Master Thesis
ISRN LUTMDN/TMKT 13/5102 SE

Exploring RFID technology adoption in Spanish oranges suppliers that handle RFID-tagged pallets

Miguel Carreño Asúa

Department of Packaging Logistics
Faculty of Engineering LTH • Lund University • 2013

LUND UNIVERSITY

Exploring RFID technology adoption in Spanish oranges suppliers that handle RFID-tagged pallets

Miguel Carreño Asúa

Division of Packaging Logistics

Faculty of Engineering LTH • Lund University • 2013

Author: Miguel Carreño

Supervisors: Daniel Helström (LTH), Jose Angel Gonzalez (UPM)

Division of Packaging Logistics

Faculty of Engineering LTH, Lund University
P.O. Box 118
SE-221 00 Lund
Sweden

ISRN LUTMDN/TMKT 13/5102 SE

Preface

This Master Thesis was conducted at the Division of Packaging Logistics, Faculty of Engineering of Lund University.

I would like to thank my supervisor, Daniel Hellström for proposing this thesis to me as well as for his support and for sharing his knowledge for RFID implementations. I would also like to thank Marianne Modalen from Svenska Retursystem for giving me the Spanish supplier contacts and for helping me along this period. Special thanks also given to Felix and Nacho from Llomabart and Anecoop for preparing my visits to the Spanish plants, and to the oranges producers Rural Sant Vicent Ferrer, Ripoll & CIA and Cheste Agraria Cooperativa that belongs to Anecoop group for bringing me the opportunity to get in contact with them with the aim of carrying out my project.

And of course I would like to thank my parents Miguel and Cristina for their constant support both in my education and in my life.

Lund, May 2013

Miguel Carreño Asúa

Abstract

Author

Miguel Carreño Asúa

Purpose

The purpose is to explore a potential adoption of RFID technology in Spanish oranges producers´ outbound flow of the grey RFID-tagged plastic pallets that are delivered to Swedish wholesalers. The exploration will be focus on aspects regarding RFID technology, like level of knowledge and awareness, the willingness to invest on it, the attitude of the companies regarding the adoption, the technological competence and the financial situation needed for adopting this process innovation within their plants.

Design/Methodology/Approach

Exploratory case study was the methodology selected for this thesis. On the one hand, this was done by studying and reviewing literature concerning RFID adoption and implementations. One the other hand, several visits to Spanish oranges producers were performed in order to collect data and to analyze the particular situation of each company.

Findings

This thesis uses existing theory and research to explore a potential adoption of RFID in Spanish oranges supplier's plants that export to Sweden using RFID-tagged pallets. The thesis also provides insights about challenges and opportunities for those companies by the exploration of technological, economic and organizational aspects that could impact on the potential adoption.

Limitations

There are several factors to think of when RFID adoption explorations are made. Thus, it is not possible to make in-depth studies of all relevant factors that affect these adoptions within the scope of this master thesis. Despite there are several supply chain actors that will take place in this work, only the Spanish producers and the exploration of RFID in those plants are within the scope of this 6-months study.

Practical implications

For companies and logistics researchers dealing with technology innovations such RFID adoptions, this thesis will provide insights, reflection and inspiration for further studies.

Keywords

RFID Adoptions, Returnable Transport Items, Packaging Logistics, Case Study, Process Innovation.

Executive summary

This master thesis has been conducted aiming to explore a potential adoption of RFID technology in Spanish oranges producers that export to Swedish wholesalers using RFID-tagged pallets. The adoption process was mainly focused on the outbound flow of those suppliers.

RFID is the generic name for technologies that use radio waves to transfer data between a reader and a tag attached to an item to be identified. RFID offers identification beyond the line of sight and the possibility of increasing the level of automation or improving areas such an inventories. This technology can be considered to be a good alternative to bar codes since a RFID tag doesn't require a line-of sight to be read and several tags can be read simultaneously. These features of RFID technology promise to impact positively in the operational processes of their users (i.e. reducing labor cost and time consuming, increase reading accuracy). Data captured by RFID readings can be stored in companies data bases and managed with traceability purposes.

Traceability is the ability to verify the history, location, or application of an item by means of documented recorded identification. As in many other industries, traceability is extremely important in agro-food sector where producers are forced by law to trace fruit from the crop to the shipping process prior fruits leave their plants. The most common way to trace fruits consists in putting a bar code label that contains information about the product on the pallets. In Spanish oranges producers' plants (Rural Sant Vicent Ferrer, Ripoll & CIA and Cheste Agraria Cooperativa (Anecoop)), information is collected at every step of the production process: growth, picking and reception, cooling, dumping, packaging, palletizing and labeling and loading. Since traceability is a need for those producers, radio frequency identification (RFID) can potentially help spanish producers in their daily traceability processes.

Apart from internal operational benefits, RFID offers the opportunity to exchange real time information to supply chain partners through special networks (i.e. GS1 EPCglobal Network for RFID) specially designed for this technology. As a result of it, better visibility on asset flow can be achieved giviving supply chain partners that use RFID the means to carry out their work with ease and efficiency. Other supply chain actors have also been analyzed in this study of a potential RFID adoption in Spanish oranges exporters' outbound flow. These companies are Svenska Retursystem (SRS) that sends empty RFID-tagged plastic pallets to Spanish oranges producers, where pallets are filled up and then delivered to Swedish wholesalers (ICA and Nowaste Logistics AB). Both SRS and the Swedish wholesaler Nowaste Logistics AB have already implemented RFID in their plants and partly take advantages of the benefits that this technology offers to their users. Moreover, Nowaste Logistics will infuse the RFID system to the inbound flow, requiring future collaboration in RFID initiatives with their suppliers.

Despite the potentials of this technology in supply chains, many firms don´t know about the existance of RFID or prevail reluctant to adopt it. The last can be explained by the fact that even though RFID brings opportunities to their applicants, there is still having several challenges associated to the adoption of this technology. In order to dig deeper into the potential opportunities and challenges of the adoption, exploratory case studies was the methodology selected. The exploration was focused on several factors regarding RFID technology adoption in those plants. These factors were assessed for each company by utilizing an analysis framework proposed by the author. This framework consists in the questions stated below, where answers of the company are also included:

-*Do Spanish Suppliers know that they handle RFID-tagged pallets?*

-*What is the level of knowledge about RFID technology of the Spanish Suppliers?*

-*What is the level of awareness about RFID technology of the Spanish Suppliers?*

-*What is their willingness in investing on this technology?*

-*What is their attitude regarding the RFID adoption?*

-*What are the technological, organizational and economic factors that will potentially impact on a RFID adoption in those plants?*

From the results of the RFID adoption explorations, it can be concluded that level of knowledge and awareness, especially regarding supply chain RFID opportunities, were really scarce. There was also a relationship between the level of knowledge and the level of awareness of those companies; the more knowledge about RFID, the more aware the company was. Another result is that willingness to invest and the attitude of the companies towards the adoption are closely related to its economic situation and thus to the capacity to invest on it. Nevertheless, Swedish clients are very important for all the companies interviewed and they will always try to satisfy their needs. So they will be open to talk to SRS and Nowaste Logistics (only Anecoop) and then to consider this opportunity for future collaborations.

Main results considering technological, organizational and economic aspects that will impact the adoption can be summarized as follows: technology aspects will not restrict that much the adoption and can be mitigated by collaborating with SC RFID partners; some organizational aspects like the size of the company (Anecoop), the technical know-how and easy decision making (Ripoll & CIA) and external pressure have been identified as an adoption enablers; in the economic layer, cost is the most important aspect to look at since the adoption will be require an investment all the companies were worried about this issue.

Supply chain technological initiatives require collaboration among different actors in order to mitigate risks and to search for common goals and interest. In order to asses initiatives to mitigate the risk of the adoption, a model for evaluating risk and gain sharing for supply chain participants was used. Intra- and inter-organizational risk and gain sharing is critical to adopting RFID technology across organizations. These risks and gains were analysed through the exploration of potential alignments and misalignments of the adoption at the strategic, the business and the process layers of the organizations involved (Spanish producers, SRS and Swedish wholesalers):

- *Strategic layer*: Integration, RFID interoperability, long term relationships and IT investment prioritized were the sources of alignments and misalignment between involved companies at this layer. On the one hand, RFID interoperability and long term relationship were potential sources of alignments for all companies (mutual gains). On the other hand, integration and IT investment prioritized were identified as misalignments between SC partners.

- *Business layer*: High cost was the only source of alignments and misalignments among involved companies at this layer. This was neither an alignment nor a misalignment, as Spanish producers will be the only ones that supposedly afford the investment.

- *Process layer*: Insufficient performance, automated data capture, improve information management, improve readability, increase pallet utilization and increase process control were the sources of alignments and misalignment between involved companies at this layer. Insufficient performance was identified as a potential alignment as it will affect negatively to all companies (mutual risk). Automated data capture, improve information management and improve readability are also potential alignments and all of this aspects will impact positively in all organizations (mutual gains). On the contrary, increased pallet utilization was considered to be a source of misalignment between Spanish producers and SRS.

Visits and interactions with the managers of Spanish suppliers were really valuable to understand and comprehend the interest and concerns of the companies of this sector. Main concluding remarks after this six-month study are:

- Spanish producers were satisfied with bar codes for traceability as this is the most accepted and spread system for traceability purposes within agro-food industry as long as all downstream partners of the cooperatives are still using this system.

- Interviewees asked during this thesis agreed upon the idea that implementing RFID in the outbound flow could impact very positively on their processes mainly in the operational layer (i.e. by automating procedures that reduce human intervention), time and costs. Spanish oranges suppliers were not aware of RFID supply chain benefits.

- It is also remarkable the ignorance of this companies about the fact that there are trading partners that are taking advantage of this technology at this moment (at least SRS and Nowaste Logistics). This fact and the scarce use and SC partner's mandates regarding RFID in Spain justify why all these companies have never thought about the RFID adoption.

- The more knowledge about RFID a company has the more level of awareness of it. It was also proved that the economic situation of a company has a direct impact in the willingness and attitude towards technology initiatives, which are few in this traditional sector.

- Lack of collaboration in technology initiatives among SC partners has been identified during this work. SC technological initiatives require collaboration among different actors in order to mitigate risks and to search for common goals and interest. No one was informed that SRS pallets contain a RFID tag and thus that there is an opportunity to use that technology and to potentially improve the SC performance as RFID and its proper management are expected to do.

Final recommendations for all the actors involved in this supply chain have been done. Apart from a common recommendation of the reading of this thesis, specific recommendations have been done to each supply chain actor in order to shape the way of further collaboration and co-operation in RFID initiatives:

- *Recommendation for Swedish wholesalers:* Since Swedish wholesalers like Nowaste Logistics already use RFID and are thinking to expand RFID at supplier level, author strongly recommends Nowaste Logistics and other wholesalers interested in investing on RFID to get in touch with SP. The expansion of its current system to inbound flows especially needs the collaboration of those suppliers that use RFID pallets. For instance, by getting in touch with Anecoop, Nowaste Logistics could share its concerns, its RFID expertise particularly in handling fruits vegetables, and its future plans about the RFID technology expansion at supplier level.

- *Recommendation for Spanish Suppliers:* Author recommends Spanish suppliers to be receptive for receiving all RFID information and plans motioned above from supply chain partners. He also encourages them to investigate the potentials of this technology by themselves. This might be result in a future RFID adoption to associate the orders to the tags contained in the grey pallets and thus potentially contribute to a better supply chain performance.

- *Recommendation for Svenska Retursystem:* Author recommends this company to share their knowledge, expertise, information and potentials about RFID grey plastic pallets with Spanish suppliers. It would be great if they facilitate information about GS1 EPCglobal network for RFID with those suppliers as well.

Table of Contents

1 Introduction

1.1 Background

Innovation is the result of a renewal process aimed at increasing the value of a product, service or strategy (Bettencourt, 2008). Innovation is complex, uncertain, somewhat disorderly, and subject to changes of many sorts. Innovation is also difficult to measure and demands close coordination of adequate technical knowledge and excellent market judgment in order to satisfy economic, technological, and other types of constraints all simultaneously (Steven, 1986). The process of innovation must be viewed as a series of changes in a complex system not only of hardware, but also of the market environment, production facilities and knowledge and the social contexts of the innovation organization (Steven, 1986).

Process innovation means the implementation of a new or significantly improved production or delivery method including significant changes in techniques, equipment and/or software (Oslo Manual, 2005).

Implementing RFID technology can be considered as a process innovation. RFID is the generic name for technologies that use radio waves to transfer the data between a reader and a tag attached to an item to be identified (Hellström, 2007). Apart from the potential operational benefits like improve efficiency or reduce time and labor costs for its applicants, RFID technology can potentially provide real-time information to manage operations and enable supply chain visibility (Hellström, 2007).

This technology can be considered to be a good alternative to bar codes since a RFID tag doesn't require a line-of sight to be read and several tags can be read simultaneously. However, it has been argued that there is a lack of empirical evidence to support this claim (White et al, 2007). In spite of the potential of this technology in the supply chains, many firms prevail reluctant to adopt, or even consider a RFID adoption. This is due to the fact that there is still having several challenges associated to the adoption of this technology.

1.2 Problem discussion

Svenska Retursystem (SRS) is a logistics company that provides with returnable transport items to the Swedish food sector, facilitating an efficient, simple and environmental-friendly service to their customers. Moreover, SRS also exports empty plastic crates and pallets to other countries, when they are filled and send out again to Swedish wholesalers. SRS sends out empty plastic pallets to Spain, where they are filled up and then transported back to wholesalers in Sweden who delivers to the retails throughout the country. Both the Swedish return system (SRS) and Swedish wholesalers, like Nowaste Logistics AB, already have RFID installations incorporated in their plants and partly take advantages of the benefits that this technology offer to their users.

However, the problem that this master thesis faces is that even though RFID-tagged plastic pallets arrive to Spain and are used in Spanish oranges producers´ plants, no one takes advantage of the potential benefits that this technology can bring yet.

Agro-food industry is specially controlled by national and international authorities in terms of norms and regulations. Nowadays traceability is mandatory and essential to have a better control both of inbound and outbound goods and inventory as well. Traceability also enables organizations to share crucial information that can be interesting at any point of the supply chain.

Due to the fact that this technology is already in place at Spanish producers plants in some way, and because of the increasing need of traceability in agro-food industry, author realized that there is an opportunity to adopt RFID technology at those plants. Thus a number of questions arise which is the foundation of this master thesis.

-Do Spanish Suppliers know that they handle RFID-tagged pallets?

-What is the level of knowledge about RFID technology of the Spanish Suppliers?

-What is the level of awareness about RFID technology of the Spanish Suppliers?

-What is their willingness in investing on this technology?

-What is their attitude regarding the RFID adoption?

-What are the technological, organizational and economic factors that will potentially impact on a RFID adoption in those plants?

1.3 Purpose

The purpose is to explore a potential adoption of RFID technology in Spanish oranges producers´ outbound flow of the grey RFID-tagged plastic pallets that are delivered to Swedish wholesalers. The exploration will be focus on aspects regarding RFID technology, like level of knowledge and awareness, the willingness to invest on it, the attitude of the companies regarding the adoption, the technological competence and the financial situation needed for adopting this process innovation within their plants.

1.4 Focus

Despite Spanish plants produce and deliver oranges to so many different clients in different countries, the emphasis will be put on a specific supply chain, which is the Swedish one. This is because they are the only pallets handled by the Spanish plants visited by the author that contain the RFID tag. Different participants of this supply chain have been contacted and analyzed in order to get a better understanding. The “other” actors will appear during this work but at a secondary level, like a Swedish logistics provider called Nowaste Logisitcs that handles incoming oranges from Spain for further distribution in Sweden.

It is known at the beginning of this project that oranges producers in Spain use reusable plastic pallets as a normal RTI without making any use of RFID tags. Therefore, the focus will be put on Spanish Producers RFID adoption in their outbound flow to Swedish wholesalers. Also a special emphasis will be put on what would be the potential benefits both for SP and for the whole supply chain (including SRS) if SP would be willing to adopt this technology. RFID grey plastic pallets has been also considered to be the focus of the thesis since this is the item that contains the RFID tag which is one of the parts needed in every RFID adoption. Figure 1.1 reflects the focus in this thesis.

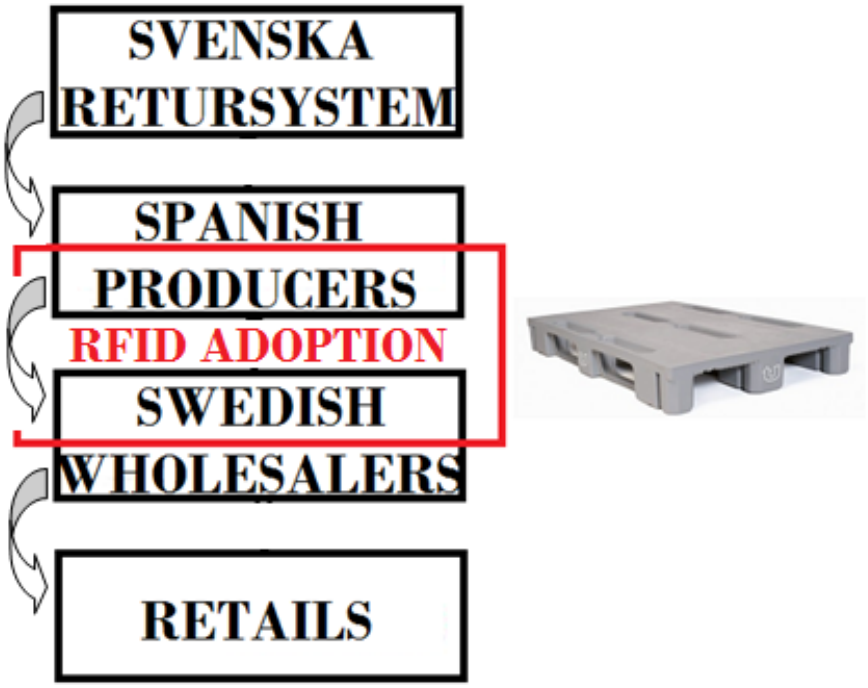


Figure 1.1 Focus of the thesis

1.5 Target group

The target group is the group composed by people, companies or institutions that will be involved in some way along the development of this Master Thesis. This target group is formed by a Swedish company Svenska Retursystem, the three Spanish oranges producers (Rural Sant Vicent Ferrer, Ripoll & CIA and Anecoop) that rent SRS plastic returnable pallets and finally more organizations connected to SRS business practices are also a part of the target group.

Considering academic interests this study also targets students and professors of "Packaging Logistics" Department at Lund Institute of Technology and professors of "Ingeniería de Organización, Administración de Empresas y Estadística" Department at Universidad Politécnica de Madrid. Figure 1.2 reflects what the targeted groups and organizations in this thesis are:

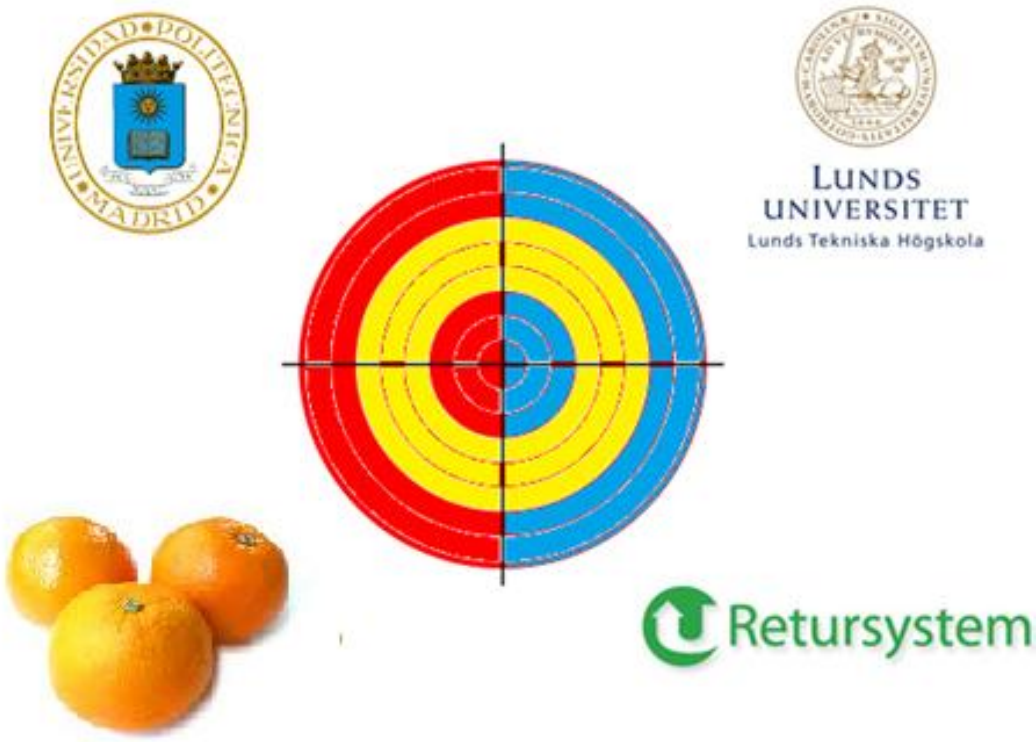


Figure 1.2 Target group

2 Methodology

2.1 Case study methodology

Case studies are a suitable method of researching when general circumstances of a phenomenon have to be studied, especially contemporary phenomenon in a real-life context (Yin, 2003). Case studies can be used to accomplish various aims: to provide description (Kathleen, 1989), to test theory (Kidder, 1982) or to generate theory (Pinfield, 1986).This project presents 3 exploratory case studies. This method was considered appropriate because RFID is a relative emerging empirical topic and then little is known yet (Yin, 2003). Several actors in agro-food industry system will take part during this study. This strategy enables an in-depth understanding of the phenomena exposed to be studied in the selected case study. Yin (2003) pointed out that exploratory strategy is preferred when the study is exploratory in nature. This master thesis will be conducted both in Sweden and especially in Spain, adopting an exploratory approach in a global supply chain. Exploratory research is a type of case study that explores those situations in which the intervention being evaluated has no clear, single set of outcomes.

