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SE 4.3 Technologies deployed to improve visibility and operational risk management within supply chains

SE4.3.1	Overview of automated identification technologies – advantages and selection criteria
SE4.3.2	**Drivers for the deployment of RFID (technological and cost advancements)**
SE4.3.3	Sensor technology combined RFID to monitor shipments and transport units
SE4.3.4	Practical examples and experiences of visibility systems deployments.

Summary

The study analyses key drivers for the deployment of RFID, including technology and software developments, costs and benefits in the supply chain such as increased visibility and transparency demands. Retailing is at the moment a key development environment for testing and implementing RFID automated identification. Technology push and hype, as well as market pull will be discussed.

With real-time information, combined with planning information organizations can improve the efficiency of their logistics processes, lower their operational costs and improve their portfolio of logistics services. The greatest benefits of RFID identification are the real time tracking and tracing of goods which means better visibility and automation and improvement of processes.

Drivers for the deployment of RFID (technological and cost advancements)

Contents

1. Objectives

The study analyses key drivers for the deployment of RFID, including technology and software developments, costs and benefits in the supply chain such as increased visibility and transparency demands. So far RFID has mainly been applied in closed and in-house systems, such as car production. However, requirements from especially big retail companies are forcing suppliers and supply chain parties to introduce RFID. Retailing is at the moment a key development environment for testing and implementing RFID automated identification. Technology push and hype, as well as market pull will be discussed.

2. Target stakeholders

Technologies for improved visibility and risk management are of interest to all operative stakeholders in the supply chain:

- D2D Service Providers**,** which include ship operators, freight forwarders, logistics providers and Motorways of the Sea (MoS) operators
- Exporters & Importers (shippers)
- European ports, national port bodies and especially small-to-medium ports

Also related organisations have interest on the topic:
- Research organisations, Systems Developers and
- The large number of specialised companies that support the Maritime and Logistics industry; this includes bankers, financiers, designers, builders, providers of Single Window (SW), Port Community Systems (PCS) and Cargo Community Systems (CCS
- The European Commission and national transport ministries

3. Glossary terms

Visibility: The ability to access or view pertinent data or information as it relates to logistics and the supply chain, regardless of the point in the chain where the data exists.[1]

[1] CSCMP: Terms and Glossary, March 2009.

4. Approach / methodology

This paper bases on current literature and performed RFID technology projects and implementations

5. Specific issues and topics to be addressed

5.1 ICT architectures and RFID

RFID technology facilitates a long range of data services within the supply chain, including identification, positioning, authentification and status. However, such services not only depend on deploying the RFID technology itself, but also implementing systems that can facilitate data exchange and processing among the relevant stakeholders. In the following we will describe concepts for architectures for such systems.

Several freight transport telematics architectures have been developed, e.g.European ITS Framework Architecture KAREN, the National ITS Architecture in USA, Norwegian ARKTRANS, Finnish TARKKI, Freightwise and Moses.

TARKKI describes open interfaces between the actors without binding them to specific technologies and without intervening in the internal systems of companies. The viewpoint of the TARKKI architecture is the freight and related information flowing through the logistics chain from sender to receiver. The architecture focuses on the processes that are directly related to the transport of goods and on the information flows of these processes. The architecture contains role definitions for the sender, the receiver, the logistics service providers and the public administration. The described process areas of the freight transport are planning, management and control, supply chain operations, and tracking and tracing. The information flows comprise management data, track and trace data and other data related to the goods order, transport agreement, transport order, dispatch note and load specification (***Figure 1***).

