privacy risks and legal concerns that grow with the use of the RFID technology.

According to Kelly E. and Erickson S. (2005), RFID technology threatens consumers through intrusion on their informational privacy. Informational privacy (or data privacy) is the consumer's right to retain control over his personal information. Further, the consumer's right to privacy includes the right to know exactly which of his personal information is collected and be informed about the identity of the data controller (the person who collects and is responsible to keep safe his personal information). The consumer can even demand the removal of the data from the database if they are unverifiable, or the correction if they are inaccurate.

Passive tags can be read from 10 meters distance and this can be limited to 10cm for security, but active tags can be read from 100 meters. Moreover, active tags are used when it is necessary to know anytime the location of the object tagged (Lockton V., Rosenberg R.S., 2005). For example, at the distribution channel, it is important for the distributor to know and locate where the shipments are to succeed better shipment handling. In this case, the privacy risk is the possibility of eavesdropping from competitors.

When RFID tags are used in pallets during manufacturing, warehousing and distribution, not so major privacy issues arise. If the tagging is limited to the pallet

level, then only a few privacy concerns arise because it is unlike to come to the possession of a consumer. The problem starts with item-level tagging where all products are tagged and will still have the tag on them when the consumer purchases them and leaves the store (Kamaledevi B., 2010). Thus, when products with RFID tags are used to retail stores, as barcodes do now, and pass into the hands of the consumer, great privacy concerns arise and it is vital to enforce legal restrictions to protect consumers.

In addition, RFID technology threatens consumers through intrusion on their civil liberties (Kelly E., Erickson S., 2005). In particular, a major privacy concern is the secret surveillance of the consumer that possesses items with RFID tags. If the RFID tag continues to be attached to the products after the purchase, it makes it possible for the retailers to monitor their customers. For example, think of a store that uses item level tagging and has readers at all its exits to prevent theft. If a consumer buys a watch from that store, whenever he enters the store wearing that watch the reader will communicate with its RFID tag and will know when that person visits the store and will even be able to record the products that he purchases every time. In this way, the retailer will be able to record the consumer's habits and activities and create his consumer profile. Furthermore, if the store connects its payment system with the RFID information, then the identity of the RFID holder will no longer be unknown and if the retailers start sharing this information then that person will be exposed.

Consumer tracing and tracking should be avoided taking all the necessary measures no matter what the cost is. Many people believe that only the technological means can protect consumers from privacy threats. However, through the evolution of the information technologies it is proven that technical mechanisms will always be vulnerable to attacks. So, on the one hand technical measures are essential but on the other hand they are not enough to safeguard privacy. A legal framework is necessary too and should be taken into consideration even at the design phase of the technology because as Lockton V. and Rosenberg R.S. suggest, after its adoption it is likely the manufacturer and the retailer to take full advantage of the all the benefits the technology provides, legal or not, in consideration of gaining competitive advantage.

Also, the consumer is vulnerable to theft too. In particular, if thieves are equipped with readers, they will be able to read the contents of the shopping bag or the value of the watch that his possible victim wears. Burglars can benefit too by choosing the house which they are going to break in, based on the content of the home via an RFID reader. In this case, RFID technology threatens consumers through intrusion on their physical privacy (Kelly E., Erickson S., 2005) and the problem will get even bigger if RFID tags are attached to money too.

6. Legal efforts in the USA, in Japan and in EU

This chapter focuses on the legal efforts that are taken in the USA, in Japan and in EU. At first, the most relevant proposed legislation by several US states is presented and then Japan's guidelines for the protection of privacy and EU's principles, summarized from working documents and recommendations, are discussed.

6.1. USA

The first reaction to the implementation of the RFID technology appeared in the USA. There they lack in data protection and therefore American consumers reacted when the RFID technology entered in their personal lives. Efforts have been made in several States, such as California, Georgia, New Jersey, Washington and

New York, to create privacy legislation or make relevant proposals for the right use of the RFID technology.

The first proposed legislation concerning RFID was introduced by California's state senate Debra Bowen. The law required business entities that use the technology, to inform the consumer about its use, obtain his written consent before the collection and process of his personal data and give him the option to destroy or detach the tag before he leaves the store. The last two requirements, the obligation to obtain written consent and the option to detach or destroy the tags, were deleted from a new version of the bill that passed senate.