Generally, exploratory research techniques simply involve conversations between a researcher and the people being studied. Although the researcher may guide the conversation across certain issues, the questioning is usually informal and semi structured. This research combines both a quantitative approach and a qualitative approach. Quantitative approach , which is based on the measurement of quantity or amount and is applicable to phenomena that can be expressed in terms of quantity, like the ROI of an implementation; on the other hand, a qualitative approach concerns with qualitative phenomenon such level of awareness of the potential adopters. Despite science is built on objective principles, Weiss supports qualitative methods by stating that "qualitative date are superior to quantitative data in density of information… not precision and reproducibility" (Weiss, 1968)

2.2 Scientific reasoning

Two major reasoning can be distinguished when considering research methodology: inductive and deductive. These two approaches have a clear opposed focus. While the inductive approach uses the data to generate ideas, the deductive approach starts with an idea or theoretical framework and uses the data to verify or disprove the idea (Schadewit and Jachna, 2007). Deductive approach has been used more frequently in this thesis. The goal of logistics research should be to ensure that theoretical systems and statements can be empirically tested. An ability to consistently explain and predict phenomena must exist (Academy of management review, 1989). The methodology chosen for making this master thesis about the exploration of RFID adoption from SP uses both a deductive and inductive methodology.

Deductive approach transforms a general theory (e.g. RFID technology) into a specific hypothesis (e.g. alignments about RFID incentives) suitable for empirical testing. This methodology still prevails in logistics researches because by using this approach a researcher can sample a fraction of the population by a probability selection method and generalize the properties of interest to the entire population with a known degree of accuracy (Beth and Fugate, 2007).

2.3 Case study design

According to Yin (2003), there are four basic types of designs for cases studies: single-case holistic design, single-case embedded-design, multiple-case holistic design and multiple-case embedded-design (Figure 2.1). In addition to selecting the case and the specific type of case study, which is exploratory in this thesis, researchers must think about the better way to conduct a case study. Prior any data collection, it should be decided whether a single case study or multiple case study are going to be used to address the research questions of the case study.

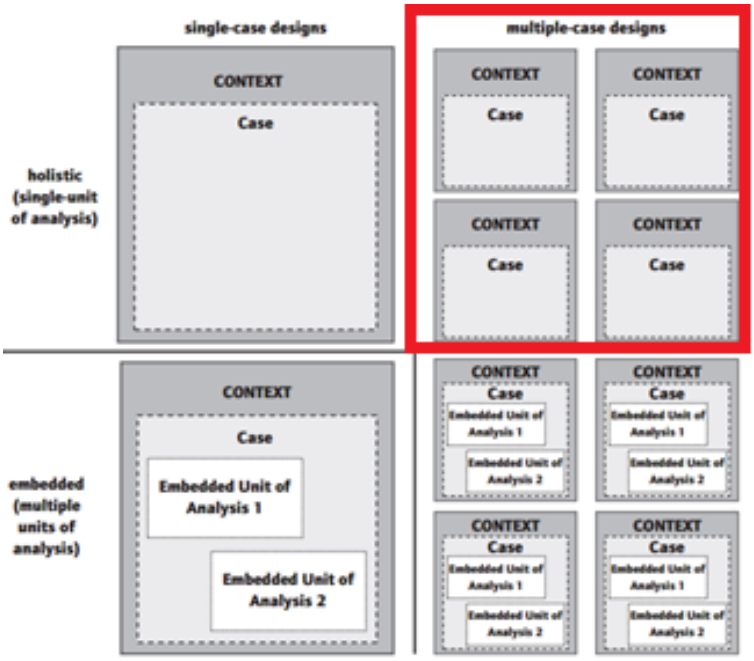


Figure 2.1 Designs for Case Studies (Robert Yin, 2003)

Case studies can also be subcategorized into holistic or embedded studies. Holistic case studies focus on the case as one unit. They might, for example, focus on broad issues of organizational culture or strategy. This approach ensures a wider view of the case. Nevertheless it can be sometimes superficial, and may miss changes in the unit of analysis that could impact on the appropriateness of the original research design. Embedded designs identify a number of subunits each of which is explored individually and then merged together. The biggest challenge with embedded designs lies in achieving a holistic perspective from the analysis of the sub-units. Based on Yin explanations about how to choose the correct design for a case study, the author selected a multiple case-study holistic design as it may represents a typical project among many different companies, and a different oranges plants believed to have different characteristics (Figure 2.2). The lessons learned from these cases are assumed to be informative about the experiences of the average of the industry.

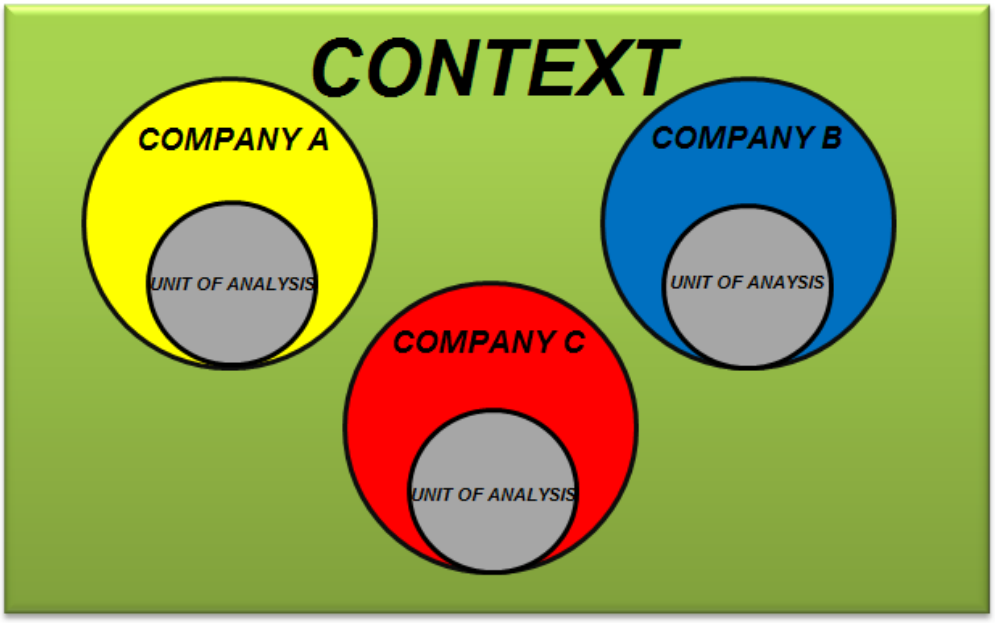


Figure 2.2 Design for the Case Study of this Master Thesis

- Context: Is the Spanish oranges market, which is the place in which this master thesis will be developed. The context is the same in all the case studies, as long as all producers belong to the same industry and they share a common competitive business environment.

- Case studies were explained during the purpose and the problem discussion. Those case studies are the different oranges exporters in Spain that have their own characteristics and specific level of awareness about RFID, peculiarities, interests and financial situations.

- The unit of analysis is the same in all the case studies. It has been assumed to be the grey plastic pallets in the outbound process from those plants considering a possible adoption of RFID technology.

2.4 Case study research design

Once the design for the case study has been defined, it is time to thinking about what the case study research design is. For case studies, five components of a research design are especially important (Yin, 2003): the study questions, the propositions, the unit of analysis and linking data with propositions and to follow some criteria in order to interpret the findings.

- A study´s questions: Asking and clarifying "Why" and "How" provide an important clue in case studies. For instance: Why SP don´t make any use to the current technology that the pallets they handle have?

- Its propositions: Some studies may have legitimate reasons for not having any prepositions. This is the condition in which a topic is the subject of "exploration". Anyhow, explorations also should have a purpose. Every exploratory study should state a purpose as well as some criteria by which the exploration should be judged. The prepositions will be needed to help identify the relevant information about individuals involved in the project. Without such propositions might be tempted to cover "everything" which is impossible to do. The more a study contains specific propositions, the more it will stay within feasible limits. Potential propositions are: the knowledge status and investment interest on RFID of Spanish Producers will increase by gaining awareness; collaboration between different parts encourages the technology adoption.

- Unit of analysis is related to the case study purpose. The choice of the unit of analysis as well as other issues can be revisited as a result of discoveries arising during the case study. Nevertheless, those units of analysis have been decided to be different producer's plants in Spain.

- Linking the data to the propositions. Set up some technique and criteria to match the data with the prepositions properly.

- The criteria for interpreting the findings. Sometimes there are no precise criteria for interpreting some findings. However, findings can be interpreted in many other different ways (i.e. by performing a SWOT analysis). This can also be done by analyzing and comparing three different cases.

2.5 Collecting the evidence

According to Yin (2003) there are three principles very important when collecting data and that were followed in this thesis:

- Use multiple sources of evidence through the triangulation, which means searching and converging findings from different sources and helps to increase validity.

- Create a case study database separated from the final report containing case study notes, case study documents, collected and created tabular materials and narratives (initial open-ended answers to the study questions suggested by investigators).

- Maintain a chain of evidence by linking initial study questions and case study procedure.

Evidence for case studies comes from six different sources: documents, archival records, interviews, direct observation, participant-observation, and physical artifacts (Yin, 2003). Evidence collection helps processes analysis by gathering the information needed to assess the study. No matter how the experience about a case study is gained, every case study investigator should be well versed in a variety of data collection techniques so that a case study can use multiple source of evidence. Data collected can be classified into two categories:

- Primary Data is collected for the first time by making observations and interviews that allow researchers to collect vast amounts of information and it is quick and low cost comparing to observation data collection. These interviews are developed when researchers know what the literature says about their topic and map out pertinent questions with possible probing sub-questions. These kinds of “open-interviews” facilitate the cooperation and allow interviewee to give feedback and suggest new questions thoughts and background about the practices of the companies. Author also has visited Svenska Retursystem offices in Helsingborg and Spanish oranges producers’ plants in Valencia (Spain) and has interacted actively with the product managers of those companies. During the meetings notes and pictures has been taken and interviews have been recorded in order to avoid any misunderstanding.

- Secondary Data is the data which have already been collected and analyzed by someone else. Several documents and archives and information have been provided by Spanish oranges producers to the author during three company visits in order to analyze particularly the context of the problem. It is important to point out that in the case of Rural Sant Vicent Ferrer and Cheste Agraria Cooperativa the interview responds are based on the personal opinion of Commercial Directors of the companies visited. In the case of Ripoll &

CIA, author interacted directly with the owners of the company, who were the ones that responded the questions. However, they felt confident enough to respond to those questions. Academic papers about RFID have been provided as well by the university tutor of this Master Thesis Daniel Hellström.

2.6 Evaluation

Whether you are planning a research project or interpreting the findings of someone else's work, determining the impact of the results is dependent upon two concepts: validity and reliability. Both concepts are what science is striving for. Essentially, validity entails the question, "does your measurement process, assessment, or project actually measure what you intend it to measure?" The related topic of reliability addresses whether repeated measurements or assessments provide a consistent result given the same initial circumstances (Handley, 2003). In research, validity has two essential parts: internal and external:

- Internal validity encompasses whether the results of the study are legitimate because of the way the groups were selected, data was recorded or analysis performed. In order words, internal validity refers to the degree to which methods have been measuring what was intended to be measured (Marshall, 1997). It doesn't apply to exploratory research as this one.

- External validity assesses the process of generalization, the confidence you can have generalizing your findings or results across more people, situations, and times not included in the study. Generalization can be achieved by performing several cases and seeing if there are common patterns to support and justify the generalization. To make rigorous research validity must be attained.

- Reliability can be measured as the level of consistency, i.e. the stability of the results of a scientific observation. To ensure validity and reliability, all the information and data collected and gathered during this project have been reviewed more than once by the author, and have also been reviewed by sending out to the interviewees and participants to avoid errors. The aim that reliability persuades is demonstrating that the operations of a study (such a data collection procedures) can be repeated with the same results.

For case studies an important revelation is that the several tactics to be used in dealing with this test should be applied throughout the subsequent conduct of the case study and not just at the beginning. It means that the design of the work actually continues beyond the initial design plans.

2.7 Master thesis phases

The process started with an academic literature review of RFID adoptions and implementations, cost and benefits visibility, limitations and more phenomena related to this technology. RFID State of Art was also reviewed, as it is a technology and every technology evolves by the pass of the time. After literature review, the author carried out several visits to SRS and Spanish Producers plants in Spain and empirical data was gathered to validate the theory and create a framework to build up further studies and investigations.

Since SRS is a B2B company dedicated to providing returnable transport items to other companies which make use of their product, they already have enough expertise about how RFID systems work. However, the purpose of this thesis is to dig deeper into RFID real users exploring how and RFID adoption could benefit to the daily practices of SRS' customers in Spain and the SC in general. During the case study complementary literature date were reviewed in order to support the empirical data and the observations. Finally, an analysis was developed based on both theory and empirical data, and some conclusions and suggestions for further improvements were suggested as well. The different phases involved in this thesis are shown below in Figure 2.3.

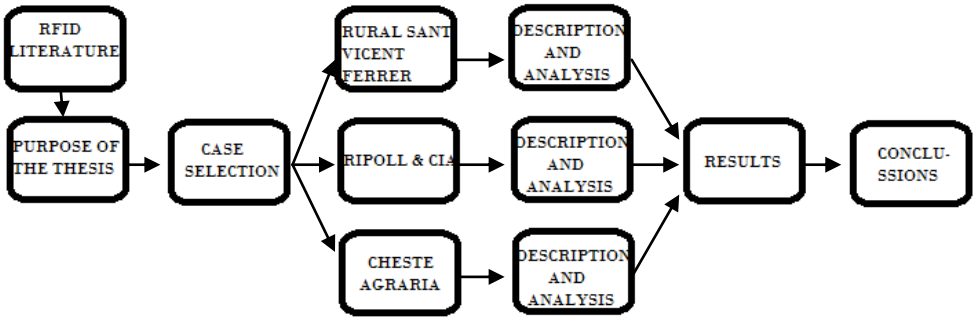


Figure 2.3 Master Thesis Phases

3 Frame of reference

3.1 RFID Technology

3.1.1 History

RFID technology is considered as a new emerging technology for several media in the recent days. However, and despite of the existence of previous knowledge about magnetic and electric radiation, radio frequency identification first studies go back to 1860.

- In 1860, a Scottish physicist called James Clerk Maxwell predicted the use of these waves and postulated its uses.

- In 1886 a German scientist, Heinrich Rudolf Hertz demonstrated that rapid variations on electric power could be projected into the space in wave form radio, similar to light waves, and that these were repeatable and measureable.

- In 1902, an Italian physicist named Guglielmo Marconi proved the first long-distance communication using radio airwaves crossing the Atlantic Ocean.
- One of the most well know use of this technology in history was when British Air Forces applied this radio waves technology during the Second World War (1942) to track and distinguish the allied airplanes from those who were enemies.

- In 1948 by Harry Stockman wrote the article called “Communication by means of reflected power” which displays the basis for the transmission of microwaves under certain conditions as well as some practical applications of this principle.

- In 1960 the need for safety in nuclear materials led to the development of RFID tags.

- In 1997 this technology was transferred to the public sector applications.

- From 1980 there is special focus on commercialization of RFID, from new applications to improvements in the technology and their associated costs.

- Nowadays RFID technology can be used for tracking the inventory, reducing the risk of theft, invoicing, access controlling to some buildings, passing through highways tolls without stopping and so on.

Even though RFID has been around for too many years, only in the last years it is gaining more and more importance for use in SCM. Bagchi (2007) reported the prediction of RFID growth from $4 billion in 2008 to $20 billion in 2013.

3.1.2 What is RFID?

RFID is the generic name for technologies that use radio waves to transfer data between a reader and a tag attached to an item to be identified (Hellström, 2009). RFID offers identification beyond the line of sight and the possibility of identifying dozens, if not hundreds, of individual items at high speed (Hedgepeth, 2007). This technology is also increasingly covering with other technologies such as sensors, GPS, and cellular telecommunication to provide accurate real-time location and environmental information (Venture Development Corporation, 2007).

RFID complements and may be is going to substitute in the medium-long term another identification technologies as Bar Codes, which has changed dramatically the way of making business over the last 30 years. Radio Frequency Identification is basically an electronic label incorporated to some items that allows them to be read with no visual contact when it passes through special gates with antennas. By using those electronic labels a unique identification is provided to every item. That unequivocal identification enables their users to deliver competitive advantages by having inventory accuracy, co-coordinating material flows, tracking the assets or reducing the theft risk and misplacements throughout the whole supply chain. In addition, and as stated earlier, the use of this technology helps the companies to overcome the lack of visibility between the supply chain participants which normally leads to problems and misunderstandings like when outbound pallets ending up at the wrong destinations .

RFIF tag can be attached to a large variety of items, for example to RFID plastic pallets, which are considered Reusable Transport Items (RTI). RTI can be defined as follows: “all means to assemble goods for transportation, storage, handling and product protection in the supply chain which are returned for further usage” (Johansson and Helström, 2007). These are gaining more and more importance by the pass of the time in closed-loops supply chain as a consequence of many reasons, like environmental regulations, the reduction of the total packaging costs in the medium and long term, the more efficient cube utilization or it effect on increasing the partnerships between companies, for instance. Those items are physical objects needed for the transportation of multiple kinds of goods and they can be used several times and are frequently treated as assets that have to be traced and tracked to enable an effective use for all the participants in the supply chain. Currently the owners of the RTI experiences uncertainty considering the lack of visibility that affects this items in terms of the number and the condition of pallets, crates and so on that return back to the cleaning plants.

By adopting electronic labels in their physical assets companies can collect the data needed to manage them in the supply chain, but this technology has to be integrated with the Supply Chain Management (SCM) systems of the different companies involved in the process. At the same time, all the information systems have to be integrated for a useful data exchange and to facilitate the analysis and interpretation of the information provided by them. Nevertheless, there still having some bad points associated to RFID technology that makes it adoption large and progressive as long as it requires an initial investment and running costs and there is still having a lack of global standards.

Moreover, as a relative emerging technology, it requires some practice and expertise. Another important issue regarding the study of new technology implementation is the lack of a global perspective of the SC. RFID system is constituted by a tag which incorporates an EPC (Electronic Product Code), a reader with an antenna and a middleware or interface for communication (Figure 3.1). The principle of the technology can be explained as follows: the reader sends out a wave, which is received by the tag. The tag sends the data by transmitting radio waves back to the reader. This data normally is a serial number associated to the particular items that contains the tag.

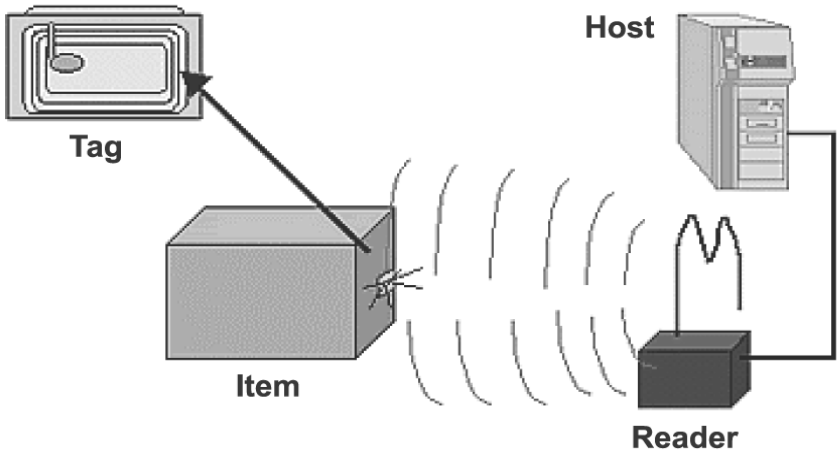


Figure 3.1 RFID System (Peter Jones, 2004)

Tags can be located in the interior of a plastic capsule or even can be printed out. These tags communicate with the reader via radio waves, which are part of the electronic spectrum. RFID systems can operate under different frequencies. Tags and RFID readers should operate in the same range of frequencies and be technically compatibles in order to enable the system to work properly. For RFID technology using passive tags, the frequencies most generally used are shown in Figure 3.2:

Characteristics of the different frequencies			
Frequency	Short Descr.	Read range (meters)	Data speed (Tags/sec)
125-134 kHz	LF	0.45	1-10
13.56 MHz	HF	<1	10-40
902-928 MHz	UHF	2-5	10-50

F**igure 3.2** Table of RFID frequencies (LogicaCMG, 2004)

Ultra High Frequency is the most appropriated frequency for Supply Chain applications as it can be read from long distances and at high speed. This is the frequency in which SRS grey pallets operate. An RFID reader works as a common radio that we can have in our car. The last one allows us to listening music in our cars. On the contrary, a RFID reader captures or produces analogical signals. The reader produces electricity which travels through a cable at a given frequency that arrives to an antenna which radiates the same signal in the air. These antennas are usually connected to the reader with cables to save cables and to reduce the power losses along the cable. The antennas not only generate the signal which is transmitted in the air, they also listens the replies from the tags. Each reader is connected to one or more antennas to ensure a satisfactory reading. This number depends on each particular system. Readers can be stationary or handheld (Figure 3.3).