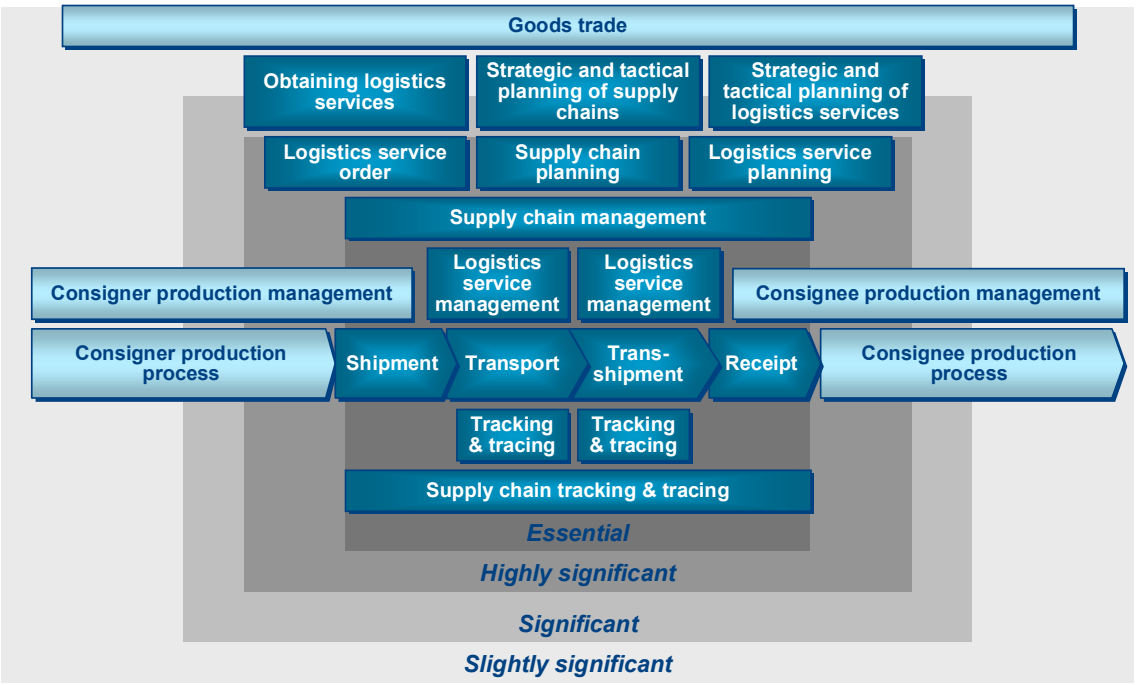

Figure 1: Different processes in supply chain management (Source TARKKI).

When the objectives defined in the freight transport telematics architecture have been reached:

- Real-time information about the location, contents and conditions of identified shipments, goods items, parcels and transport vehicles can be collected in a controlled manner.
- The collected information can be combined with planning information and refined appropriately to be used during various parts of the process and distributed efficiently and timely to actors.
- By collecting, refining and distributing information efficiently organizations can improve the efficiency of their goods transport logistics processes, lower their operational costs and improve their portfolio of logistics services.

RFID is an enabling technology for supply chain visibility as defined in TARKKI vision. The following drivers help the implementation of RFID through the whole supply chain:

- "Power shifts within the supply chain". During the last decades the decision making has been moved towards the end of the supply chain. Big players such as Wal-Mart, Department of Defence is US and Metro have started to demand IT improvements in the supply chains.
- "Supply chain inversion" - the logistics systems control is changing from push to pull
- Pressure to decrease inventory levels
- Increasing legislation and directives, such as identification and tracking of the origin of a product, e.g. tracking of food from the individual farms or even animals
- Pressure to decrease logistics costs, e.g. pressure to automate operations

- Demand for visibility through the supply chain and communication needed for that
- Reduction of shrinkage (stealing, minimising losses).

Based on the implementation plans from Wal-Mart, Metro and the US Department of Defence, a following timetable for the implementation of RFID can be expected:

- Ongoing: use of RFID in closed systems, due to the lack of standardised and interoperable systems. Most implementations use inductive technologies.
- 2005 onwards: use of RFID on transport unit (pallet) level in open systems, based on ePC approach, under impulse of the big retail chains.
- Future: use of RFID also on other than ePC architectures and also on product packages. If the price of tags decreases significantly, under 5 cents, the retail chains will demand to put tags on single items. Also the price of readers has to decrease considerably (under 100 €), and readers could be embedded in e.g. mobile phones.