In 2010, at least 11 states introduced legislation related to RFID. Moreover, some of the most relevant in our case are, in Georgia the House Bill (HB) 16 that prohibits the electronic tracking and monitoring of another person without the consent of the related person, in New Jersey the Assembly Bill (AB) 1732 that requires businesses to notify customers when RFID technology is used and collects information about them, in New York the AB 274 that requires the labeling of retail products or packages that contain RFID tags and the SB 8196 that enacts the RFID Right To Know Act requiring to disclose the use of RFID devices, label all the retail products that contain RFID tags, set standards for labels, set points of sale removal of RFID tags and restrict aggregation and disclosure of personal information.

Finally, in Washington State, Representative Jeff Morris introduced the House Bills 1006 and 1011. The aim of these bills is to inform consumers that the RFID technology is in use and that they can decide whether they want to possess a product with an RFID tag or not. In particular, HB 1006 requires a government or business entity that sells RFID-tagged products must label them, unless the tags are disabled, deactivated, or removed at the point of sale. The label must be universally recognizable by the public and clearly indicate that the RFID technology is used and the particular products are tagged.

The second bill HB 1011, which was introduced in 2009, prohibits governmental or business entities from reading an RFID tag that is possessed by a consumer, without first obtaining his opt-in consent. The opt-in consent must be either in writing or electronically and the government or the business entity must disclose that by consenting he agrees to let the governmental or business entity collect, use, or retain data gathered for any purpose. Also, the bill states that opt-in consent is not required in cases such as health or safety reasons, triage or medical care during a disaster, incarceration and court order. For more information about privacy legislation related to RFID from 2004 until now, you can visit National Conference of State Legislatures (http://www.ncsl.org/default.aspx?tabid=21255).

To conclude, American consumers created a group in 1999 called Consumers Against Supermarket Privacy Invasion and Numbering (CASPIAN). Now, this group focuses on the use of the RFID chips from the supermarkets and its aim is to educate consumers about the vulnerabilities and the privacy risks that arise from its use and encourage privacy-conscious shopping habits (http://www.nocards.org/). CASPIAN proposed the RFID Right to Know Act of 2003 according to which business entities should use labels on products that contain RFID tags to state that the tag can transmit information to a reader both before and after purchase. They also suggested that those labels should be in a conspicuous type-size and prominent location and in print that contrasts with the background against which it appears.

6.2. Japan

In Japan, in 2004, the Ministry of Public Management, Home Affairs, Posts and Telecommunications (MPT) and the Ministry of Economy, Trade and Industry (METI) issued the "Guidelines for the Protection of Privacy with Regard to RFID Tags". The objectives of the guidelines are to protect the consumer privacy while encouraging the use of RFID tags. According to these guidelines and as Natsui T. (2006) explains, the consumer must be informed about the presence of RFID tags, their location, their nature and the information that they record. The consumer has also the right to choose if he wants to make the tag unreadable after he purchases the product and the business entity has the right to try to persuade him not to destroy the tag, by explaining to him what the benefits of its use are. Furthermore, business entities that use RFID tags must inform consumers about their uses, their benefits and their disadvantages, so as to maximize consumer awareness and succeed the technology's healthy development.

6.3. European Union

As Murakami Y. (2004) states, unlike Japanese people, Europeans have high privacy consciousness. The European Union is studying privacy and data protection principles related to the RFID technology. In January 2005, the EU's Article 29 Data Protection Working Party published a Working Document (WP 105) on data protection issues related to RFID technology where the advantages offered by the RFID technology and the privacy concerns are presented. Further, the importance of the implementation of the basic principles set out in the EU Data Protection Directive and the Directive on privacy and electronic communications are highlighted and the technical characteristics of the technology, its multiple uses in many sectors and the privacy implications are presented. Finally, guidelines for legal processing and data security are suggested.

In 2006, Viviane Reding, the European Commissioner for Information Society and Media, launched a public debate on RFID and in 2007 a communication from the commission to the European parliament, the council, the European economic and social committee and the committee of the region summarized the importance of a European RFID policy and its further development.

Later, on May 12th 2009, the European Commission issued a recommendation on the implementation of privacy and data protection principles in applications supported by RFID. This recommendation invited Member States to ensure that the industry develops a framework for privacy and data protection impact assessment and provides guidance on the design and operation of RFID applications in a lawful, ethical and socially and politically accepted way. Moreover, guidance about data protection impact assessments, information security, transparency on RFID use and awareness raising actions are also suggested.

In particular, the Commission recommends the Member States to ensure that RFID operators conduct privacy and data protection impact assessment before an RFID application is deployed, assign a person to review it and make its results available to the competent authority. They should also ensure that they take measures to raise awareness, provide examples of good practise, ensure the development of an easy to understand information policy, determine whether RFID tags placed on products represent a likely threat to privacy and if so deactivation and removal at the point of sale should be done immediately without charge.