Figure 3.3 RFID stationary and handheld readers

When a reader emits a signal in space through the antenna normally expects a reply from another element to maintain the communication. In radio frequency identification this task is done by the tag (Figure 3.4). The reader decodes the data inside the tag by analyzing the shape of the wave created by the tag in the nearby electromagnetic field. The shape of this wave depends is a function dependent on the amount of 0´s and 1´s contained in the tag. There is a large variety of types of tags, and the election of the type differs between the different applications. We can classify them in terms of the source of energy (active if it has a battery that works autonomously or passive if not), according to its size or its reading distance, according to its memory (read only, write once and read many times, programmable read-write and so on). These tags can be printed as smart labels or encapsulated by plastics in order to protect their integrated circuit and should be compatible with Gen 2 standards following EPCGloblas´ Tag Data Standards or ISO/IEC 15961. Tags can be put almost on everything, from pallets and crates, vehicles, pets and even persons.

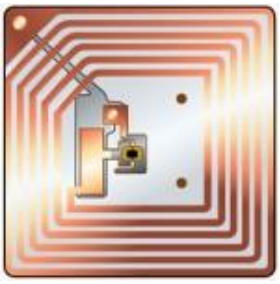


Figure 3.4 RFID tag

RFID technology allows getting a real time information data of the products and their physic flow when those items pass through the reader. Those lectures are automated and a huge amount of information can be processed simultaneously. Even though a RFID system works independently, this is connected to a production logistic system. The middleware is located between the RFID hardware and the software of the company such a MRP or ERP systems (Figure 3.5). Its functions are to manage the RFID system at a software level and receive and filter the signal of the tags in order to convey only the useful information for the enterprise systems. Middleware can also provide value-added services before sending the information to the enterprise management system. For example, it can detect expired products alarming the plant responsible for an immediate withdraws.

Figure 3.5 Middleware principle

Different manufactures have adopted alternative strategies considering the middleware of RFID. While Oracle still being apart from the middleware, SAP delivers its own auto identification infrastructure (SAP Netweaver), making sure a better integration of the RFID technology in information systems.

For example, how RFID passive system works can be summarized in 5 steps:

- When the tag passes through the reader it is activated.
- Tag sends the requested information which it has programmed inside.
- The antenna, which emitted the original signal, receives the respond.
- The reader sends out the information to the middleware.
- The middleware sends out the information received from the tag to the enterprise software.

3.1.3 Regularization and Standardization

EPC is a number system known as the next generation of barcodes and designed to identify all kinds of products. The EPC is intended to be globally accepted, joining the market all over the network. It consists of a numerical code uniquely designed to identify the product. In the EAN13 (barcode), the first two digits refer to the country which attached the code. The following 5 or 8 digits refer to the code company that owns the brand. The remaining digits refer to the code of the product. The last digit is the check digit that can be calculated mathematically using the numbers of the code.

The new way of coding is intended for using with RFID chips prepared to store the 96-bit EPC code. However, to accomplish Gen 2 standards at least 64 bits are needed. Although the number of EPC code can be represented by bars, its huge size makes it non-practical. Electronic Product Code is normally the only information recorded on the chip of the RFID tags. It is basically a long number that provides a unique identification of an item. The structure of the EPC is well defined at EPCglobal web site.

EPC number is divided into 4 categories (Figure 3.6). This first one contains the version and it takes 8 bits. The second part reflects the number of the manufacturer of the item in which the tag is attached. The third one shows the number of the product; it could be “blue pallet 900x750 mm”, for instance. And finally, the last one contains the serial number of the tag that occupies 36 bits that means it can have billions of serial numbers for each product and manufacturer.

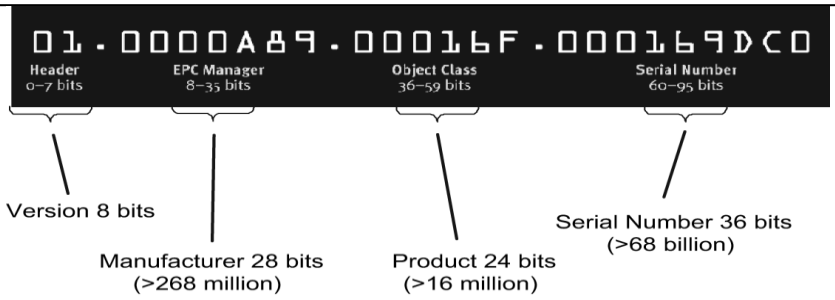


Figure 3.6 Electronic Product Code (David C. Wyld, 2006)

RFID tags have been used for decades for mostly special purpose, proprietary tracking purposes. However, in modern commerce almost everything needs to move fluidly across enterprise boundaries. By providing open standards for tags, readers, and middleware EPCglobal Network has enabled the creation of a standards based industry where tags applied in one country can pass through many different organizations to their final destination and the identity of the object understood and authenticated (Asher et al. 2007). The EPCglobal Network is a community of trading partners engaged in the capture and sharing of EPC-related data through use of EPCglobal standards based technologies. This technology application enables the organizations to gain information about their products and gain more visibility along the supply chain. This global standard combines RFID technology, an existing infrastructure of telecommunication network and the EPC to create real-time information that connects the companies to the products along the network. EPCglobal Network is comprised by six parts:

- *Electronic Product Code (EPC)*: Has been previously described.

- *Electronic Product Code (EPC) Tag*: The tag is physically attached to the item (i.e. pallet). The tag can be encapsulated or printed out in the smart labels. Contrary to barcodes, RFID tags have to be selected with precision because reading rate performances deeply change from one tag model to another. Therefore, solution providers have to study which tag correspond the best to a specific asset tagging which will load specific product. However, although the strict selection of the tag and its fitment is required, this will not suffice to guarantee asset's accurate read performance at each steps of the supply chain. In an open loop system like the supply chain, several players will use different tag models, different tag locations, different asset configurations (e.g. goods loaded), different RFID readers, etc. In this context, following the recommendation could not always guarantee that each asset could be read by each actor. Therefore, asset tagging certification could be a solution indispensable. This certification could be done by accredited RFID labs that abide by a sort of "Asset Tagging Certification Test Methodology" (Vican, 2009).

- *The reader*: The tag is read when passing through it. Readers can be stationary or handheld (Vican, 2009):

    - Handheld readers will be indispensable to control the inventory of assets unloaded such as pallets or crates staked and to associate the goods and the asset during the preparation process in order to track and trace the goods by tracking and tracing the asset.

    - Stationary readers are fixed to specific location will be the solution the most wanted by companies in order to count the inbound/outbound asset movements. Most often the location of the readers will be shipping gates, but it could be also conveyor belts or rotational tables which film the shipping unit. These readers should be automated and therefore connected with movement sensors, traffic lights and monitoring equipment in order to help operator visual control and offer a high reading performance. Most of the time they will identify multiple assets loaded with goods and moved quickly through a gate (shipping or receiving processes).

- *Electronic Product Code (EPC) Middleware*: Connects the readings with the company IT systems. Companies need software that sits between the readers and IT infrastructure. Since the RFID middleware is positioned directly in contact with the physical hardware, it can perform a vital data filtering and aggregation function, by helping to cut down on the data volume moving further up the pipe and closer to company systems. This solution have to inspect the data upon initial capture, and in applying business rules, must help to turn raw data into actual meaningful information that constitutes real events and transactions. Moreover middleware solutions have to help companies in the management of the reader pool in doing controls, configurations and upgrades of new firmware (Vican, 2009).

- *Electronic Product Code Information Services (EPCIS):* provide for storage and retrieval of filtered and processed information about different events within the supply-chain. The EPCIS offers two interfaces: one for query request and the other one for capture operations. The query interface allows trading partners to query information about any event data stored in the EPCIS-repository together with business context. However for such a decentralized architecture, since the complete information about an individual object may be fragmented across multiple organizations, there is a need for lookup services for locating all the providers of the fragments of information that constitute the complete supply-chain or lifecycle history for an object (BRIDGE, 2007).

- *Object Name Service (ONS):* The EPC of each unique product is stored on a lookup service that works similar to internet. ONS provides pointers to authoritative information about an object; this usually means that they provide a pointer to the information services provided by the manufacturer of the object. Multiple types of services can be included in ONS records, including not only EPC Information Services (EPCIS) but also product-specific web pages, web services and other data, such as XML data about products (BRIDGE, 2007).

The first step in the whole process of operation with the EPCglobal Network (Figure 3.7) is when the tag is read by a reader. This code read by the reader is transmitted to the middleware, which is responsible to efficiently manage the entire process of sending and receiving data. After receiving the information, the middleware sends the received EPC to a local server of the company, which tries to find the PML file associated with that product code EPC. In fact, throughout the process the programming language PML is used in order to describe physical objects on the network and also to include schemes that allow the definition of all the characteristics of a product or object. This language consists in a standard language PML that allows representing and distributing information about the objects, and making possible the standardization. In the case of finding the product, process ends. If not, the middleware sends the EPC to the ONS server (which is based on the same infrastructure as internet), that issues a request for location of the PML. All authorized companies can access corporate ONS with the aim of seeking information about a particular product. The ONS system connects EPC with its associated PML file automatically. The ONS system responds to the middleware petition facilitating an IP address. Once the middleware gets the IP address in the response, this connects to the correspondent PML server which will provide the PML archive needed for identifying the product. Information flow in a supply chain using architecture of the EPC-based global network is shown in Figure 3.8.

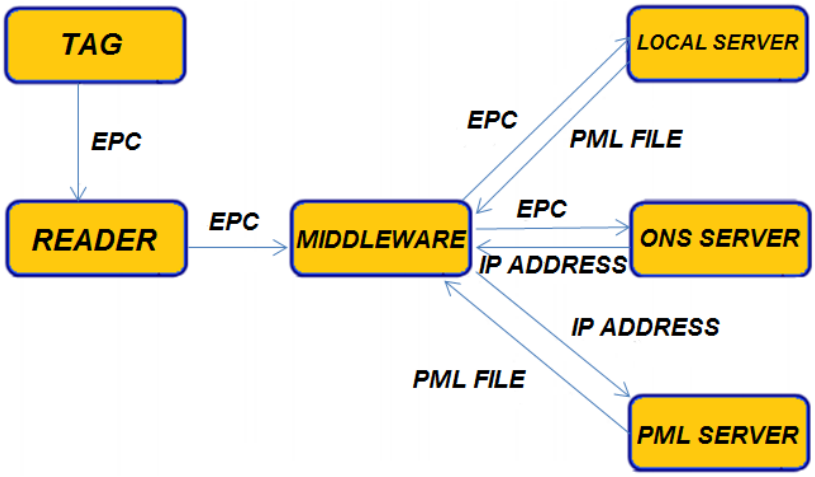


Figure 3.7 How EPCglobal Network works

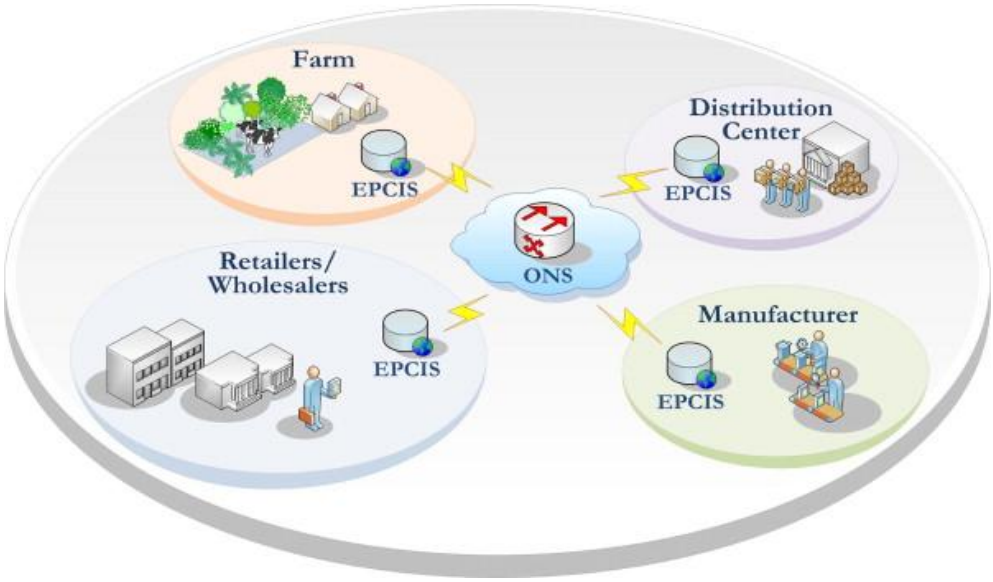


Figure 3.8 Architecture of the EPC-based global network (Wang, L. et al, 2013)

GS is a private organization which main function is to elaborate and apply international norms in order to achieve a greater visibility in the supply chains as well as global supply and demand. GS1 are the most utilized norms in the supply chains worldwide. This organization is present in 108 countries all over the world, with headquarter in Brussels. GS1 has designed and implemented global standards for supply chains. GS1 standards provide a structure that allows handling products, services and information in an efficient and secure way. Becoming a member of GS1 requires paying an annual fee.

The standards contribute to the exchange of information between companies. Moreover, these standards allow each company to establish and visualize its own supply chain and traceability. Their use is spread globally in different sectors from small retailers to big international companies. GS1 standards play an important role against the piracy and falsification of products.

GS1 EPCglobal, a subsidiary of GS1 (Figure 3.9), is determined to carry out the development of the RFID technology by defining and implementing standards that achieve that RFID technology is active all over the world. GS1 defines 7 identifier system keys, each one of them can be encoded in an EPC. EPC Network standards and data exchanges specifies the encoding and decoding procedures for writng/reading RFID tags. Different identifiers of GS1 are shwon in Figure 3.10.

Figure 3.9 GS1 subsidiaries

GTIN	**Global Trade Item Number** Assigned to any item (product or service) that may be priced, or ordered, or invoiced at any point in any supply chain. A GTIN identifier may be bar coded using the Application Identifier (01). A serial number that is used in conjunction with the GTIN identifier may be bar coded using the Application Identifier (21).
SSCC	**Serial Shipping Container Code** Identifies an item of any composition established for transport and/or storage which needs to be managed through the supply chain. An SSCC identifier may be bar coded using the Application Identifier (00)
GRAI	**Global Reusable Asset Identifier** Used to identify types of reusable package or transport equipment that are considered an asset. It is used to enable tracking as well as recording of all relevant data associated with the individual asset or asset type. The GRAI is assigned for the life time of the asset and may be bar coded using Application Identifier (8003).
GIAI	**Global Individual Asset Identifier** Used in a diverse range of business applications ranging from tracking like recording the life-cycle history of high value equipment. The GIAI is assigned by the owner of the asset and may be bar coded using Application Identifier (8004)
GLN	**Global Location Number** Used to identify physical locations and legal entities where is a need to retrieve pre-defined information to improve the efficiency of communication with the supply-chain. Global Location Numbers are a prerequisite for Electronic Data
	Interchange (EDI)
GSRN	**Global Service Relation Number** Used to identify the recipient of services in the context of a service relationship. It is used to enable access to a database entry for recording recurring services. The GSRN is normally assigned by the service provider and may be bar coded using Application Identifier (8018). Note that the GSRN is not an identifier for a person - but for a service relationship and should only be used within the context of a particular service.
GDTI	**Global Document Type Identifier** An identifier for a document type combined with an optional serial number and used to access database information that is required for document control purposes. The GDTI is assigned for the life time of the document type and may be bar coded using Application Identifier (253)

Figure 3.10 Identifiers of GS1 (Bridge, 2009)

3.1.4 RFID VS Bar Codes

RFID usage delivers solutions for applications which can only be covered insufficiently with conventional identification methods. Radio frequency identification, as an auto ID technology, has the same purpose than bar codes but has different qualities. Major difference is the contactless transfer of data via electromagnetic waves. RFID is a collection of mature technologies that has been used, among other things, as complement to bar codes. Labor intensive manual processes that incorporate bar code scanning for identification and tracking of corporate assess are still used in medium to large organizations.

The bar codes labels that started a revolution in identification systems and asses tracking are now being found inadequate in an increasing number of cases. Bar codes may be inexpensive but they have low data capacity and can´t be reprogrammed. RFID system will replace the old tracking systems in a long run. Nevertheless bar codes cannot be replaced by RFID at once. This problem of dual system situation is described in many articles (Ngai and Gunasekaran, 2009; Ross et al. 2009). The next table (Figure 3.11) illustrates the main differences between RFID and bar codes making a comparison between them

	Bar Codes	RFID
Technology	Optical detection	Radiofrequency
Information	Only reading capacity. Not upgradable information	Writing and reading capacity. Upgradable information
	Only provides an identification number	Delocalized and upgradable data base
	Without capacity of storing information	With capacity of storing information
Reading automation	Requires line of sight	Doesn´t require line of sight. Wireless auto ID
	Individual reading	Simultaneous reading
Robustness	Sensitive to the knocks and to the dirt	Resistance and robustness
Safety level	Low security level	High security level
Monitoring	Discrete monitoring	Continuous monitoring

Figure 3.11 Comparisons between Bar Codes and RFID (Carrasco-Gallego and Ponce-Cueto 2008).

3.1.5 RFID State of Art

By the pass of the time, grocers, and food providers are increasingly concerned with food safety and quality. Fresh oranges require proper temperature management throughout their distribution. Even slight temperature variations in storage and refrigeration systems can lead to food damages, thawing, uneven quality, and potential health issues that reduce customer satisfaction and consequently can lead to brand damage and loss of revenue when a problem occurs. Pallets and their contents can be bad-handled during the transportation along the SC, especially in long-distances shipments including import and export issues. Frequently visual inspection is the only way to ensure the good food quality and how fruits and vegetables have been handled before the delivery and thus DC´s and groceries are forced to accept the shipments based on these criteria. In order to secure high quality and long shelf life and proper conditions in general, a good temperature management throughout the SC is needed.

Nowadays the temperature is controlled by checking briefly the truck cooling system. In that context emerges the idea of controlling more effectively both the track of the filled pallets and their temperature since the moment they arrive to the warehouses when they are prepared for further distributions. Intelleflex is company based on the USA, leader in providing on-demand data visibility solutions for tracking and monitoring products and assets. This company is specialized in tracking solutions using RFID tags (Figure 3.12). These active tags incorporate a special sensor capable to control the temperature and other conditions. In addition to the sensitive capacity of the tag, there are more advantages of this system like its cost and precision.

Figure 3.12 Intelleflex TMT-8500 RFID tag (Intelleflex website)

Traceability and food safety need to be simultaneously addressed during transportation processes. Intelleflex system provides on-demand temperature monitoring at the pallet and package level every step of the way. Without unpacking or modifying the distribution processes, users can get actionable data to instantly determine the shipping and storage history of every pallet, container or package to improve the management of your fresh supply chain. This technology increase visibility and condition of the pallets during the whole supply chain. This can be done without modifying the current operations and providing quality and increasing the self-life at the same time. Moreover, by measuring the temperature condition from harvest to DC´s inventory can be managed based on First Expire First Out (FEFO) instead of FIFO, reducing the risk of food damage. They have a large variety of tags: STT-8000, SMT-8100, TMT-8500, BAT-8300, and FBT-840. Each one has different characteristics and specifications.

RFID is not an isolated technology that provides a unique identification to an item to increase it traceability. As mentioned before, those tags can incorporate simultaneously other technologies, like cooling technology. The author of this master thesis has been in contact to Kevin Payne which is the Senior Director of Marketing at Intelleflex. He provided the author with relevant information about this technology and a couple of cases studies to exemplify the large potential benefits of this system. One case study which is a good example about how this tags work in a real shipment can be found in the business case carried out by John Ryan in 2012 about tracking a shipment from California to Hawaii. In that case each pallet or separate shipment in the container needed its own unique tag that recorded each pallet’s temperature through handling. The tags are configured to communicate with a reader and data is transmitted through a wireless device that used GPS tracking thereby allowing data and location to be transmitted via satellite (John Ryan, 2012).

Ampatdis (2012) introduces a new RFID application: A real-time labor monitoring system (LMS) with the ability to track and record individual picker efficiency during manual harvest of specialty crops. This system utilizes existing commercial harvest equipment and integrates a digital weighing scale, RFID reader, computational unit, and a portable data logger carried by pickers. The RFID reader, digital scale and computational unit are assembled on a common portable chassis. As pickers transfer fruit into a standard collection bin, the system reads the picker's ID (RFID tag) and the weight of fruit. Weight data can then be transmitted wirelessly to the picker's data logger which records and displays the incremental and total weight of harvested fruit. An algorithm to record, process and store the data was developed by Matlab.

3.2 RFID Implementation

Supply chain technology is identified as one of the primary facilitators of a supply chain excellence strategy. When it comes from implementing a new supply chain technology such RFID, there are three important rules to succeed (Stank et al. 2011):

- The first one is to make sure that the leading edge of the technology is used appropriately. Firms that can tolerate higher levels of risk normally have the opportunity to develop a successful application and competitive advantage.

- The second rule states that people issues are tougher to address than technical issues. Cross-functional and cross-company human-technology interface issues add a much higher dimension of complexity to adoption, acceptance and usage. So the level of knowledge and the awareness about RFID and the way different departments collaborate to generate new technological ideas to push the managers to switch the technological strategy will be another important factor in adopting RFID. Technological implementations can success by addressing discipline project management in place and an excellent project leadership.