5.2 Vision (Source RFID Roadmap)

In 2015 supply chain partners receive and use necessary real time information. RFID is the technology which makes this vision possible. RFID is integrated in the supply chain processes and phases. RFID is widely used in the management and control of transport units, items and packages of trade and industry. RFID is used e.g. in the following applications:

- Transport units and items
- Packages
- Some individual products (valuable goods, medicines, clothing)
- Authentication
- Access control
- Data gathering applications.

The objective of an automated identification system is that all information needed (in tags) on a transport unit are read without stopping. The technology should also be capable to individualize the tags and read them from short distance.

NFC (Near Field Communication), a technology related to RFID, will be integrated in mobile phones and will be widely used in electronic payments and data collection applications. In addition to logistics and electronic payments, life cycle applications (e.g. maintenance, recycling) of products are an important application.

The vision for different identification levels is the following:

Transport

- All transport units and vehicles can be identified automatically. All vehicles are equipped with tags.
- Tracking and tracing as well as incident management of vehicles and valuable goods is in use (satellite positioning, different terminals etc.)
- Agile transport control is in use

- Electronic transport documents are in use. These support the use of RFID identification.

Transport items / units

- Major RFID solutions of industry and trade are in use
- Other types of applications are also in use (in case RFID do not fit e.g. bulk, metal, liquid etc.)
- Standards and codes exist and are in use
- Information system integration exists

Products

- On product level valuable goods, certain food products, clothes, electronics, dangerous goods are equipped with tags
- The price of a tag is under 5c

Personnel

- RFID is in wide use in access control

Improved capacity of computers and networks and ubiquitous sensing contribute to the implementation of applications. Also short range wireless communication and integration of systems improve the use of new applications and services.

An International study from Aberdeen Group in April/May 2006 gave parallel results. During the next few years, RFID will transition from a technology affecting the edges of a company's operations to one that permeates processes and workflow across an organization.

5.3 Benefits of RFID automated identification

The most important question is how to obtain Return On Investment (ROI) in RFID implementation. The benefits do not come only from the automated identification. RFID is an enabler for other features such as real time information of goods flows and inventories. This helps companies in the supply chains to improve their processes and here the real big economic benefits are.

The greatest benefits of RFID identification are the real time tracking and tracing of goods which means better visibility and automation and improvement of own processes. (***Figure 2***). Why RFID identification and tracking is needed:

- No visual connection is needed and several items can be identified at time
- Automation degree can be improved and manual working phases reduced
- Tags withstand environmental circumstances better than bar code; e.g. dust and wear
- The identification process is reliable
- It is possible to include more information compared to bar codes, when needed
- Fraud can be prevented or made more difficult
- Shrinking can be reduced
- Quicker action at recalls even on individual product level
- The follow-up of inbound and outbound logistics becomes easier
- Productivity increases (ROI)

Retail goods are the most difficult targets for RFID identification as the product assortment is very broad. The use of bar codes in retail sector started in the seventies. According to the report, product RFID based identification does not become common within short timeframe. Certain EU directive on food tracking requires already now product specific marking. The information content of tags is still open for different branches and different types of supply chains.