On March 31st 2010, a privacy and data Protection Impact Assessment (PIA) Framework for RFID applications was proposed by an informal RFID workgroup led

by industry representatives, based on the Commission's Recommendation. According to them, the proposed PIA Framework would help the adopters of the RFID technology to establish and maintain compliance with privacy and data protection laws and to provide its benefits while integrating privacy by design at the early stages of the development.

On July 13th 2010, the EU's Article 29 Data Protection Working Party published an opinion in response to the proposed PIA Framework (Opinion 5/2010, WP 175). The Working Party concluded that the proposed PIA Framework wasn't fully accepted in its current form and should be improved. Specifically, it states that the proposed PIA Framework doesn't make it clear to the RFID adopters how to assess privacy issues and establish compliance with data protection laws and it doesn't explicitly address the tag deactivation principles. Also, it recommends that the PIA Framework should also give guidance to the adopters to decide when is the most appropriate time and conditions to conduct a PIA. So, the Working Party concluded that the industry should propose an improved PIA Framework taking into account all its comments.

Later the same month, the European Network and Information Security Agency (ENISA) published an opinion with practical recommendations to improve the proposed PIA Framework. And as a consequence, on January 12th 2011, the industry proposed a revised PIA Framework, taking into account all the recommendations and comments provided both by the Working Party and ENISA.

The revised PIA Framework addresses the process for conducting PIAs of RFID applications before deployment and separately for each RFID application they operate, and specifies the scope of resulting PIA Reports, as the European Commission recommended. In addition, because many RFID application operators within particular sectors may be considering similar applications, this framework provides a basis for the development of PIA Templates so as to produce PIA Reports more efficiently.

On February 11th 2011, the EU's Article 29 Data Protection Working Party published an opinion in response to the revised PIA Framework (Opinion 9/2011, WP 180). This time the Working Party suggests that the revised Framework not only addresses the most concerns, but also presents stronger guidelines for the RFID operators who will implement this PIA Framework. Also, the Framework clearly claims RFID operators to evaluate the risks that may arise when the tags may be used (or misused) by third parties and especially in the retail sector when they are carried by consumers. Thus, the Working Party accepted and endorsed this revised PIA Framework and suggested to translate the PIA reports in other languages too, since some RFID Applications will be implemented in several Member States.

7. Conclusions and Legal Proposals

Considering all the above it is concluded that a legal framework is vital to limit the way the RFID technology is used by government and business entities. Especially with the implementation of the RFID in the supply chain, data protection and privacy became two of the major challenges. The technological means are necessary and should be implemented in respect of privacy and regulation, but cannot protect the consumers enough. Serious privacy risks are posed when the technology is used and legal regulation should be considered even at the design phase of the technology.

In EU several attempts have been made to create guidelines and data protection principles related to the implementation of the RFID technology so as to be

generally accepted and adopted by all Member States. The first attempt was in 2005 when the EU's Article 29 Data Protection Working Party published a Working Document on data protection issues related to RFID technology. And the last attempt until today was on January 12th 2011, when a privacy and data Protection Impact Assessment Framework for RFID applications was proposed and the Working Party endorsed it a month later.

At the same time, it is observed that the most common policies that are accepted by many US states are the prohibition of the tracking and monitoring of another person without his consent and the labeling of retail products that contain RFID tags. Also, the notification that clearly indicates that the RFID technology is used and collects information and that the particular products are tagged is required and the choice to remove the RFID tag after the purchase of a tagged product is given.

However, because until now each US state, and generally each country, has its own legislation and principles or no legislation at all, problems can be caused with imports and exports. So, it is suggested to create and enforce laws nationally and when products containing RFID tags are exported to other states or countries the consumers will still be protected.

Also, it is recommended to apply the Personal Data Protection Law whenever the RFID technology is implemented to an application anywhere in the world. The basic principles that settle the collection and use of personal information and assure adequate privacy protection should be implemented and adjusted to the technology's special features (Alexandropoulou E., Mavridis I., 2007). In particular, the purpose of the collection must be disclosed and data should be used only for the purpose stated. In the case the business entity wants to use them for other purposes, it must first obtain the data subject's consent. Furthermore, the business entity who stores and processes personal information is responsible to keep them accurate and up to date, inform a person about the information collected that concerns him and save them in a safe place.

To sum up, with the evolution of the RFID technology and its intrusion to our personal lives, a new era began where the technology outstripped the existing law. The existing law doesn't protect the consumer enough and changes or additions should be made. Further, it is important the new principles and bills to be carefully established so as not to hamper the evolution of this promising technology. They must facilitate the positive uses of the technology while protecting consumer privacy.

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