- The third rule is to make sure that supply chain technology projects have clear practical implications. Little is known about psychological process that decision makers experience when evaluating technology projects, especially those of supply chain nature, i.e. that have to be shared with or used to link other organizations:

    - Understanding of readiness across the different actors to influence the effectiveness of technologies such RFID that serve to connect them.

    - Describing how imbalanced technological readiness within and across firms functional groups influences the organization's overall capabilities for managing external technology linkages.

    - Exploring adoption issues that impact upstream and downstream supply chain firms. Facilitate the establishing of new connections between people and/or organizations involved in order to assist the adoption process.

    - Understanding how organizations deal with the need to perpetually upgrade technology when it can brings new benefits for their processes and practices.

- Identifying the ideal composition and dynamics of supply chain information technology selection and implementation teams.

- How supply chain technology projects should be "rolled-out" piecemeal, versus all at the same time. It also includes the coexistence of the previous system with the new RFID system incorporation in different steps.

- How to implement supply chain technologies when multiple partner firms are connected using the same system but have differential technology clock speeds and/or budgets for upgrade/reinvestment.

- How the costs of information technology are considered when determining the ROI of supply chain initiative. This point also includes the assessment of the effort of different contributors when the adoption (efforts, energy and investments).

There are too many challenges and limitations related to the implementation of new technologies along supply chains. At the same time there are several factors that hinder a successful implementation, like the top management support, risk level, training of users, the lack of communication between different departments throughout the companies, and user management of the implementation process.

3.2.1 Limitations of the implementation

Although many RFID implementation cases have been reported, the widespread diffusion of the technology and the maximum exploitation of its potential still require technical and process issues to be solved ahead of time. Today´s limitations of the technology are foreseen to overcome and specialists are already working on those issues. There are some limitations when implementing RFID (Kaur et al. 2011). The most important are:

- *Standardization*: There are several normative applicable to RFID technology, but each one belongs to a different regulatory organization: ETSI, ISO, EPC… Companies transcending a closed-loop solution and wishing to share their application with others may encounter conflicts as cooperating partners need to agree in standards concerning communication protocols and so on.

- *Cost:* There are too many costs associated with an RFID implementation. The initial investment requires investing on readers, printers, servers, cables and switches, proper software and training and education programs for the employees. On the other hand, important saving can be reached by using RFID (out of stock, minimized inventory losses, reduced labor cost…).

- *Collision*: Attempting to read several tags at a time may result in signal collision and ultimately to data loss. To prevent this, anti-collision algorithms (most of them are patented or patent pending) can be applied at an extra cost. The development of these methods, aimed at reducing overall read time and maximizing the number of tags simultaneously read, still goes on (D.W. Engels and S.E. Sarma, 2001).

- *Frequency*: The optimal choice of frequency depends on several technical factors, such as the transmission mode, the properties of the tagged goods and the environment, and the international standards in frequency allocations which vary depending on the region of the world.

- *Quick technology obsolescence*: One of the common concerns of companies implementing RFID today is the rapid obsolescence of the technology, especially in view of the investment cost. Technology is continuously evolving and new protocol standards, faster and more fault-tolerant readers quickly outdate their predecessors.

3.2.2 Implementation model

Daniel Hellström, associate professor and researcher at Packaging Logistics Department of Lund University proposed an implementation model in 2007 based on the implementation of RFID in IKEA and Arla Food. It contains 6 stages:

- *Initiation*: In this stage Define the problem/opportunity should be defined. This stage also includes the development of different concepts about how to solve the problem to reach a solution that match both the business process and the technology. If the focus is only in the technology and not on the business practices this results in a business application with limited benefits.

- *Adoption*: A comparison of the benefits and costs should be performed by assessing the chosen concept and system design economically which serves as an aid in the decision process. This analysis can give an idea about an estimation of the payback time of the initial investment. It can be the way to gain top management support for the implementation. Another important part of this stage is to develop and perform and RFID trial that facilitates understanding of the technology.

- *Adaption:* Choose the system integrator based upon software and hardware requirements, cost etc. In this stage a system integrator is chosen an installed after comparing the different system integrators. The integrators should be evaluated according to the technical requirements but also based on costs and the expertise of the integrators.

- *Acceptance*: Inform, train and discuss with employees and end-users about the use and usefulness of the system. Gaining user and organizational acceptance of the RFID implementation is an important part for a successfully implementation.

- *Routinization*: Perform installation changes to accommodate employee´s needs and improve the level of automation and performance of the implemented system and analyze and interpret the data accumulated from the system. It is important to encourage the usage of the new system. By doing this, employees gain a better understanding and then they can make suggestions about how to accommodate the new system to their needs.

- *Infusion*: Use the implemented system infrastructure for other applications and use the knowledge attained regarding the technology involved, as long as the knowledge of the technology is already gained. Having implemented an RFID system might provide a company with the opportunity to expand the implemented system and gain benefits which were not previously economically viable.

3.2.3 Risk and gain sharing in RFID inter-organizational adoption

Collaboration in the adoption of a new technology among supply chain partners and good relationships with suppliers is essential for a supply chain to be competitive (Attaran, 2012). Regarding a supply chain perspective, most companies don't worry about the behaviour of their supply chain partners. According to Narayanan and Raman (2004), companies often look for their own interests ignoring those of their network partners and then supply chains performed poorly. Those results aren't shocking when you consider that supply chains extend across several functions and many companies, each with its own priorities and goals. Yet, all those functions and firms must pull in the same direction for a chain to deliver goods and services to consumers quickly and cost effectively.

Supply chain works well only if the risks, costs, and rewards of doing business are distributed fairly across the network. Implementing collaborative change initiatives in supply chains presents various challenges both in intra-organizational and inter-organizational layers. Identifying risk and gain is a fundamental step towards aligning supply chain initiatives, which is in turn to critical factors for inducing supply chain coordination, and integration and avoiding myopic behaviour of firms (Hellström et al, 2011).

These authors came up with the conclusion that intra- and inter-organizational risk and gain sharing is critical to adopting RFID technology across organizations. In fact, there is a need for balance between risk and gain sharing on different business layers for supply chain actors when RFID is implemented across organization borders (Hellström et al, 2011).

Inter-organizational mismatches are an obstacle to RFID implementation. If there are mismatches in the balance, risk and gain sharing is essential that organization involved in supply chain initiatives come up with a mutual agreement (Hellström et al, 2011). Therefore that authors pointed out that in order to adopt RFID across organizational borders there is a need to mitigate risks. This can be done by aligning the incentives of all the key decision makers in their supply chains. For example, alignments in technology initiatives can be reached by firms by adopting revenue-sharing contracts.

3.3 Justification of RFID in RTI managed by Pool Operators

Returnable crates and pallets are classified into reusable articles category. Carrasco-Gallego and Ponce-Cueto (2011) use the term reusable articles (RA) to refer to durable products intended to be used multiple times by different users in different locations of a supply-chain network.

This means that the time needed for each consumer is short compared with the article lifetime, and that each use cycle does not significantly deteriorate the product. It also implies that after each use, the RA needs to be returned to an adequate location where it is made available for the next user. In many cases, RA can even be directly reused after their collection (Carrasco-Gallego and Ponce-Cueto, 2011).

Reusable articles can be classified into 3 different categories according to its usage:

- Returnable packaging materials (RPM), coined by Van Dalen (2005), refers to primary packaging materials used to protect and hold the products for the end consumers. Examples of this category are refillable glass bottles for drinks and beverages, gas containers and so on.

- Returnable transportation items (RTI). This term was coined by Johansson and Hellström (2007) and includes secondary and tertiary packaging materials which are used for assembling goods in material handling and transportation in the supply chain and then returned for further usage. It is important to remark that those items are not in direct contact with the product consumed by the end customer. Examples of RTI include pallets, crates, tote boxes, trays, roll cages, etc. The major part of the returnable transport items are used in Business to Business operations.

- Reusable products (RP) includes those products used multiple times along it lifecycle. Library books or surgical instruments fit into this category.

The rationale for considering together these three types of items as reusable articles resides in the fact that the three categories share the same logistical characteristics. Hence, the results obtained from the analysis of an individual class (RTI, RPM, or RP) can be extended to all classes of reusable articles (Carrasco-Gallego, Ponce-Cueto, 2011). Different factors are considered by firms when adopting RTI: the packaging material costs, damage reduction, inbound transport, outbound transport, solid waste reduction to meet waste reduction levels demanded by governmental regulations, sorting ergonomic and safety issues, cubic efficiency, tracking, labor, cleaning and repair and line layout changes.

However, this list doesn't include shrinkage or theft misplacements of RTI which is estimated to be around 10% annually according to a survey made by Aberdeen Group in 2004. RTI fleet often represents an initial investment, and shrinkage may represent a considerable operating cost (Johansson and Hellström, 2007). Recent surveys indicate that they are often managed with scarce visibility. The Council of Supply Chain Management Professionals (2006) defines visibility as "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".

In order to gain visibility, tracking systems are needed to manage and control where and how RTI are moving, and to reconcile RTI supply with demand. For instance, Twede found that cost for tracking, handling and shorting of RTI tend to be underestimated or not considered while initial investment, cycle time and return transport costs are at the center of attention when RTI adoption decision is made. Johansson and Pålsson (2009) pointed out that logistics performance is more dependent on how data are utilized rather than how data is captured.

In this line, a case study carried out by Hellström at Arla Foods suggested that tracking systems are needed to manage and control RTI systems but they don't provide themselves any benefits. It requires management attention and adequate data analyzing to increase visibility (Johansson and Hellström, 2007). The efficient management of RTI requires the transparency of the supply chain. The most important condition is the coordination of information and the corresponding movement of the RTI.

The realization of these advantages in correlated to the level of partnership as well as with the organizational and technical conditions. Recently, several pallets producers and pool service providers have started to seriously explore the integration of RFID into their pallets. The tag should become an integrated part of the pallet in order to identify each pallet individually as this will help to improve the control of production and repair, will allow a clear authentication, gives the users in the pool a valuable tool to control flow, quality and ownership of the pallets, and will open new possibilities in supply chain management (GS1 org, 2010). However, the implementation of RFID is not exempt of challenges and difficulties and, in addition, is often unclear how the value promised by the technology (inventory visibility, inventory reduction, increased sales, etc.) is attained in practice (Carrasco-Gallego, Ponce-Cueto, 2009).

According to BRIGE Technical Guideline (2009), in pool systems, asset are owned by professional pool operators and rented to users. Pool operators manage the movement of their pools between trading partners (Figure 3.13).

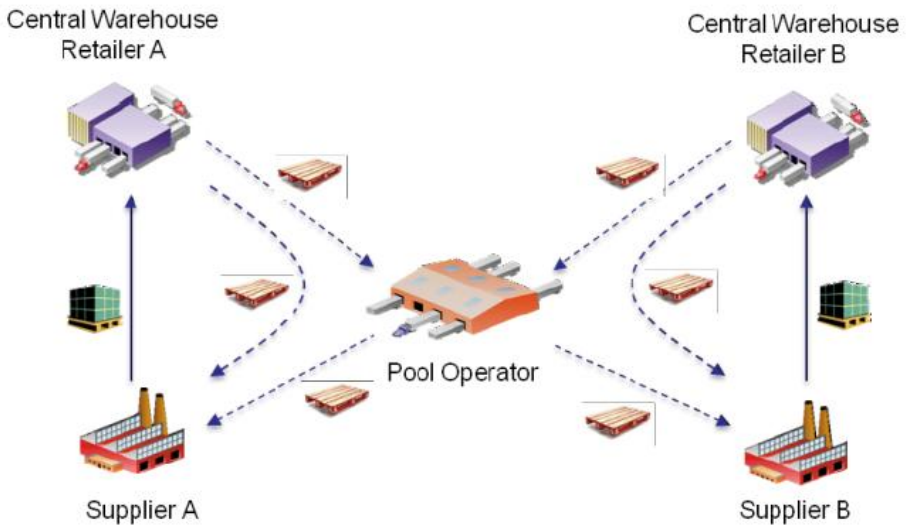


Figure 3.13 Pooling model with pallets (BRIDGE, 2009)

The efficiency of Asset Management depends on visibility. For example, in the pooling model, the pool operator needs to know the inbound and outbound movements of assets being used by companies in order to invoice its customer for the amount of time the assets is stayed at a customer's location. The pool operator needs also to know the final destination of the assets and their pick-up time (empties collection). In the exchange model, the companies have to know the exact number and location of the delivered assets and the exact number and location of the collected assets in order to manage asset trading accounts and balance the difference with their partners.

However, current practices do not allow for much asset identification capture and exchange during the logistic processes, and thus give way to lots of errors and approximation. Therefore, even if they wanted to, companies cannot exchange relevant information concerning the asset flow with their trading partners because they do not have accurate visibility on their own internal flow. In the end, there is no transparency on asset flow and therefore no efficient Asset Management. In order to improve visibility on assets circulating in the supply chain, three improvements are greatly needed. First, there is a need of identification. Assets can be "traced & tracked" in the supply chain if and only if they are identified with a code.

This code is needed for identification so as not to confuse one asset from another during the logistic processes. Secondly, there is a strong need to automate the data capture of this asset identification. Trading partners need to automate their processes in order to improve their productivity (i.e. reduce time per process) and their reliability (better process quality). Finally, because the supply chain is an "open loop" world and Asset Management involves multiple different companies, there is also a need to exchange relevant information concerning assets with trading partners. On one hand, better visibility on asset flow gives Asset Management specialists, such as Pool Operators and Pool Providers, the means to carry out their work with ease and efficiency. On the other hand, for the other trading partners in the supply chain such as manufacturers, retailers, carriers and logistics providers, will benefit as well. Potential benefits both for pooling operators and for trading partners for exchanging information are shown in Figure 3.14:

Pool Operators	**Trading partners**
Adjust their pool size according to the actual demand and at the same time improve reactivity to customer demand	Optimize exchanges with partners (delivery and collection of empties)
Improve their processes such as asset delivery, collection and reconditioning	Reduce number of disputes
Identify the problems starters and therefore improve their fight against asset damages, counterfeiting or unauthorized reuses capacity to fight against asset damages, counterfeiting or unauthorized reuses	Improve asset accountability
Invoice customers with better transparency and fairness	Reduce costs (rental, reconditioning...)
Invoice pricing competitiveness (rental, repair, transportations…)	Reduce asset over stock

Figure 3.14 Benefits of visibility in Pool Sytems (BRIDGE, 2009)

3.4 Traceability in fruits and vegetables market

Justification of the use of RFID in agro-food industry can be found looking at RFID technology benefits that apply to any kind of industry. Companies in food industry are specially driven to improve their traceability for several reasons. Primary among these are food safety and legal aspects (Coff et al. 2008). A specific definition for traceability within the agro-food sector is "The ability to locate an animal, commodity, food product or ingredient and follow its history in the supply chain forward or backward" (OnTrace, 2007). Nowadays food safety is considered a big concern in several countries and traceability of the products is mandatory by law.

That's why technological implementations towards traceability strengthening are crucial in that sector. Food and Agriculture Organization (FAO) inform of 2012 established some guidelines embracing the cost-effective management tools for ensuring food quality and safety. The main objectives along this subchapter are to recognize the importance of a proactive approach to quality and safety in agro-industrial enterprises, to review the tools and systems available for ensuring food quality and safety throughout the agricultural food chain and to illustrate the principles of product traceability and their importance as a support mechanism in food quality and safety programs (FAO, 2012).

The sustainability of an agro-industrial company depends largely on its capacity to obtain information on what is happening in the market and its skill in exploiting this information to react to market signals. Another important component for accessing markets is knowledge of customer requirements for quality and safety, combined with an awareness of the public and private standards within the target market. Consumer demands are not limited to the quality aspects, which they can judge themselves, but increasingly consumers are asking how products are produced and what guarantees a company can offer in terms of its commitment to quality and safety.

These considerations apply not only to the final product, but also to how a company approaches all its management processes. Since food hygiene and safety requirements for marketing have been increasing at both international and national level, companies have adopted programs like good agricultural practices (GAP); good manufacturing or good production practices (GMP/GPP); hazard analysis and critical control points (HACCP); and quality and safety management systems such as standards ISO 9001(specifies the requirements for quality management systems applicable to the enterprise) and ISO 22000 (addresses food safety management.) over the last decade. Based on the need for safety and quality in fruits and vegetables, standards and certifications drivers are shown in Figure 3.15.

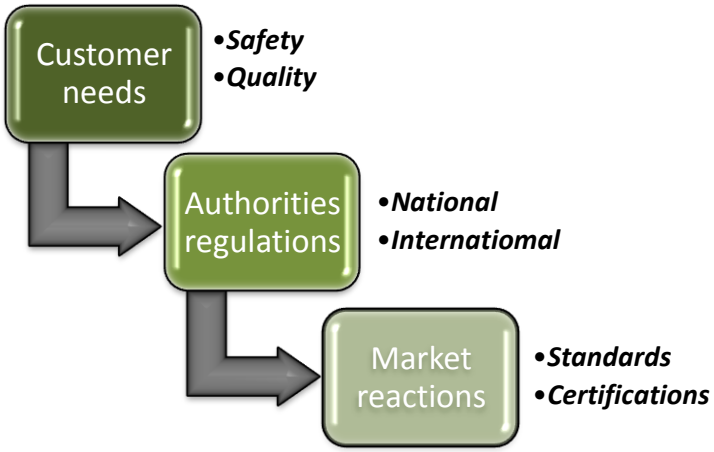


Figure 3.15 Standards and Certifications drivers

These programs have risen up in order to gain consumer confidence in food quality and safety and the regulations of the authorities to protect consumer rights like health and to guarantee food quality and safety along the supply chain. Those concerns about quality and safety are expected to continue rising. Final costumer's awareness about this topic must force the companies of the agro sector to adopt new policies prioritizing customer satisfaction fulfilling their expectations about quality and safety. These policies should be widespread throughout the whole supply chain, from the start (producers) to the end (retails).Therefore all the actors in the entire process (producers, processors, packers, transporters and distributors) share responsibility for implementing measures to prevent and control food damages.

Different Governments have the responsibility to ensure food safety and quality in order to maintain certain health protection level. How responsibilities for food quality and safety are organized varies from one country to the next. This involves either several agencies or a single agency coordinating or assuming full responsibility for this subject. The mandatory regulations of the European Union began with the White Paper on Food Safety of 12 January 2000, which proposed an integrated approach throughout the food chain and a new harmonized, transparent legal framework applicable from farm to fork. Of particular interest is Regulation 852/2004 on food hygiene. This set of regulations is based on six general principles that provide a conceptual framework for all its components (FAO, 2012): the food chain, risk analysis, prevention and precaution, transparency in the market, co-responsibility of all the various actors in the chain and traceability. Traceability is the ability to follow the movement of a food through specified stage(s) of production, processing and distribution.

Product traceability has become an increasingly important requirement for the development of worldwide voluntary and mandatory food standards aimed at ensuring quality and safety. Effective traceability can only be reached by used bar codes or RFID technology. In the context of a food control and certification system, traceability is a tool that can be used to protect consumer health by guaranteeing food safety and ensuring correct practices in the food trade, thereby contributing to the effectiveness and efficiency of the various integrated measures for food safety. However, traceability is not enough itself to improve results relating to food safety or to ensure the application of correct practices in the food trade and requires supplementary measures and appropriate requirements (FAO, 2012).

The stringent new regulations of the European Union demand for food exporting countries have verifiable traceability systems. The required response times and volumes of information to manage, makes the incorporation of information technologies (IT) an investment that ensures the delivery of agricultural products to markets according to new demands and regulations concerning food and safety. This IT system ensures that the authorities have more control in food companies, which facilitates official supervision activities within the whole process allowing them to take more accurate actions if some incident occurs.

Traceability refers both to internal and external depending on where the need for trace comes from. When it comes to traceability for export, one of the obstacles to overcome is the cultural differences due to lack of agreement on what it means and what is the scope of the concept. Many companies believe they have traced products when in fact it is not, and only discovered the mistake in the event of a problem on arrival. Depending on the severity of the incident, the practice indicates the recall of all merchandise associated to the problematic lot.

However, if the information provided by a correct traceability does not apply to every case level the company must withdraw all of their shipments to all destinations rather than remove the damaged lot. If it occurs, the economic consequences would be enormous, but it also contributes to a negative impact on the repercussion and commercial credibility, both to the company and the country even though only rarely these events have an impact on consumer health. When a traceability system is well integrated with IT, it can provide significant improvements for the different actors of the value chain such as: efficient management of logistics and supply and increased productivity.

Traceability supports agro-industry in several ways (FAO, 2012):

- By taking measures when a risk has been identified to facilitate the rapid removal of the food from the market, thereby minimizing any potential negative impact on consumer health, economic losses or future detrimental effects on trading, including damage to the brand image.

- By improving the company's competitive position in the market increasing consumer confidence in the product, as well as by guaranteeing the product's authenticity, the accuracy of the product information and the product characteristics.

- By managing, controlling and optimizing production processes.

- By pinpointing where a fault occurred, which producer is responsible, how much of the product needs to be removed from the market and where the product is located.

Information tracking and access for all participants in supply chains can be reached by implementing web software structured to provide various services to all the categories thanks to the a Application Programming Interface (API) which ensures uniformity data to consult or send. Information tracking systems also provide a reference web interface to access the product info card displaying all information and data released as feedback by the manufacturer, wholesaler, retailer and consumer (Papetti, 2012). Each part of the supply chain contributes with the data collection related to the product at each step of the process. Centralized database storages all the data collected.