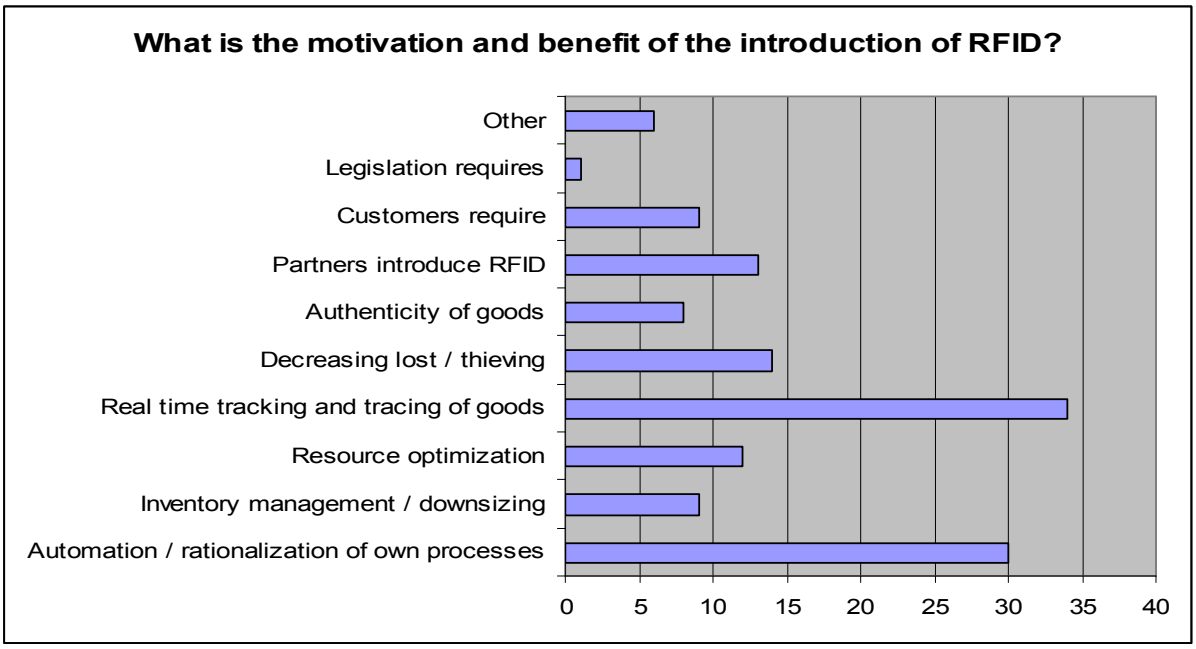

Figure 2. Results from Internet survey (n= 49) (Source RFID-Roadmap)

At the moment the largest interest is in the transport item or unit identification and tracking. When prices come down and the technologies develop the identification of a single product becomes possible.**Error! Reference source not found.** A tag, attached to a product label adds intelligence to the product and this can be utilised both in supply chains and in product life cycle monitoring. Other possible applications are:

- Production control
- Vehicle tracking and tracing
- Consumer information.

In the supply chain the identification can be done on different levels (vehicle, freight container, transport item/unit, SKU, product package). Identification systems should be built on hierarchical levels so that always the highest level will be identified, e.g. vehicle. Information on lower levels, such as pallets and packages, can then be found from information systems.

Pålsson has reviewed academic literature regarding RFID technology on a broad basis, in logistics and related fields, to analyse findings which impact on logistics or supply

chain management. Most popular areas have been track and trace, RFID vs barcode and inventory management efficiency.

5.4 Vehicle and freight container tracking

The use of active RFID for vehicles and freight containers in multimodal chains has been investigated and piloted in many projects. This topic is dealt in more detail in SE 434 Case Studies

In a Finnish pilot project dealing with containers, road vehicles and railway wagons, different commercial active RFID products, which use the 2.45 GHz, 868 Mhz and 5.8 GHz frequencies were tested. All tested systems worked well. Two systems, using the 868 MHz and 5.8 GHz frequency, were installed in a Finnish harbour. The piloted RFID techniques worked almost faultlessly in the pilot in the winter of 1999. (source Trackideff)

Rail operator VR Cargo has piloted passive UHF technology in 2007 for rail freight. The pilot consisted three automatic reading points and 350 wagons with 9-month test period. Pilot scheme covered the number of events, data transfer to the server, the raw data processing and report generator. The system gave direction of the train and wagons, wagon ID, order and time stamp. The system was based on EPCglobal Gen2 / ISO 18000-6C standard. This pilot showed that passive UHF technology is well suited for train and wagon recognition. Sensor information is needed in addition to the identification information for different purposes. In addition, the use of handheld terminals provides more opportunities for manual labour reduction.