3.5 RFID in Spanish industry

For the moment, none of the leading retailing companies in Spain, such as El Corte Inglés, Carrefour or Mercadona has launched an RFID mandate similar to those launched by Wal-Mart, Tesco or Metro. Moreover, economic situation is an important barrier that hinders the opportunity to spread the use of RFID in Spanish industries in general and agro-food sector in particular. Recent studies states that the growth of RFID in Spain is insignificant comparing to the average of growth in Europe. Nevertheless, some companies operating in Spain have already started to test the potential of RFID in their internal business processes through pilot tests and limited-scope implementations (Carrasco-Gallego, Ponce-Cueto, 2009).

One of the most relevant cases about RFID implementations in Spanish industry is Correos case. Correos is the National Post Service of Spain and it is a modern efficient company that seeks to constantly improve it services through innovation. Correos mission is to provide a universal high quality postal service at an affordable price. It is the leading in logistics and Transportation Company in Spain and it presents one of the most extensive passive RFID implementations in Spain. Every day it reaches 19 million homes and 2 million companies transporting over 25 million objects. To do this it has 10.000 retail outlets over 30.000 admission mail boxes and a fleet of 11.500 vehicles. Correos is strongly committed to innovation and quality. It uses RFID to study the quality of their deliveries and it aim is to find areas for improvements within the logistics processes in order to increase efficiency of the universal postal service.

The system is based on the identification of deliveries by electronic labels. These electronic labels, which contain a microchip with the code of the letter, are put on each letter. A team formed by external people collaborating with Correos for this experiment ("penalista") exchange postal mail between them. The sender "penalista" introduces a passive RFID tag in a test letter that is posted in a randomly chosen postbox or post office with rigorous control of the date and time. The letters are transferred to the automatic processing center in the area of origin when the first reading is taken once they are unloaded from the van and passed though the bay.

When they go into the automatic room, the second reading is taken. In the sorting process a code is printed with the information related to the date and time at which the letter passed through the machine (Figure 3.16). When it leaves this and goes to the dispatch bay another check is made. Again the information is caught by the radio frequency reader when the correspondence is loaded. When the transport reaches the destination center the controls are repeated at the same point: in the unloading bay, in the transfers of the trays to the sorting room, in the automatic machine, at the exit to the bays, and in the bays themselves before the van leaves for the delivery unit. Finally, when the test letter arrived to the intended recipient, the exact time of arrival would be recorded by the addressee "penalista" in the corresponding database. The whole RFID process map implemented in Correos is shown in figure 3.17:

Figure 3.16 RFID tag of Correos

Figure 3.17 Correos system map

This project begins with the installation of this technology at the loading and unloading bays of 15 automatic sorting postal centers, 330 readers, 2.000 antennas, 5.000 passive microchips and 4 RFID mobile systems. With this control system any anomaly can be detected in real time and action can rapidly be taken. Correos intends to further develop their RFID use through projects related with the control of their logistics assets (postal containers and trays, mailbags, carts, vehicles, etc.) or the control of postbox collections) (Carrasco-Gallego, Ponce-Cueto, 2009).

3.6 RFID in Spanish agro-food industry

Due to the introduction of food traceability regulations in Spain, companies in the horticultural sector have had to invest in technology to enhance quality and safety in their business processes. Bar code traceability system prevails in the majority of agro-food installations in Spain. However, there are some cases in which the need for a better on-time control of inventory and the accurate on-time information have led to a RFID technology implementations. There are different companies in agro-food sector that have already implemented RFID system; this is the case of Cosiva. The way that the companies use radio frequency identification differs depending on the particular case. However, the benefits that this technology offers to improve the effectiveness and efficiency of these plants are basically the same.

Cosiva was a cooperative producer based in Valencia specializes in citric fruits especially oranges. Unfortunately this company is in bankrupt since 2012. Cosiva consisted of more than 500 small farms, producing 20,000 tons of citrus oranges a year, and the challenges it has had to face in recent years have not only been related to traceability regulations. Forced by need of traceability requirements and encouraged by the need for both operational and administrative processes improvements, they implemented RFID on its plant.

By the use of bar codes, boxes and pallets had to be constantly re-labeled and all the reverse logistics also had to be managed. Immediate consequences were the increase of expenses considering both resources and time. It was also an unreliable system, as when labels were exposed to water they became damaged and peeled off, making the number of correct readings unsatisfactory. Moreover, Cosiva strongly believed that in this type of process the best solution would be an installation of automatic system.

The administrative director reported that solutions based on bar codes were clearly unsatisfactory and expensive continued and that they also caused errors in different parts of our production line, especially in goods receiving and weighing. He stated that these errors had an effect on the payments we had to make to the members of our cooperative. The company found the answer to its problem when it discovered radio frequency identification (RFID) technology. Mesurasoft, the company that had developed the traceability software application, contacted Intermec and discussed requirements.

A reliable, flexible and economical identification system was required to assure comprehensive traceability management from loading by farmers to the entering the food preparation area. Ensuring that the RFID tags could withstand shocks, liquids and any other eventuality that might occur in this type of environment was another important objective. It was also necessary that they could be reused, and that the reading systems enable the company to work in real time. Mesurasoft and Intermec proposed a solution based on the latest IF4 and IF5 fixed readers and portable IP4 terminals, all with Gen2 technology.

The system implemented will be described later. They also designed and patented a type of casing that enabled the tags to travel with the goods and withstand conditions such as pressurized water or impacts on roller belts. The author of this master thesis was in contact to Alberto Fornés, an agronomist engineering who works for Mesurasoft S.L. that has carried out several RFID implementations. Alberto provided the author general information about the system and the challenges and difficulties for the implementation. He also provided a TV video record and some internet links which exemplified how the process is and how it works.

The solution they came up with is described as follows:

- When a lorry arrives with goods after harvest, an employee enters the corresponding data into the tag using a handheld terminal including producer, variety, carrier, grade, size, and even the exact plot from which the product has come (Figure 3.18). This information is saved in the system's database and a tag is associated to it (using an IF4 reader), which accompanies the product throughout the following stages: weighing, insertion into chambers and/or in the grading and preparation process, at which point the tag is reset and can be used again as a new identification tag.

Figure 3.18 Employee entering the information in the tag

- When the oranges arrive at the warehouse, it is logged by putting one RFID tag per pallet among the oranges. This tag remains with the pallet as long as it contains oranges. Once the oranges enter in the warehouse, oranges are weighed. The weighing process is carried out after reading the tag, providing that the pallet is perfectly positioned on the scales. If not positioned correctly, the IF5's alarms will be activated, alerting workers that there is a problem. Once the pallets have been weighed, the system informs the user so that they can be removed and taken to the production line or the cooling chamber (most common) which are the two possible destinations. When the pallet is transferred to the production line, the tag is removed and reset until reused on another pallet. In order to achieve the full benefits of the technology, IF5 RFID readers have been installed in every area of the warehouse in which the oranges needs to be identified for continuous monitoring. The entire RFID process is shown in Figure 3.19:

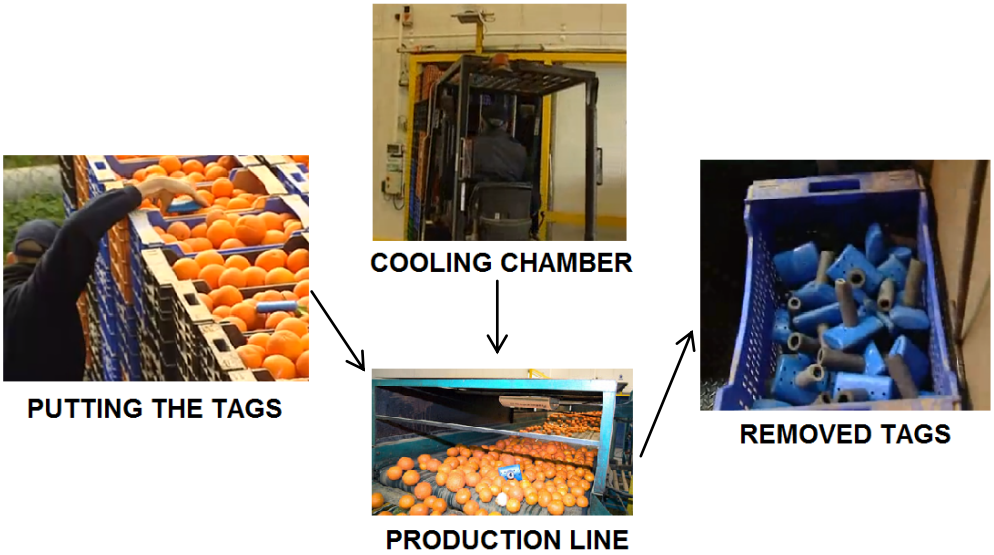


Figure 3.19 COSIVA Process description

The results of this implementation were satisfactory. There is a 100% of reading accuracy, which makes the system more relievable. Another important advantage has been the human labor needed in the process. Except at the entrance, where a qualified person is required, the entire processes are automatic. The faultless control system has also enabled the cooperative to avoid the negative effects of complaints made by transport operators, warehouse staff, agents and even customers after outbound process. Then errors related to human intervention has been reduced as well.

4 Case study descriptions

4.1 Context of the master thesis

The context of this master thesis is the Spanish oranges market which is the place in which this master thesis will be carried out. The context is the same in all the case studies, as long as all producers belong to the same industry and they share a common competitive business environment. Oranges market belongs to agro-food sector, which plays a very important role in Spanish economy, employing thousands of people.

Agro-food industry is very oriented to exportations, which means that in several fruits and vegetables, more than 50% of the production crosses the boundaries of Spain directly to foreign countries for further consume. This is the case of citric, peppers and tomatoes. Agro-food sector in Spain has been characterized by its independence of public power and its focus on market, especially in foreign markets. According to FEPEX (2013) technology innovations in this sector are aimed to:

- Get a large variety of fruits and vegetables

- Implement better ecologic production techniques, in reaction to the higher awareness level of the consumers and the society in general regarding the environment and food safety.

- Have a more efficient control of the production conditions in order to reduce the production costs, to improve the quality and adjust the supply and the demand

The exploration of a process innovation performed in this master thesis through the adoption of RFID in the oranges suppliers´ plants in Spain refers to the third point above. The three companies visited by the author along this Master Thesis were located in Valencia (Spain).

Valencia (Figure 4.1) is a province of Spain well-known because of the quality of its citric, specially the oranges. The particular warm and wet climate makes this region of Spain one of the most proper for oranges cultivation. This province has an established tradition in the cultivation of orange which dates from the Muslim era. This recognition is currently supported by the Citrus Geographic Indication of Valencia, including all municipalities of Valencia (Valencia, Castellón and Alicante). This sector has a particular authority's protection, as long as oranges cooperatives are one of the largest sources of work in this region.

Figure 4.1 Valencia (Google Maps)

4.2 Supply chain overview

During this chapter also a supply chain overview will be performed, with the aim of describing the different actors involved in this particular supply chain which range from producers to retailers.

Since the focus of this Master Thesis is in Spanish Producers outbound flow, especial emphasis will be put both on Spanish suppliers and Swedish clients where oranges are delivered. Three different Spanish suppliers (Rural Sant Vicent Ferrer, Ripoll & CIA and Cheste Agraria), Svenska Retursystem (which is the company that owns and delivers grey RFID pallets to Spanish producers), Nowaste Logistics which is one of the 2 Swedish wholesalers where oranges arrive (this is special interesting for its previous RFID implementation) and two major Swedish retailers (ICA and Coop) will be described in this chapter.

Figure 4.2 illustrates Spanish suppliers and their respective Swedish clients (wholesalers). As it can be appreciated in the figure, all the suppliers use SRS grey plastic pallets to deliver the oranges to ICA warehouse in Helsingborg. Apart from ICA, Anecoop has other Swedish client which is Everfresh AB a sister company of Nowaste Logistics). However, oranges to Everfresh AB are delivered using wooden pallet instead of grey plastics pallets. The potential RFID adoption in Spanish suppliers' outbound flow will also contemplate the potential idea that Nowaste Logistics (that is already equipped with RFID) starts using SRS grey pallets for transporting the incoming oranges from Anecoop.

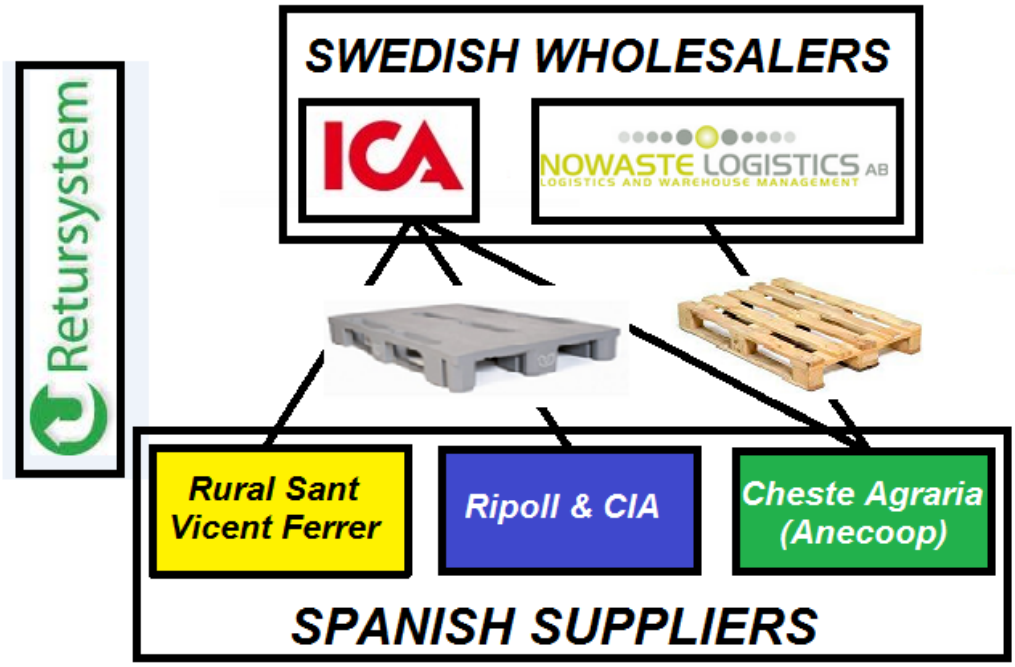


Figure 4.2 Spanish suppliers and Swedish wholesalers

As long as one of the main focuses in this master thesis is on SRS grey pallets, grey pallets ordering and transportation (Figure 4.3) are described below:

1-ICA orders the oranges to Anecoop and Llombart-exports. As it was said before, Anecoop acts as the intermediary between Swedish market and its cooperatives of oranges producers, but Llombart-export is a simple intermediary that matches the demand of Swedish market and some Spanish supply.

2-According to the volume of ICA´s oranges orders, Anecoop and Llombart-exports are in charge of ordering the respective amount of pallets to Svenska Retursystem based on their calculations about the number of pallets needed for fulfilling orange´s orders.

3-Svenska Retursystem is the one that pays the transportation of empty pallets to Spain. However, this transportation is included in the Spanish producer's fees for using the plastic pallets. The fee that Anecoop and Llomabrt-exports pay to SRS consists in an initial cost per pallet and a variable cost per pallet and per day until a pallet reaches the next step in the supply chain (Swedish warehouses).

4-Anecoop and Llomabart-exports are responsible for contacting and assuring the means of transport (trucks) to distribute the oranges from Spanish cooperatives to Sweden. Transportation fee is included in the bill that ICA has to pay.

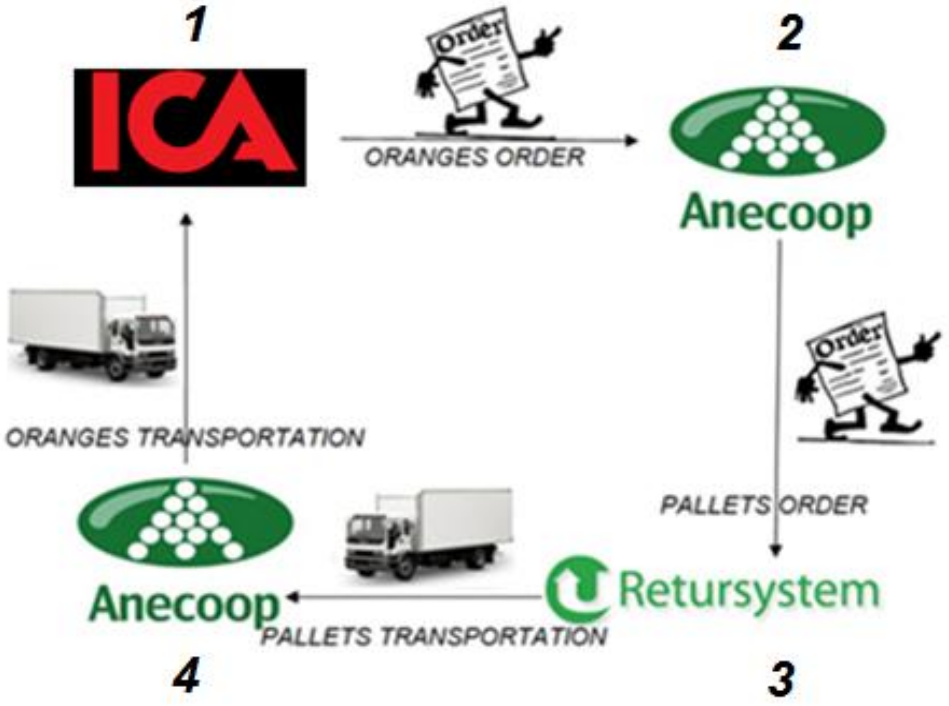


Figure 4.3 SRS grey pallets ordering and transportation process

4.2.1 Spanish Producers

Spanish Producers are those that collect the oranges from the field and export it to several countries around the world (especially in Europe) after processing it in their facilities. These producers and the different issues regarding a possible RFID adoption in their plants have been the focus of this thesis. The companies visited by the author are Cheste Cooperativa Agraria, Ripoll &CIA and San Vicent Ferrer Cooperativa, both located in Valencia (Spain). A complete description of the companies will be developed later on this thesis.

After reviewing RFID literature and doing the first chapters of the Master Thesis, the author travelled to Spain in order to investigate and explore the level of awareness and the level of interest on RFID of Spanish oranges providers which export oranges to Sweden. Three different plant in Valencia (Spain) were visited the 21st and the 22nd of March. These visits were prepared and guided by 2 different companies, Anecoop and Llombart-exports, which are the intermediaries between different cooperatives in Spain and the Swedish clients (Figure 4.4). These two companies and their major activities will be described as follows:

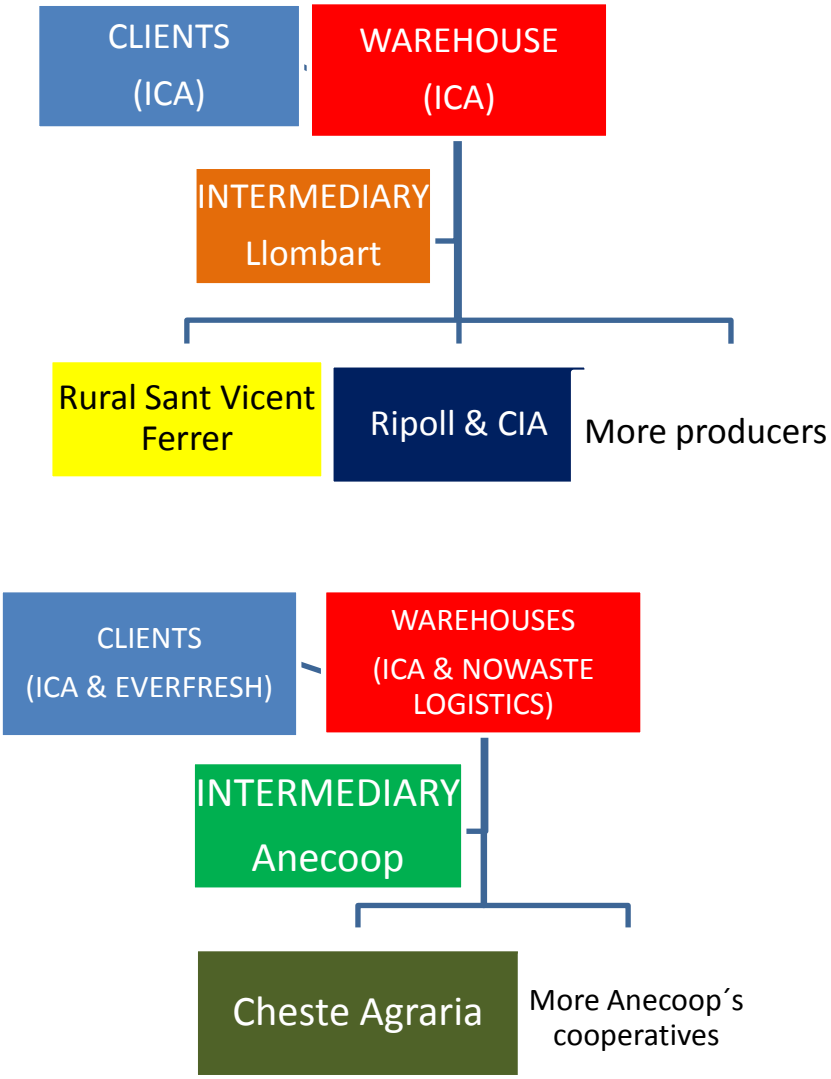


Figure 4.4 Clients, Warehouses, Intermediaries and Producers Mapping

Anecoop was founded in 1975, when a group of Spanish citrus fruit cooperatives joined forces in order to expand their product range, reach new markets and improve their bargaining power with large-scale distributors. They set up Anecoop, a second-tier cooperative or "cooperative of cooperatives" which embraces 79 member cooperatives. Today Anecoop is the Mediterranean's leading fruit and vegetable producer, the Spanish leader in marketing fruit vegetables and salad stuffs, the world's leading citrus fruit exporter and second largest marketer and Europe's top watermelon and kaki supplier. Due to its big size and the negotiation power this cooperative has, Anecoop deals directly with its different clients without needing any intermediary. The turnover of the group is around 500 millions of Euros a year, it exports to 60 countries and it handles around 675000 tons of fruits and vegetables a year.

Llombart-exports is a company that acts as an intermediary between producers and clients throughout Europe in fruits and vegetables sectors. They have access to a large pool of partners experienced producers who cover a wide range of quality products. Llombart-exports informs its customers on the current market situation, prices and harvest expectations. In addition, they keep in close contact with the growers to ensure that they benefit from first-hand information. Its services range from order, including price agreement and produce procurement, quality management and certifications to delivery. It also offers just-in-time delivery, arrange and monitor the transport of fresh produce - from producer to customer and they actively support their customers in the sales process through sales campaigns, development and design of new brands and many other special services.

The first visit was guided by Felix Roda which works for Llombart-exports. A meeting was held on Rural Sant Vicent Coopèrativa in Benaguasil (Valencia) with Ramón Barber, the commercial director of the cooperative. After visiting this cooperative in the morning, the author had a lunch with Felix which had prepared another visit in the evening in other plant. This plant was Ripoll & CIA, located in Carcaixent (Valencia). Unlike Rural Sant Vicent Ferrer Cooperativa, this plant was not a cooperative; it was a family-owned company. A meeting was set up with Felix (Llombart-exports), Inés and Pablo Ripoll, who belong to the family that own company.

Next day author visited Anecoop main offices located in Valencia´s downtown. It was a large meeting with Nacho Juarez who is the commercial responsible for the north zone clients of Anecoop. Nacho also facilitated to the author a contact to visit one of the 76 cooperatives which belong to Anecoop group. This cooperative was located in Cheste that is 20 km away from the city of Valencia. Cheste Cooperativa Agraria was visited during the evening and guided by Daniel, the quality technician of the cooperative.

4.2.2 Svenska Retursystem

Svenska Retursystem (Figure 4.6) is the pool logistics operator that was established in Sweden at the end of the 90´s and is the one which owns and manages the returnable plastic pallets and crates that are sent to Spanish producer´s plants for filling and further transportation to Sweden, where oranges are consumed.

In the 1990s, a number of working groups were formed to study, test and discuss the possibilities of introducing an open-loop pool for transport packaging, including trays and pallets. Svenska Retursystem (SRS) is a Swedish business wide pool system founded in 1997 that employee 100 people. It headquarter is located in Stockholm.

SRS has around 1000 clients both in Sweden and outside Sweden and has a turnover around 4, 4 billion SEK. It is owned 50% by Swedish Food and Drinks Retailers Federation (which major actors are ICA Sverige AB, Coop AB, Axfood AB and Bergendahls Food AB), and 50% by an Association of Daily Goods Supplier DLF (Coca-Cola, Arla, Scan…).This company develops and operates an efficient and environmental-friendly return system that simplifies and improves customers' logistics and distribution of goods with a 99, 8% delivery precision.

This company develops recycling systems based on crates and pallets that provides and effective supply chain, from producer to wholesaler and finally to customers in stores. Its core values are three: simplicity, environment and efficiency. The system is simple because is covers the whole supply chain; it is efficient because it leads to a reduction of material and wastes; and it is environmental-friendly since important material saving can be reached by using the same packaging system much more than once. The main idea behind SRS foundation was to provide a centralized efficient logistic service throughout Sweden applying reverse logistics.

Reverse logistics is becoming an important issue as the world of today has to deal with the destruction of the rain forest, acid rain, ozone depletion, global warming, hazardous waste and the depletion of non-renewable natural resources. Reverse logistics refers to the logistics management skills and activities involved in reducing, managing and disposing of hazardous or non-hazardous waste from packaging and products.

In systems with return logistics all the containers are owned by an agency. This is the case of Svenska Retursystem, where containers that are not used are stored in its depots. Pallets and crates that arrive to SRS facilities in Helsingborg, Örebro, Vasterás and Molnlycke are cleaned and maintained for further reuse (Figure 4.5).

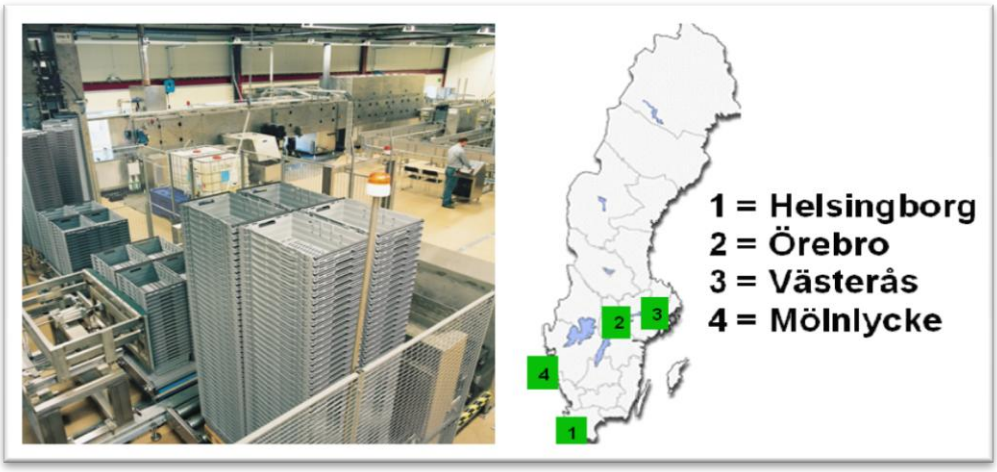


Figure 4.5 Senska Retursystem washing plants

The key performance indicators for pool depot systems include: Total cost saving (comparing to disposable packages), Speed of circulation (maximizing number of trips per year for each tray), Space reduction of empty returnable packaging, Dimensioning of typical need for packaging units (per day, per week, per month…), Management of seasonal and peak variations, Minimized loss of packaging items, Minimized geographical imbalances and Administration cost and control systems. The issue of introducing RFID to replace paper labels with bar codes is an example of the pool company's ambitions to take the lead as the driver of logistics efficiency. First generation of returnable crates were not designed for RFID technology.

However, the second generation family of trays was redesigned for a future installation of RFID tags on their transport packaging. It resulted in a pay-off time of less than three years. But RFID technology is still too expensive to introduce on a full-scale basis. (Gutafsson, 2008). According to Gutafsson, in 2008 10% of the pool company's turnover comes from exports of empty trays and pallets (Figure 4.6) to fillers abroad. Meat from Ireland and fruit from Spain are examples. The numbers of exports are expected to increase. That's why a company appointed an Export Sales Manager to deal with foreign customers. Major European retailers already have their own returnable transport trays, which are also sent empty to fillers abroad.

Figure 4.6 Svenska Returnsystem pallets (SRS website)

The central agency monitors the movements of the pallets with data from the participants on the number of pallets shipped between them through the "Returportalen", which is the name of the management interface on the homepage. Goods deliveries are to be reported at Returportalen in connection with the physical delivery. If deliveries are not reported continuously, the balance can be affected and lead to incorrect balances when performing inventory (Figure 4.7). For a better control of their pallets (Figure 4.8), SRS eventually sets up a day in which all the users of the system have to perform an inventory in their installations. It is important that all completed deliveries have been reported the day before the inventory.

Figure 4.7 Inventories (Returportalen)

Figure 4.8 Grey pallets (SRS)

In spite of the fact that SRS owns two different kinds of pallets (black and grey), the grey plastic pallet tagged with RFID (Figure 4.9) is the one which is used by Spanish oranges producers. SRS pallets contain two passive tags that are encoded with global returnable asset identification numbers, GRAI-96, and follows Gen 2 standards following the EPC scheme and EPCglobal´s Tag Data Standard. The use of these pallets with RFID eliminates the tagging stage, but the tag number should be connected to specific orders and transport labels still need to be attached to a pallet. The description of this item is shown below:

Figure 4.9 Grey Plastic Pallets features (SRS website)

Figure 4.10 Svenska Returnsystem crates (SRS website)

For using the crates (Figure 4.10) all participants involved in the flow of goods pays a deposit on the crates as they pass through the system. It means that when the producer receives the crates, he pays a deposit to SRS (around 5 €). When producers send the filled crates to the wholesaler, this one pays the same deposit to the producer, and so on. The wholesaler is the responsible for collecting and storing the crates after being emptied at stores. For using the pallets the users have to pay the delivery of the pallets and then a variable fee depending on the number of pallets they have and the number of days that a pallet stay at the user facilities. When there is an enough amount of pallets or crates for a cost-effective collection, SRS picks them back to their facilities (Figure 4.11).

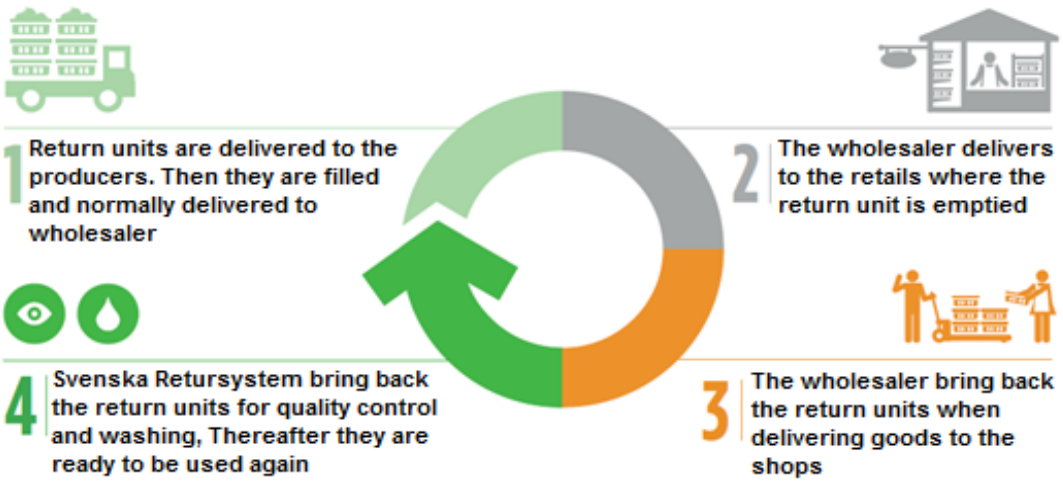


Figure 4.11 Depot system: Pallets and Crates flow (SRS website)

4.2.3 Nowaste Logistics:

This is one of the two Swedish wholesalers that are part of the supply chain of this thesis (the other is ICA Helsingborg), and the most interesting to talk about because of its RFID implementation. Nowaste Logistics (Figure 4.12) is a third party logistics provider that focuses on logistics solutions for warehouse activities demanding high effectiveness and efficiency. Nowaste Logistics performs logistics services for its sister company, Everfresh AB. Apart from Everfresh AB, Nowaste Logistics also offers logistics services to other companies. Everfresh AB is one of the main clients of Anecoop. Contrary to ICA and despite the fact that Nowaste Logistics is equipped with RFID technology, Everfresh AB orders the oranges in wooden pallets instead of SRS grey pallets. However, author has considered important to take Nowaste Logistics into account in this thesis because of it is a supply chain partner that will potentially benefit if Anecoop adopts RFID in its outbound flow.

In Nowaste Logistic´s warehouses (Copenhagen Stockholm and Helsingborg), mixed pallets are produced and mixed and uniform pallets are consolidated in orders to wholesalers and retailers. Around 300 persons work for Nowaste Logistics, 200 of them work in Helsingborg, where the head office is located. The warehouse in Hellsingborg has an area of 11500 m2 and handles 100000 secondary packages each day in average. The turnover of the stock varies from 1, 6 to 2, 2 days. During a week orders are sent to approximately 850 different retailer and wholesaler stores.

Around 830000 different kinds of pallets (included grey pallet) are shipped from Nowaste Logistics warehouse in Helsingborg each year. Nowaste Logistics is always looking for innovative ways to improve efficiency and reduce possible sources of error. One of these error sources was the occurrence of outbound pallets ending up at wrong destinations, since it is both costly and reduces customer satisfaction. In order to assure customer satisfaction, innovation and fast response to customer demands are important issues for the company. The managers at Nowaste Logistics saw a great potential in RFID technology and they decided in 2009 to invest in a RFID implementation to manage the outbound product flow from their warehouses.

The author of this Master Thesis has been in contact to Robert Davstedt who is a Project and IT Controller at Total Produce (The group that owns Nowaste Logistics). Robert was so proud about the idea of this Master Thesis as long as Nowaste Logistics is thinking about incorporating RFID also in its inbound flow. This interest in pretty obvious: they have already invested money on RFID systems, and they can benefit of the potentials of the technology in the inbound flow just by buying hardware equipment because software system is already in place.

This requires cooperation between upstream partners by adopting RFID in their outbound flow. Robert said that hopefully the first step to implement upstream in the supply chain will be taken this summer. According to Robert, they are going to implement RFID in the inbound process of the facilities first hand with Swedish suppliers, but later on with the rest of suppliers. He argued that the implementation downstream has so far been none mainly due to economical discussions and that the current low misplaced goods and efficient receiving are contributing to reduce RFID adoptions.

Figure 4.12 Nowaste Logistics AB Helsingborg (Nowaste Logistics website)

4.2.4 Retailers:

Spanish producers main clients in Sweden are two of the major retails of the country: ICA and Everfresh AB. Everfresh AB main client in Sweden is COOP.

Coop is the name of the KF Group's grocery retail group. It is the largest customers of Everfresh AB (sister company of Nowaste Logistics). Coop accounts for 21.5% of the grocery retail market in Sweden. The number of employees is 7300. All Coop stores order their oranges by themselves directly from Everfresh AB. These orders make up the majority of Nowaste Logistics outbound flow.

ICA AB is a Swedish retailing corporate group. Most of its operations are based in Scandinavia, and the company is the largest retail company in the Nordic countries. ICA was owned by the participating retailers until 2000 when half of the company was sold to the Dutch retailer Ahold. It acquired a further 10% in 2004. Ahold is prevented by contractual obligation from exercising majority control over ICA (Wikipedia, 2013).

4.3 Rural Sant Vicent Ferrer Cooperativa

Rural Sant Vicent Ferrer Cooperativa (Figure 4.13) is a cooperative located on Benaguasil (Valencia). This was the first cooperative visited by the author, so all was pretty new at the beginning. The person interviewed at this company was Ramón Barber, Commercial Director of the cooperative, which explained how a normal cooperative works, how the cooperative is organized and who the owners of it are. In order words, he tried to open the eyes of the author regarding the way these types of organizations are managed. Each farmer member of the cooperative is the owner of a part of the company, and decision making only depends on the farmers´ agreements.

After that, he provided information to the author about the company, like number of employees, the clients, and the Swedish customers they export to. At peak season around 400 people work for this cooperative. Around 80% of the oranges they handle are exported to Europe, Russia and Canada. This company handles 25000 pallets in a year, of which 3000 are SRS RFID pallets. The only Swedish client this cooperative has is ICA, which forces this cooperative to handle SRS RFID pallets when sending the oranges to Sweden. Invoicing process is done manually in this company, which is an indication that this company level of innovation is still immature.

Author also explained to Ramón the principles of this Master Thesis as well as RFID technology principles and benefits for applicants and for the supply chain in general. After a one-hour meeting, Ramón was asked to fill the interview that was sent to him a couple of days in advance. Then author was invited to visit the plant and the production process guided by a quality technician.

Figure 4.13 Sant Vicent Ferrer Cooperativa

4.3.1 Production process description

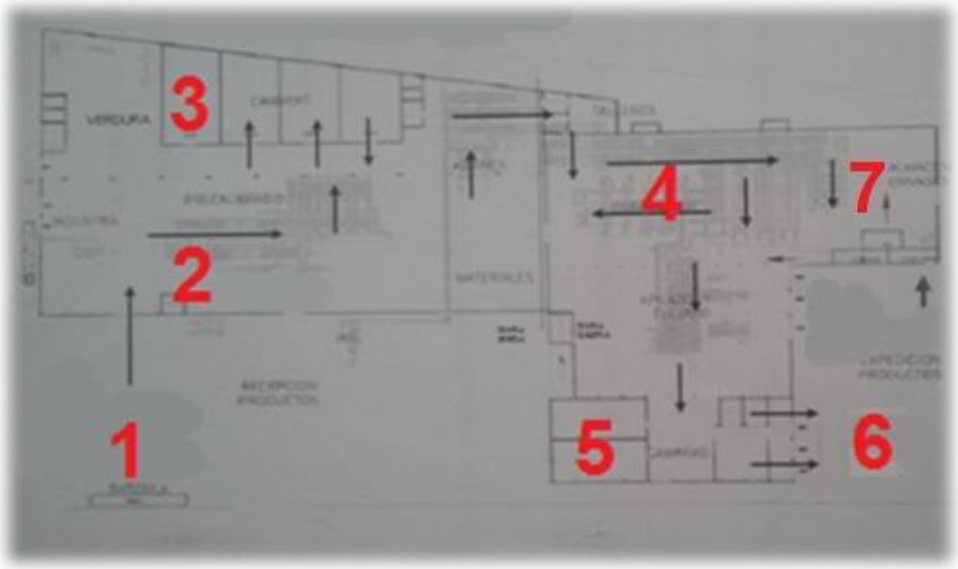


Figure 4.14 Rural Sant Vicent Ferrer Cooperativa Layout

1-Entrance:

This is the gate where the oranges collected in the harvest pass through. Oranges are contained in a blue crates and those crates are stacked in wooden pallets. Before entering in the facilities, the pallet information (type of the orange, the color, the date, the weight and the farmer) is labeled and the label is attached manually by an operator to a crate. This information is then registered in the company data base.

2-Precalibrating process:

Once the pallet has entered in the facilities, it has two possible destinations. Oranges can pass through the pre-calibrator, where they are classified in terms of its size to further storage in the cooling chamber (Figure 4.15) or they can go directly to zone 4 where oranges can also be calibrated and immediately packed for fulfill the orders. At the entrance of the pre-calibrating machine there is an automatic reader for the bar codes, which read the information associated to the pallet and automatically reports that information to the company management system. Ramón argued that the reading process normally works properly, but sometimes there are errors of reading due to the bad state of the label or because of the position of the label. After pre-calibrating process oranges are loaded in same packages (blue plastic boxes) and tagged again identifying the size, the date and the variety of the oranges. This information in also recorded into the company data bases, which allows them to have an accurate control of the type of oranges they have in stock at that moment.

Figure 4.15 Pre-calibrated oranges

3- Cooling chamber:

This zone should preserve a temperature around 5 Celsius degrees. This is the destination of oranges that have been pre-calibrated in zone 2 and has to be stored for further orders. It can also be the destination of the oranges that enter in the plant through the entrance 1 and also have to be storage before pre-calibrating basically as a consequence of demand and process requirements.

4- Production line:

The production line (Figures 4.16) is composed by a calibrating machine similar to the pre-calibrating one and by the production line itself. The calibrating machine is needed for the oranges that go directly to this zone without having been prior pre-calibrated. The entrance of the calibrating machine includes an automatic bar code reader. In this case there is no need to attach a bar code indicating the size of the oranges since it passes directly to the production line according to this. In this area and before packing, oranges are waxed and introduced in an oven to fix the wax. Several employees work along the production line checking the state of the oranges and packing the packages needed to fulfill the different orders of each specific moment.

As it was said before, it is remarkable the vast amount of different packages (both at crate and pallet level) that this cooperative handles depending on the client. In the case in which oranges are packaged in cardboard boxes, oranges can be palletized manually or automatically since there are only two automatic machines for palletizing. The operator is the responsible for selecting the proper pallet for each order and for putting the pallet at the end of the line in order to fulfill it once the boxes leave the production line. In the case of IFCO compressed boxes (which are a plastic boxes with an approximately one cubic meter of capacity), they are filled in a different line and then stacked one on top of each other above a plastic pallet that also belongs to IFCO system.

Figure 4.16 Production line top perspective

5- Cooling chamber:

It is similar to the cooling chamber of zone 2. It also has to preserve the same temperature and the same conditions of the oranges like the other chamber. This is located prior the loading gate of the plant where oranges are loaded into trucks in order to protect the oranges exposed to be in that area large periods of time before trucks arrive to the facilities. Although the information about the pallets that are in this chamber are recorded in the data base of the company, on this stage operators perform manual inventories to make sure that the orders have been processed.

6- Loading gate:

After tagging the orders with a bar code label and the storage in the cooling chamber (most common), packed oranges leave the factory by truck through the loading gates (Figure 4.17) to be delivered to the different clients. When truck driver arrives, the delivery note is signed and the pallet bar code is read to check that the order is matched properly and to report this information to the data base of the company that confirms the delivery of the order. This is the first year the cooperative is reading the bar codes when pallets leave the plant, and this decision was made in order to mitigate several confusions like: now exactly the date when goods leave the plants, make sure that orders have been fulfilled (before this was done manually through the delivery note, which often lead to misunderstandings).