Suitability of passive RFID technology to road vehicles was investigated in a Finnish case study. The objective was to test how read operation succeeds in real highway environment. Typical problems that arise in transport applications are caused by different vehicle speeds, varying reading distances, weather conditions and location of tags and readers. The aim was to test both 1) identification of bypassing vehicle from the roadside and 2) identification of a tag installed inside road structure. Technical goal was to see how standard equipment (not specifically designed for high speed applications or long distances) performs in a field experiment. Firstly the location of the tag in vehicle was chosen. The reader was able to read a tag installed in vehicle's plastic bumper from a distance over 2 meters using 0.5 W power. This location suits well for reading from the roadside. For portal applications it is better to install the tag behind windscreen. Secondly the tests were done using a moving car. The tags could be read up to speeds of 100 km/h, though only with distances of less than 1 meter.

5.5 Development phases in the use of RFID in logistics

RFID is not introduced overnight. Small steps are needed, for example start up with the big suppliers and afterwards a first implementation phase with the next group. In Roadmap study 2006 over half of the respondents supposed that RFID will become

common in identification of returnable transport items within two years and about one third in identification of transport unit in within 3-5 years. Also tags in product packages will become more common but in each product the tag will come earliest after 6 years (2013->). Within 5 years over one half of the big actors will demand tags. At the moment, the largest interest lies with the returnable transport item or transport unit tracking (**Figure 3**). As we know, the development has been much slower as predicted in this or many other studies.

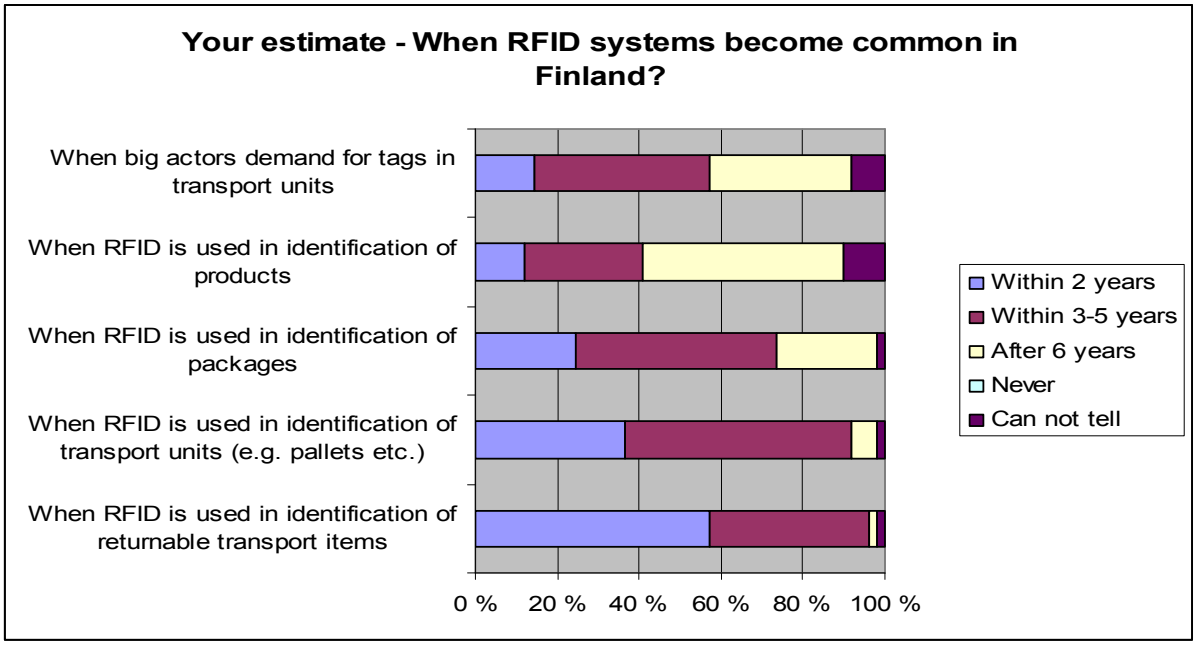

Figure 3. Results from Internet survey (n= 49)