Figure 4.17 Loading gate and IFCO green packages

7- Packages depot:

This is the place where empty pallets and different boxes are stored to be further utilized in the factory. The operator is the responsible to pick them up depending on the different orders which are processing in the production line.

As it can be extracted from the process, traceability of the product is made both for internal and external control due to external regulations. Traceability process starts at the entrance of the plant and ends when trucks are loaded for further distribution. Ramón Barber argued that since bar codes are a well-established way of traceability among the cooperative and their trade partners, they have never thought about implementing RFID in his plant. However, they have a little knowledge about what RFID is and he also knows that there are more agro-food industry plants in this region that are already using this technology. The interview and the responses of Ramón will be developed in the following chapter about the analysis and findings.

4.4 Ripoll & CIA

Ripoll & CIA is a private plant owned by Ripoll family which is located in Carcaixent (Valencia) founded in 1980. Two persons were interviewed it this visit at the same time: Inés Ripoll and Pablo Ripoll, which are the managers (and partly the owners) of the company. The number of people who work for this company varies a lot depending on the seasons, but they are around 300 when the highest human labor is needed at peak seasons. This company has different brands for their oranges, regarding clients, variety of arranges and their quality. Ripoll & CIA handles 20000 pallets in a year, of which 1200 are SRS RFID-tagged pallets.

This company delivers to local Spanish market, Sweden, Norway, Denmark, Finland, Belgium, France, Germany, Check Republic and Poland. Exports include the majority of the production, reaching almost the 90% of their deliveries. Ripoll & CIA is highly committed with food regulations, and they have already introduced a quality system based on ISO standards. Like in Rural Sant Vicent Ferrer Cooperativa case, the only Swedish client this cooperative has is ICA, which forces this cooperative to handle SRS RFID pallets when sending the oranges to ICA warehouse in Helsingborg. Oranges are transported by truck directly from the cooperative to Sweden. All invoicing processes with their clients are done manually in Ripoll & CIA.

A meeting was held in the offices close to the production plant. As in the previous visit, interviewees were informed about this Master Thesis and the study of the adoption in its outbound flow. When author started to explain RFID principles, Pablo Ripoll interrupted him saying that they already use RFID in their processes and that they are familiar with the technology. Unlike the other plants, Ripoll & CIA has incorporated RFID in its daily operations. This RFID implementation took place in 2005, but only for internal operations. Some RFID processes have been modified or eliminated from the practices of the company but the current overall performance is highly satisfactory according to the interview respondents.

However, there is a high coexistence among RFID and bar codes, which are widely utilized also in this plant. After the meeting, author was also invited to explore the practices of the company, and the different parts of the production process guided by Pablo Ripoll which put special emphasis on the RFID installations and the part of the process affected by this.

4.4.1 Production process description

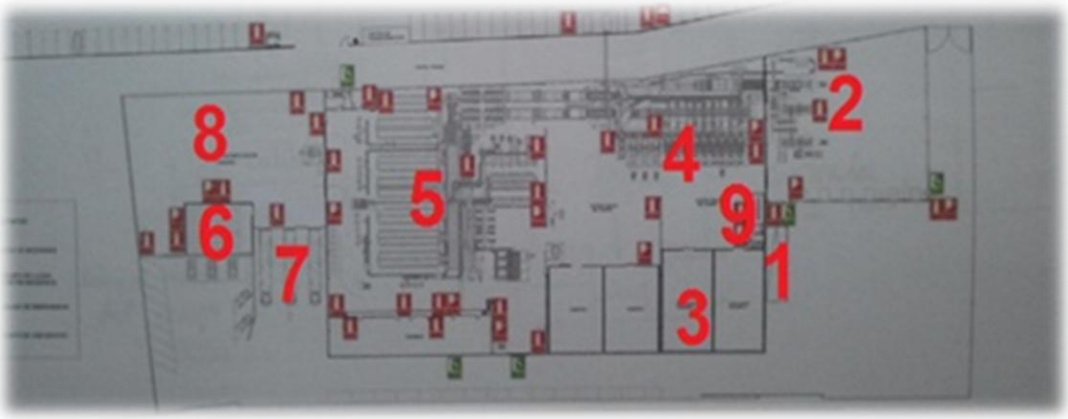


Figure 4.18 Ripoll & CIA Layout

1-Entrance:

This is the gate through which the oranges collected in the harvest enter in the plant. Oranges contained in a blue crates and those crates are stacked in wooden pallets. Before entering in the facilities, the pallet information (type of the orange, the color, the date, the weight and the farmer) is labeled and the label is attached manually by an operator to one crate of per pallet. Oranges are weighted after harvest. The system recognizes automatically the weight of the truck and estimate the amount on oranges (in kilograms) that the truck contains.

2-Chamber for the incoming goods:

Pallets filled with oranges after entering in the facilities as well as empty pallets are stored and handled in this zone of the factory. As the same as in the other case, oranges can be incorporated directly to the pre-calibrating process or can be stored in cooling chamber (zone 3) when there are no orders to process and in order to lead oranges deterioration because of the temperature.

3- Cooling chamber:

This zone should preserve a temperature around 5 Celsius degrees. Differently than in Rural Sant Vicent Cooperativa case, in the case of Ripoll & CIA this chamber is utilized both for the incoming oranges that haven't been processed yet and for pre-calibrated oranges.

Over the last years, these gates in the chamber were equipped with RFID readers. When oranges were pre-calibrated and palletized in the pre-calibrating line (zone 4) a RFID tag contained inside of a plastic capsule is put on each of the pallet with all the information required at this step of the process. Then, this "tagged-pallets" go to the cooling chamber in order to maintain the oranges in good conditions after being processed for the orders. This process will be further developed later on it.

The reason why they decided to take the readers off from the cooling chamber entrance is that, as can be appreciated in the picture below, there are several tagged-pallets after pre-calibrating process waiting to enter into the cooling chamber. The problem was that due to space limitations, that tagged-pallet have to stay near RFID readers, so it led to non-desired readings that have to be removed from the system. Those problems resulted in the removal of the readers from the gates.

4- Pre-calibrating line:

In this factory, all the oranges are pre-calibrated before entering in the final production line (Figure 4.19). Bar code attached at the entrance of the factory is automatically read at this point by an automatic fixed bar code reader and then reported to the company information system data base. All the oranges that the factory handles pass through this point. The size of the oranges is not the only thing determined along this process. Moreover, in Ripoll & CIA plant the quality of the oranges is measured through an especial camera capable to identify the color of the oranges and their shape when they pass through pre-calibrating line (Figure 4.20).

There are 3 lines for each oranges size an each one of the three lines contains different oranges in terms of quality. Once the oranges leave this process, they are packed in the blue crates and an operator introduces the information about the oranges (size, quality of the oranges and the cooling chamber where oranges will be stored) manually in their system. Then he passes this information to a RFID tag which is introduced in one of the top crates of the pallet. After that, oranges go the cooling chamber until they are finally processed for the orders.

Figure 4.19 Pre-calibrating line

Figure 4.20 Software for the quality of the oranges

5- Production line:

In the dumping process there are RFID readers that detect what kind of oranges are going to be processed in this line. After that, an operator is the responsible to remove the RFID capsule from the line and drop it in a box that contains more capsules to be reused again (Figure 4.21).

Figure 4.21 Employee removing TFID tags

As in the other case, oranges are waxed and introduced in an oven to fix the wax before packing. In Ripoll & CIA´s production line there are also several employees that work along the production line packing the packages needed to fulfill the different orders of each specific moment. These employees are not required to analyze the state and quality of the oranges, as long as they have been determined automatically during the pre-calibrating process and it is contained in the RFID tag. As in the other case, employees are responsible for packaging oranges in the production line manually in the cardboard boxes. Ripoll & CIA only uses cardboard boxes as the packaging system that goes directly to fill the pallets.

The number of different cardboard boxes is huge due to the fact that this company has different own brands and they also have different customers. This company doesn't handle any kind of packaging system similar to IFCO system or something like that. The pallets this company handles are basically SRS tagged pallets and wooden pallets (EURO-pallet, CHEP pallets and one-way disposable wooden pallets). Ripoll & CIA owns two automatic machines for palletizing. In the other lines, palletizing orders are done manually.

6- Processing chamber:

This is another cooling chamber that maintains the oranges refrigerated when orders are waiting to be loaded in the trucks for their distribution. At the entrance of this zone, pallets are wrapped with a plastic film and attached with a bar code with all the respective information of the oranges and the order. Like in the other case, on this stage manual inventories are performed to make sure that the orders have been processed.

7- Loading gate:

It is shown in Figure 4.22. This is the same process than in Rural Sant Vicent Cooperativa case. After leaving the processing chamber, packed oranges are loaded into trucks to be delivered to the different clients. An employee reads the bar codes and signs the delivery note when pallets leave the plant in order to have a better internal control and to make sure that the orders are matched properly.

Figure 4.22 Loading gates

8- Packages depot:

This is the same process than in Rural Sant Vicent Cooperativa case. This is the place where empty pallets and different boxes are stored to be further utilized in the factory. The operator is the responsible to pick them up depending on the different orders which are processing in the production line.

4.4.2 RFID internal applicaiton

In zone 9, there is all the equipment needed for the RFID process. After the oranges are pre-calibrated, the operator introduces the weight, quality and the size of the oranges as well as the date and the cooling chamber where this pallet is going to be stored. After entering all this information in the computer, this employee takes a RFID capsule (Figure 4.23) and puts it near the device shown in Figure 4.24 and Figure 4.25. This device associates all this information from the computer to the tag.

Figure 4.23 RFID capsule tag

Figure 4.24 RFID device for transmitting information

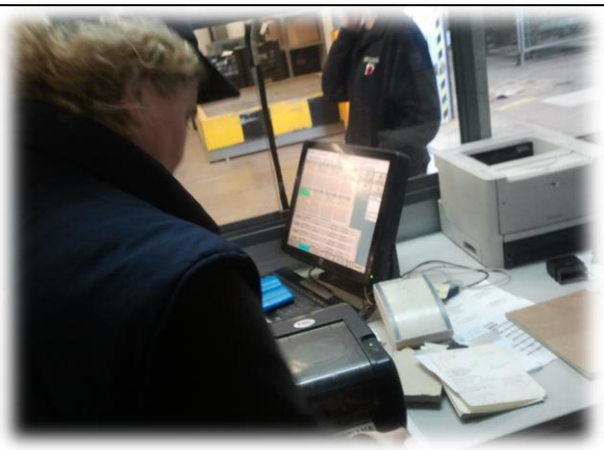


Figure 4.25 Operator introducing information in the RFID capsule

By doing this (Figure 4.26), Ripoll & CIA is able to have a fully control about the stock available in the cooling chambers when they receive an order. Managers and logisticians are also capable to detect the different orders that are in the production line at any time because at the entrance of this zone is where RFID readings take place, and this information is all the time available in the information system for the internal control of the company. But this system brings other advantages; for instance, employees can detect in which cooling chamber a pallet that contains a specific size and quality is located when it is the time to process one order demanding those specific oranges. Tags contain an EPC identifier that provide them a unique identity and follow Gen2 standard for RFID. Tags and readers operate in Ultra High Frequency. Software and middleware installations were carried out by Mesurasoft SL.

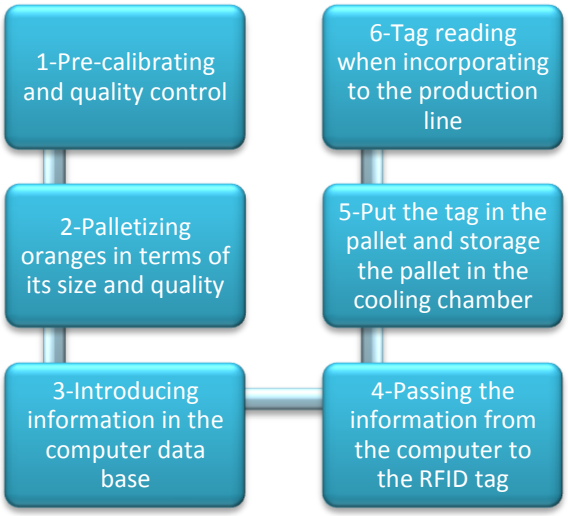


Figure 4.26 RFID whole process

4.5 Cheste Agraria Cooperativa

Cheste Agraria Cooperativa (Figure 4.27) is a cooperative located in Cheste (Valencia). As it is known, in the cooperatives there are a limited number of farmers which are the ones who owns the company. Not all the cooperatives of the group exports to Sweden. In this case, the interview was performed at Anecoop offices in Valencia with Nacho Juarez who is the Commercial Responsible for the northern Europe market. Anecoop is like a cooperative of cooperatives, which means that 76 different cooperatives widespread throughout this region joint forces together aiming to reach commercial and organizational gains. The number of employees of each cooperative is around 300 employees at peak season on average and has a large list of clients in 60 different countries. Anecoop group handles 900000 pallets in a year, of which 6000 are SRS RFID pallets. After the meeting at Anecoop offices, Nacho contacted a cooperative of the group which was visited by the author that afternoon.

Figure 4.27 Cheste Agraria Cooperativa

According to Nacho, all the cooperatives that belong to this group have the same traceability requirements and have very similar internal processes when processing the oranges. Nacho provided to the author a lot of information regarding traceability in Anecoop cooperatives. It was pretty similar to the practices of Rural Sant Vicent Ferrer Cooperativa and Ripoll & CIA, but in order to shorten the amount of information during this report, this information was included before to get a general overview of their traceability practices. This cooperative has two Swedish clients: ICA (SRS grey pallets) and Everfresh (wooden pallets). The largest client of Everfresh is the Swedish retailer company COOP.

This cooperative was the only one that provided documentation about traceability processes to the author, which range from oranges growing to the outbound flow in the plant. This documentation was contrasted and reviewed by the author, and traceability practices of Anecoop were pretty much in line with traceability practices of Rural Sant Vicen Agraria Cooperativa and Ripoll & CIA.

4.5.1 Traceability in Anecoop´s cooperatives

4.5.1.1 Traceability process

Traceability requirements procedures close the circle of the information from field to costumer. Traceability scheme provided by Anecoop to the author consists in:

- The identification procedures for the raw product.
- The storage flow protocol for identification and efficient handling.
- The software and/or procedures to link during packing process the different field lots with the final product, either separating lots (for very big lots) or aggregating in groups of traceability.
- The labeling for boxes, pallets, or sales of units (nets) of the final product with the correspondent traceability lot code.

The whole traceability process and filled information will be summarized in Figure 4.28 and Figure 4.29 respectively. Despite the fact that this information about traceability processes was provided by Anecoop, this processes is almost identical in the other cooperatives visited. Of course there are exceptions, like in the case of Ripoll & CIA that will be reviewed later, where a RFID system was implemented in order to support and reinforce internal processes.

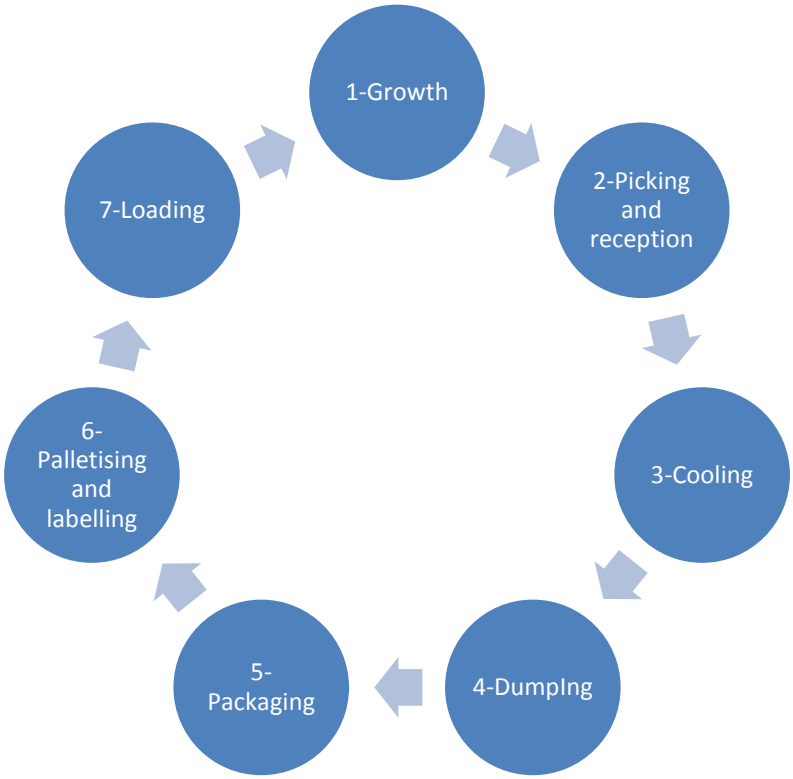


Figure 4.28 Traceability process flow (Anecoop catalogue)

PROCESS	SOURCE OF INFORMATION	FILED INFORMATION	REMARKS
GROWTH	Grower individual plot data (fertilization, treatments, irrigation…).	Computerized or manual file of the field's info.	Accessible files.
PICKING AND RECEPTION	Plot ID, picking date, variety, amount In Kg, quality and size.	Collect of information and unmistakable identification of the lot.	Follow labeling specs. First oranges classification.
COOLING	Cold storage	Collect if data and link of processes with their values of control (temperature, CO2...).	
DUMPING	Identification of lots by laser readers (bar code labels) or time marking of labels (conventional).	Conventional or automatic lot data captured.	Rejection of lots non suitable for special works.
PACKAGING	Post harvest treatments.	Treatments registration with control values.	
PALLETISING AND LABELLING	All pallets labeling with EAN 128 or conventional with serial/lot code.	Link timing of processing with labeling time (manual or automatic).	In automatic traceability, immediate registration of original lots.
LODING	All the coming information and data and lorry number, client, time of loading…	Link commercial lots with traceability global information.	Easy and quick availability of the info.

Figure 4.29 Anecoop´s traceability steps (Anecoop catalogue)

4.5.1.2 Traceability modules

There are 6 different modules where traceability information is required (Figure 4.30). Cooperatives basically store information in their data bases basing on the different stages: Parcels management (control over the crops) and Factory management (control over the internal processes).

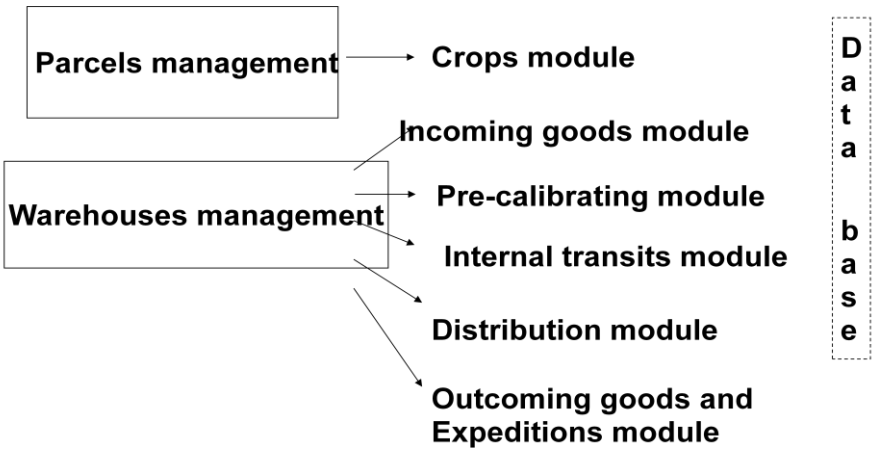


Figure 4.30 Cooperatives traceability modules (Anecoop catalogue)

4.5.1.3 Bar codes

For the labeling Anecoop has also developed together with EAN international a global labeling system. This is based on EAN-13 commodity codes and adopts the EAN-128 configuration of labels to pallets and boxes (Figure 4.31). It will include a general data-base in real time for all the members of the supply chain, with record of the traceability information. Traceability practices follows the regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002 laying down the principles and requirements of food law, establishing the European Food Safety Authority and laying down procedures in matters food security. Therefore, all products must be traceable from January of 2005. Anecoop uses EAN 13 bar codes and EAN 8 for unit for sales, and bar codes EAN 128 for units of transport and logistics.

Figure 4.31 EAN bar codes (Anecoop catalogue)

The most used and standardized among Anecoop practices is EAN 13 bar code: number 84 refers to the country, number 12276 refers to Anecoop, number 12345 refers to the product code (Anecoop catalogue) and 1 is the digit of control. According to the New Regulation (EC) No. 178/2002, all products must be traceable from January of 2005. In order to do this, Anecoop performs commissioning of Traceability in two different levels: Traceability to drive sales and traceability box and pallet.