Doubts about the maturity of technology and standards are the biggest concerns at the moment. Also costs and benefits which can not be verified slow down the implementation in logistics applications.
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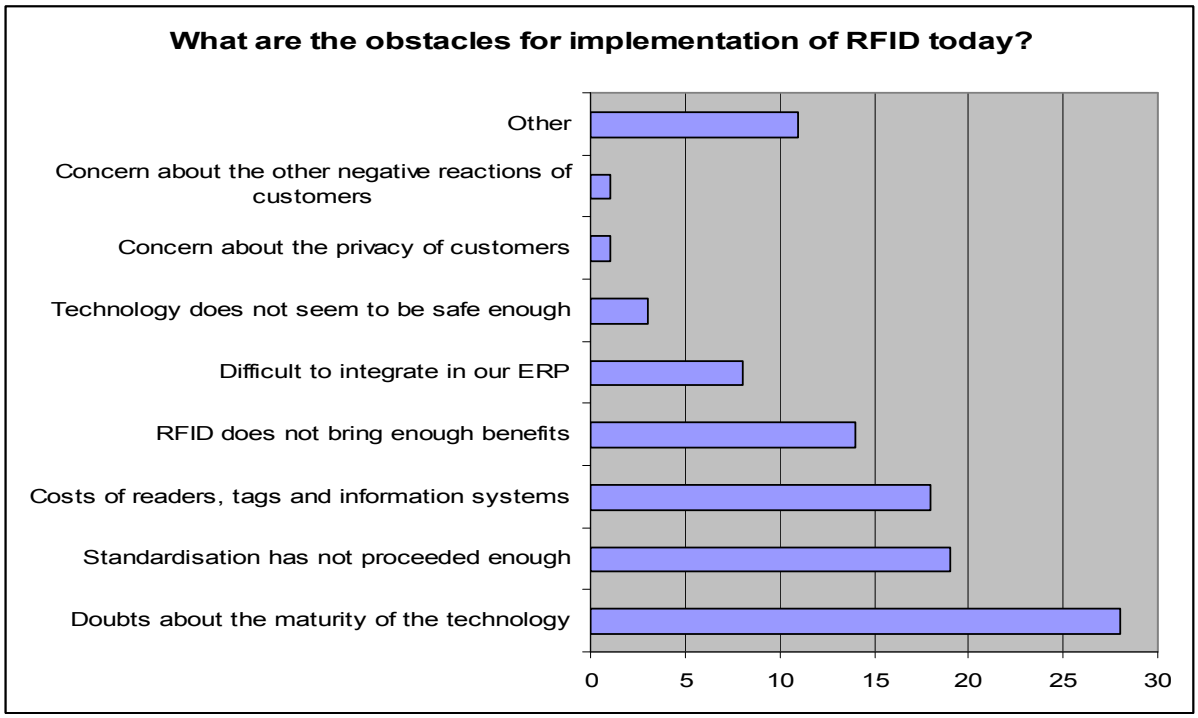

Figure 4) The experts have the opposite opinion: according them technology and standards are ready enough for implementations, but this message has not yet been assimilated by possible users. The introduction of RFID technology is expected to start from the side of retail but a better target could be e.g. technical wholesale. The study from Aberdeen Group**Error! Reference source not found.** indicates that Consumer Packaged Goods, consumer electronics, health-care, pharmaceutical, aerospace and defence and high-tech industries will be the first adapters.

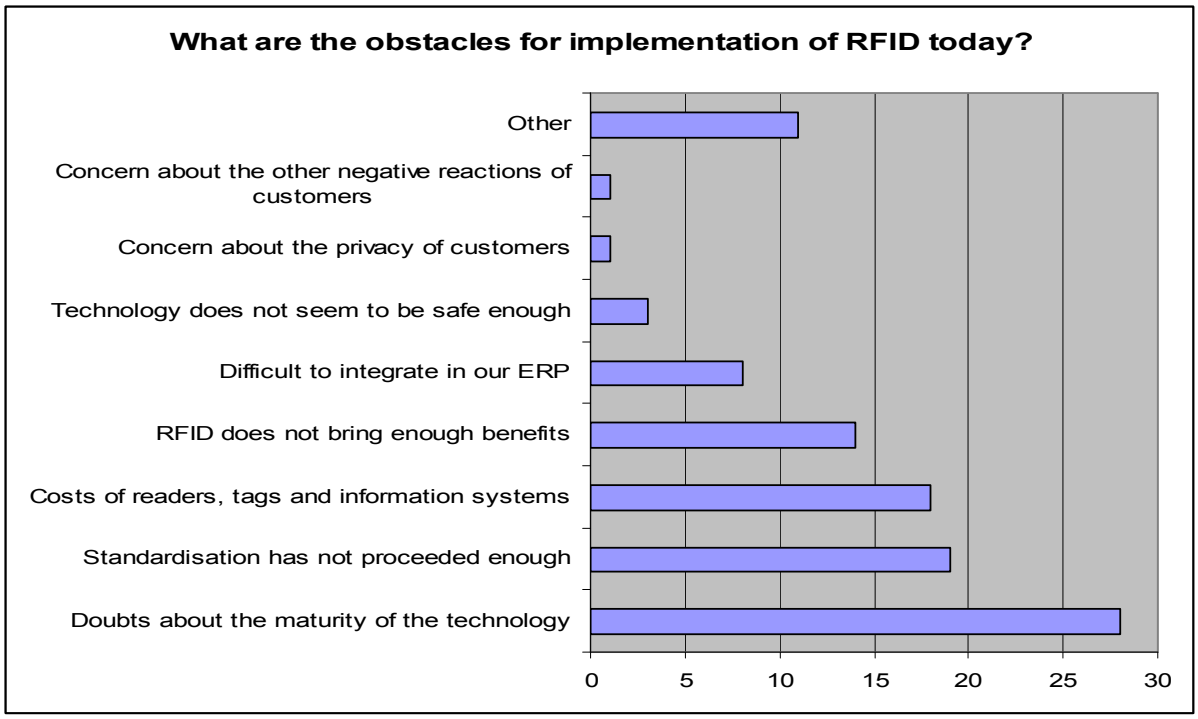

Figure 4. Results from Internet survey (n= 49)

The company management has the key role in investment decisions and implementation. The benefits and ROI should be justified to them. In any case there will become more closed systems. Companies should put effort in wider and open logistics applications and multi actor supply chains.

In 2004 large organisations, like Wal-Mart, US Department of Defence, Metro have published specifications for the use of RFID on transport and logistic units. Metro started to pilot the technology in November 2004 and Wal-Mart in January 2005. The first reports from these pilots reported 99% reading range for pallets, using disposable tags placed on shrink wrappings.

The research was performed in 2006. However, tagging of pallets and cases has not achived the volume expected at the moment of research: only 225 million passive UHF tags were used for this application in 2009, which is only a small increase with the volume of 200 million for this application in 2006 and far less than the 1 billion tags, which was the estimate for 2009 in early 2007[2]. The main reasons have been technical failures (poor read rates with high moisture content and metal products), lack of infrastructure and lack of mutuality of benefit between retailers and the rest of the supply chain. Work is still preserving however.

(IdTechEx, RFID Market Forecasts 2009-2019,
http://www.idtechex.com/research/articles/rfid_market_forecasts_2009_2019_00001377.asp

5.6 Best practices in the implementation of RFID projects

Rush Tracking Systems (www.rushtrackingsystems.com) has made a list of 6 best practices for RFID deployment[3]:

1) Identify and quantify the business value of RFID.
Focus on specific use cases where real-time visibility provides tangible cost savings, such as inventory and costly errors. Keep a broad perspective across the value chain to identify additional value add use cases to leverage the "network benefit" of RFID. The greater the number of touch points for each tagged asset, the stronger the business case for RFID.

2) Assess the processes impacted by RFID.
What is the effect of low-cost, real-time accurate visibility onto the stakeholders, assets, and processes? What are the opportunities to improve productivity, quality, throughput, and overall value? Identify which non-value-added process steps could be simplified or eliminated, and document current and desired process flows. When resources are

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[2] http://www.dcvelocity.com/viewpoints/?article_id=715

[3] http://www.rushtrackingsystems.com/news.asp?ID=29

constrained, it is time to rethink legacy processes and focus on delivering value to customers.

3) Establish an enterprise roadmap and prioritize individual projects based on risk, cost, and value.
The enterprise vision establishes what direction you will take the organization; however, once the strategy is in place, it needs to be broken down into smaller, more manageable steps. Ideally, each step would stand alone and deliver cost savings and valuable knowledge about technology, business process and captured benefits to justify additional steps towards your strategic goal.

4) Deploy responsibly with clear goals.
Be honest about defining the expected outcome for each step of the project. Most likely, there is a need to balance the challenges and benefits of creating, enhancing, or eliminating current processes with introducing new technology, when assessing the true financial impact of the investment.

5) Assess and communicate the value delivered to the business.
At the beginning of each project, determine how to measure benefits and communicate results with others. It is important to evaluate the impact of a pilot project, how results will be measured, and how the costs and benefits will be extrapolated to the rest of the business, to ensure that enterprise cost savings can be realized across multiple product lines, plants, and business divisions. Capturing organizational benefits cleanly from the outset and stating assumptions up front will enable to correlate and integrate measurable results each step of the way.

6) Iterate the plan based on learnings.
It is important to evolve the project plan based on incremental learning. Reassessing which processes are positively impacted by RFID, adjusting scope and prioritizing the value of use cases is a key element of unlocking the true value of RFID.

5.7 Security issues related to RFID (tag cloning, identity theft)

In the most simple case a tag contains only an identity number, and the related information is in the central database. Security issues have to be taken into account when other data than the tag ID is included. For instance the Gen 2 standard specifies that fields can be either (temporarily) locked or permanently locked, by means of a password, which is stored in the tag memory. Data is usually sent without encryption. Encryption can be added, but this has a trade-off for reading distance. Possible security risks are:

- ”sniffing”: reading of information without the owner’s consent (e.g. a third party can identify the shipment)
- ”spoofing” and cloning: by writing information to an empty tag, a tag can be cloned. For instance a basic EPC Gen 2 has no unique tag ID, and the data can be programmed to another tag.

- ”relay attacks”: device, which receives the information from tags and uses this information later to emulate or track tags.
- ”jamming” and ”denial of service”: the radio communication between tag and reader can be disturbed or prohibited by transmitting disturbing signals
- hacking of tag passwords and encryption algorithms. EPC Gen 2 include “access” and “kill” tags, which give a basic security to the tags, but which pose a risk. The security algorithms can be cracked and this information can be used for fraud. For instance, the Mifare Classic security algorithm has been cracked in 2008 and published, making the millions of Mifare Classic tags in use for payment or access control vulnerable to fraud. Smart cards with higher security have been brought on the market (e.g. Mifare Plus).
- hacking of readers. When readers are connected to the internet, fraud is possible by getting access to the information read by the reader.

6. Conclusions

RFID is an enabling technology for supply chain visibility. Real-time information about the location, contents and conditions of identified shipments, goods items, parcels and transport vehicles can be collected in a controlled manner. The collected information can be combined with planning information. By collecting, refining and distributing information efficiently organizations can improve the efficiency of their goods transport logistics processes, lower their operational costs and improve their portfolio of logistics services.

RFID is not introduced overnight. Small steps are needed. Technology and standards are ready enough for implementations.

7. References

EU projects EURIDICE, SMART-CM, INTEGRITY, eSEAL
Business cases like Metro, Wal-Mart
Farmaceutical (ePedigree), Electronics, US DoD.
Active RFID: Cases Controlmatic, Bioett, Identec, ITAIDE project
ZIGBEE applications
TARKKI
RFID Roadmap
Aberdeen
Pålsson
Trackidef
Road pilot
(IdTechEx, RFID Market Forecasts 2009-2019,
http://www.idtechex.com/research/articles/rfid_market_forecasts_2009_2019_00001377.asp
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