Anecoop has specific automatic programs that recognize the date and time of the unit manufactured (nets) with automatic tracking system by identifying the machine and a clock (Figure 4.32). Traceability of the sending unit (crate/box and pallet) is made by using the serial code (00) of the EAN 128. Figure 4.33 shows the crate/box label:

Figure 4.32 Date and time of the unit of sales (Anecoop catalogue)

Figure 4.33 Crate label (Anecoop catalogue)

In the first bar code, number (01) refers to the type of product; number (92) refers to the type of crate, while number (414) refers to the cooperative. The second bar code is the Serial Shipping Container Code which contains a fixed indicator 1, the EAN code of the supplier 8412276 and the number of the crate or box 0000167548. Regarding the pallet label, Anecoop uses bar codes as well. This bar code is shown in Figure 4.34:

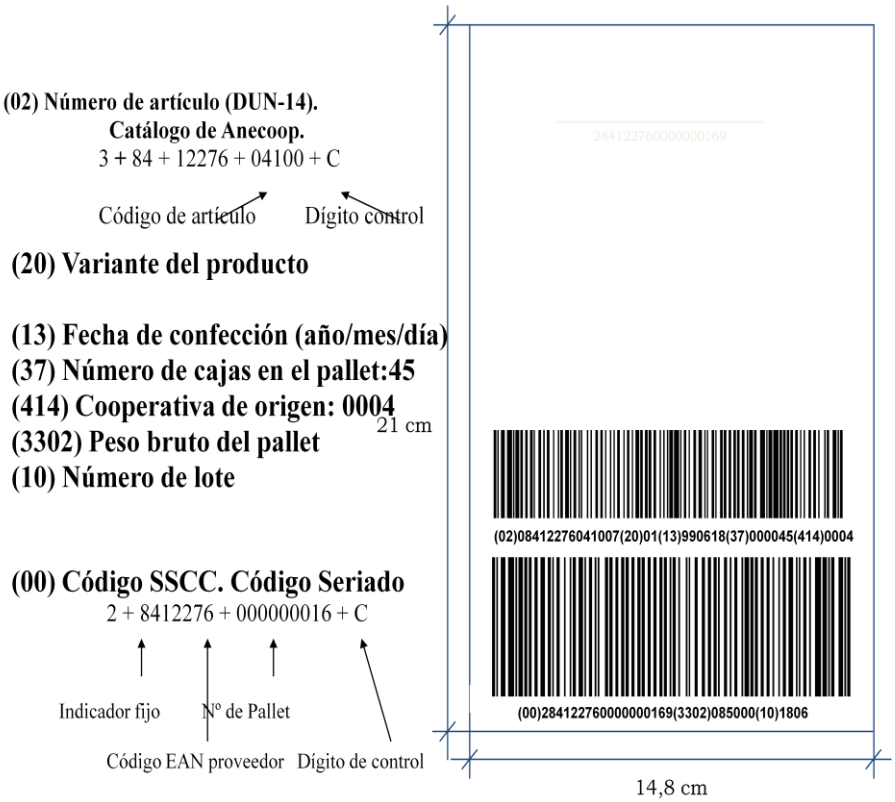


Figure 4.34 Pallet label (Anecoop catalogue)

Although it is indicated in the picture, text it is in Spanish, so translations in English referring to the meaning of the most important digits in the bar code are described here. In the first bar code, (20) refers to the type of product, (13) refers to the date the label is printed, (37) is the number of boxes/crates per pallet, and number (414) refers to the cooperative. In the second label, the relevant numbers are (3302) which means the total weight of the pallet, and the number (10) which refers to the number of the lot. As in the crate/box-level bar code, the second bar code contains the Serial Shipping Container Code with a fixed indicator 2, the EAN code of the supplier 8412276 and the number of the pallet 000000016.

4.5.2 Production process description

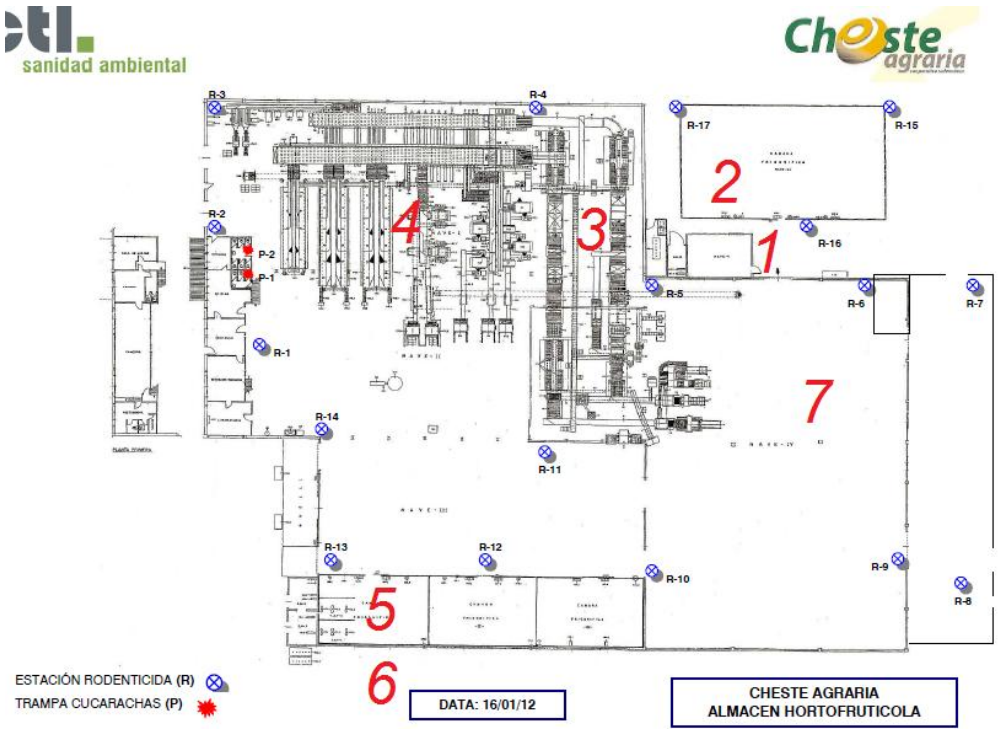


Figure 4.35 Cheste Agraria Cooperativa Layout

1- Entrance:

As in the other cases, the entrance is the gates through which the oranges collected in the harvest enter in the plant. Oranges contained in a blue crates and those crates are stacked in wooden pallets. Before entering in the facilities, the pallet information (type of the orange, the color, the date, the weight and the farmer) is labeled and the label is attached manually by an operator to a random crate of this pallet. Oranges are weighted after harvest. The system recognizes automatically the weight of the truck and estimate the amount on oranges (in kilograms) that the truck contains.

2-Chamber for the incoming goods:

This chamber is used only for oranges in the incoming process from the harvest. Pallets filled with oranges before entering in the facilities are stored and handled in this zone of the factory when there is no need to process those oranges at this moment.

3- Pre-calibrating line:

At this point and before entering in the line, an employee read the bard code with a portable reader. In this factory, all the oranges are pre-calibrated before entering in the final production line. At this step, both the size and quality of oranges are checked by measuring both the diameter and the defects in the surface of the oranges by a visual contact using a camera (Figure 4.36). Contrary to the other factories, in this plant all the oranges that leave pre-calibrating process enter directly to production line. There is also a software program connected to this line capable to identify processing orders.

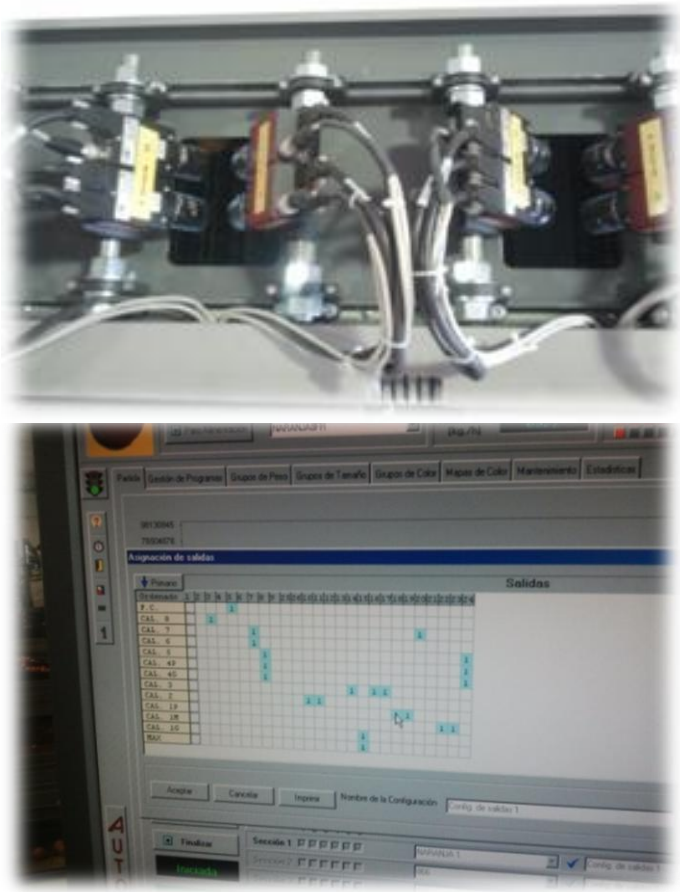


Figure 4.36 Camera detector and software program

5- Production line:

All the oranges that leave the pre-calibrating machines enter automatically in the production line, where oranges are packaged according to its quality and size and based on the different orders at this moment. In this area and before packing, oranges are waxed and introduced in an oven to fix the wax. Several employees work along the production line checking the state of the oranges and packing the packages needed to fulfill the different orders of each specific moment. As in Rural Sant Vicent Ferrer Cooperativa plant, there is a vast amount of different packages (both at crate and pallet level) that this cooperative handles depending on the client.

In the case in which oranges are packaged in cardboard boxes, oranges can be palletized manually or automatically since this factory only owns two automatic machines for palletizing. The operator is the responsible for selecting the proper pallet for each order and for putting the pallet at the end of the line in order to fulfill it once the boxes leave the production line. At the end of the line the pallet is weighted and wrapped and a bar code is printed and attached to the pallet.

IFCO plastic boxes don't need any cardboard box to be filled as long as nets of oranges are introduced directly on them. This cooperative also packages oranges using special cardboard boxes which dimensions similar to IFCO boxes (1 cubic meter approximately) where oranges are also put inside in the nets. They are palletized into CHEP blue wooden pallets.

Cheste Cooperativa Agraria also produces oranges to COOP supermarkets in Sweden (Figure 4.37). Contrary to the case of ICA, where oranges are filled into customized cardboard boxes, oranges for COOP are packaged into Svenska Retursystem plastic returnable crates and then palletized into wooden pallets.

Figure 4.37 COOP orders using SRS reusable crates

5- Cooling chamber:

In this chamber employees perform manual inventories to make sure that the orders that have been processed match with the information recorded in the data base of the company. This is done to avoid problems once the truck driver arrives to the factory. The main purpose of this chamber is keeping low temperatures to avoid oranges to get damaged. This is located prior the loading gates of the plant where oranges are loaded into truck for distribution process.

6- Loading gate:

This is the same process than in the other cases. After tagging the orders with a bar code label and storing the oranges in the cooling chamber, packed oranges leave the factory by truck to be delivered to the different clients. Here an employee also signs the delivery note with the truck driver reads the bar codes when pallets leave the plant in order to have a better internal control and to make sure that the orders are matched properly.

7-Packages depot:

The packages depot is part of the plant reserved for storing empty packages that employees pick up depending on what orders have to be processed at that moment. In the picture below can be seen the variety of the cardboard boxes that cooperatives normally handles for their different clients.

While Rural Sant Vicent Ferrer Cooperativa and Ripoll & CIA invoice manually, Cheste Cooperativa Agraria and the other companies member of Anecoop group invoices using EDI systems. Electronic data interchange (EDI) is a method for transferring data between different computer systems or computer networks. It is commonly used by big companies for e-commerce purposes, such as sending orders to warehouses or tracking their order. It is more than mere e-mail; for instance, organizations might replace bills of lading with appropriate EDI messages (Wikipedia 2013).

However, and despite the fact that their Swedish clients are also equipped with EDI systems, they only utilized EDI system for invoicing in Spanish and Finish markets. Nacho Juarez was asked about that issue, and he said that he didn’t know exactly the reasons why invoicing process are still done manually with Swedish clients. But what he confirmed is that that is because Swedish clients don’t impose this system for invoicing to Spanish suppliers, because they are already ready and willing to adopt this system in collaboration with them.

Anecoop group also look to innovate in their corporate management processes to help optimize resources and hence streamline costs. A single computer management system in the member cooperatives and the setting up of sole product marketing groups are examples of the recent innovations taken by the group. Anecoop also inaugurated in 2004 a laboratory equipped to carry out its R&D projects.

5 Case analysis and findings

During this chapter both individual analysis of each company and a cross-case analysis will be performed. Single case analysis will help to become familiar with each case and with the topic that this work concerns. In the cross analysis the different dimensions of the analysis will be compared looking for similarities and intergroup differences. These analyses will be based on different aspects regarding RFID technology adoption needed for responding the questions proposed in the Problem discussion, which is the purpose of this thesis. The analysis will be done by describing the potential internal benefits, SC benefits and barriers of the adoption perceived by the respondents and by utilizing an analysis framework that will be described after. Intra and inter-organizational alignments of RFID adoption among SC partners will be also identified and analyzed in this chapter.

5.1 Analysis framework

Looking back to the methodology, case studies can be used to accomplish various aims: to provide description to test theory or to generate theory. What this thesis is intended for is to provide description about a specific topic through an exploration of a RFID adoption in a certain companies in Spain. Nevertheless, theory regarding RFID adoptions and implementations limitations can be tested and assessed for these case studies through the interactions and the experiences gained during this work.

In order to provide these general descriptions of the different Spanish suppliers needed for reaching the purpose of this work, an analysis framework was used. The next table (Figure 5.1) presents the framework utilized to analyze the different companies. The framework was created by the author in order to assess this study in a way that allows extracting relevant and practical information from case studies to the companies involved in this master thesis.

This framework consists in 8 questions and will be used by the author in order to obtain findings for of the potential adoption of RFID in Spanish producers ‘plants. Those questions are based on exploring the level of knowledge, awareness, willingness to invest, attitude and the economic, technological and organizational aspects that will have an impact on the potential adoptions. The explanation and then justification of the selection of those questions are also included in the table. These tables were filled by the author basing on the peculiarities of each company, on the qualitative scores given regarding by companies and also basing on the interactions with the interview respondents considering the potential adoption.

QUESTIONS	EXPLANATION
Do Spanish Suppliers know that they handle RFID-tagged pallets?	Strategic supply chain relationships are seen as critical to high performance and developing innovation capacity (Soosay, C. A. et al, 2008).
What is the level of knowledge about RFID technology of the Spanish Suppliers?	The innovation-decision process begins with the knowledge stage. One cannot begin the adoption process without knowing about the innovation (Rogers, 1962).
What is the level of awareness about RFID technology of the Spanish Suppliers?	The level of awareness of a technology and its benefits leads potential users to decide whether they want to investigate further and then adopt it or not.
What is their willingness in investing on this technology?	Katz and Shapiro (1986) found that a determinant for adoption is the willingness from the manufacturer to make investments and promote the new technology.
What is their attitude regarding the RFID adoption?	A favorable attitude is a key requirement for technological innovations (Davis et al, 1989).
What are the economic factors that will potentially impact on a RFID adoption in these companies?	Investing in new technologies requires having economic resources and a stable financial situation.
What are the technological factors that will potentially impact on a RFID adoption in these companies?	The process by which a firm adopts and implements technological innovations is influenced by the technological context (Tornatzky and Fleisher 1990).
What are the organizational factors that will potentially impact on a RFID adoption in these companies?	The process by which a firm adopts and implements technological innovations is influenced by the organizational context (Tornatzky and Fleisher 1990).

Figure 5.1 Analysis framework

5.2 Rural Sant Vicent Ferrer Cooperativa

5.2.1 Analysis

In the case of Rural Sant Vicent Cooperativa, the only RFID tagged pallets they handle are SRS pallets. As it was shown in the case description, this amount is very little comparing to the total sum of pallets. Moreover, Ramón (the commercial director of the company) didn´t know that SRS pallets are tagged with an RFID tag. After explaining how this technology works to Ramón, he mentioned that the main problem he appreciates in adopting RFID is that due to the small number of RFID pallets they will need to attach a smart label to each of those pallets that don´t contain an RFID tag, which are the majority. And there will be needed associating the orders to SRS pallets in some way as well, so he said that there is a high level of complexity for the company. Investing on smart labels plus the investment in all the hardware, software, running cost and maintenance is a large amount of money for this sector.

The interviewee said that probably one of the more complex problem its cooperative will face adopting RFID is the lack of technology expertise of the employees and the lack of recent technology initiatives at top management layer in recent years (i.e. they still invoicing manually). This is justified by the main barrier that this company and Spain in general faces: the economic situation and the difficulty to get funds to finance the investment. At the same time he really thought that this adoption will not report any competitive advantage, as all of their clients are satisfied with the current traceability system which is in place at this moment.

However, he really appreciated some benefits associated to this technology that will contribute to a better performance of the company and thus to a higher profit and to a higher level of satisfaction of their clients. This is because three or four pallets don’t reach their final destination in a year. But this amount is almost irrelevant as long as they handle 25.000 pallets in a year. Ramón was also very interesting in the potentiality of this technology to reduce labor costs and time through automate the outbound or whatever process in the factory. He also pointed out bar codes get dirty and dusty in such rural conditions. The interest of RFID technology as that point was exemplified by the possibility to mitigate the bar codes reading errors implementing a more reliable data capturing such RFID that guarantee a high reading rate no matter in which conditions the pallets are. Despite all the filled orders are stored in the data base, employees also perform manual inventories to check that this information is correct. The respondent argued that this system will help to reduce inventory costs associated to loaded and tagged pallets before leaving.

Interview respondent was informed about some Swedish wholesaler’s upcoming implementation in its inbound flow. He was also informed that SRS RFID tagged pallets follow the EPCglobal GS1 standard for RFID, which enables the participants in GS1 network to catch real-time information of the tagged items among the trade-partners in a supply chain. He said that if any client (ICA) or distribution center forces their suppliers to adopt radio frequency identification and GS1 standards for this technology, his cooperative probably will follow those requirements because of

Swedish market is a very important one for them. He was asked to complete a table scaling the importance of RFID barriers (Figure 5.2), RFID internal benefits (Figure 5.3) and external benefits (Figure 5.4). Score 1 means that this is a little or an irrelevant barrier for the company, and score 5 means that this is a huge barrier. In the same way, score 1 means that this is a non-important benefit for them and 5 means that this benefit will be very important:

BARRIERS	SCALE
Perceived benefits	2
Complexity of the system	4
Organizational compatibility	4
Top management support	4
Organizational readiness	1
External factors	4
Technology competence	4
Firm scope	3
Size of the company	4
Low level of communication between partners (to reach an agreement)	3
Low level of RFID implementations downstream your company	5
Low percentage of RFID pallets that your company handles	5
Financial and economic situation	5

Figure 5.2 Rural Sant Vicent Ferrer Cooperativa perceived barriers

INTERNAL BENEFIT	SCALE
Reduce labor costs	4
Reduced time needed in the process	4
Increase accuracy in the process	3
Improve the management control within your company	2
Reengineering your current process	2

Figure 5.3 Rural Sant Vicent Ferrer Cooperativa perceived internal benefits

SUPPLY CHAIN BENEFIT	SCALE
Improve assets accountability	2
Rental cost reduction for pooling model	5
Efficiency of trading partners ´management account (i.e. invoicing)	2
Optimize exchange with partners through a better visibility	3

Figure 5.4 Rural Sant Vicent Ferrer Cooperativa perceived SC benefits

5.2.2 Findings

QUESTIONS	Rural Sant Vicent Ferrer Cooperativa
Does Rural Sant Vicent Ferrer know that they handle RFID-tagged pallets?	*This cooperative was not informed and didn't know that they are handling RFID pallets.*
What is the level of knowledge about RFID technology of the Rural Sant Vicent Ferrer Cooperativa?	*The interviewee and a quality technician that guided the visit to the plant had scarce knowledge about RFID technology. They only recognized what radio-frequency and the basic principles of it.*
What is the level of awareness about RFID technology of Rural Sant Vicent Ferrer Cooperativa?	*Despite they knew barely what radiofrequency is, they didn't know that much about the potential advantages and practical applications for adopting it in the plant and sharing tags information in SC.*
What is the willingness of Rural Sant Vicent Ferrer Cooperativa in investing on this technology?	*At this moment they are not willing to invest on it. Despite having some inconveniences from them, bar codes work efficiently in general and they have no need for replacing this system. On the contrary, they will be willing to think about it if any of their clients want them to associate orders to a RFID tag.*
What is their attitude of Rural Sant Vicent Ferrer Cooperativa regarding the RFID adoption?	*The commercial director had a negative attitude towards the adoption. Apart from this, Swedish clients and wholesalers haven´t shown any unconformity yet and RFID is not in its priority list.*
What are the economic factors that will potentially impact on a RFID adoption in Rural Sant Vicent Ferrer Cooperativa?	*Even though author doesn't have the exact economic figures of the company, he noticed that this aspect will hinder technology adoptions in this plant. Moreover, Ramón said that this investment is not affordable for them at this moment.*
What are the technological factors that will potentially impact on a RFID adoption in Rural Sant Vicent Ferrer Cooperativa?	*This company is not in a technology forefront. This is a traditional industry where level of technology remains low comparing to other sectors. Moreover, in comparison with the other plants visited, this was the most technologically delayed (i.e. manual invoicing, no automatic quality classification…)*
What are the organizational factors that will potentially impact on a RFID adoption in Rural Sant Vicent Ferrer Cooperativa?	*Regarding managerial capabilities, and due to the size of the company, there is not any person or team appointed to drive technology changes and those services are highly dependent on external companies. Top management support in technology initiatives is very low at this moment.*

5.3 Ripoll & CIA

5.3.1 Analysis

The meeting was held with Inés and Pablo Ripoll, who belong to the family that owns the factory. As in the other case, the purpose of the meeting was to understand the level of knowledge and awareness about RFID, the interest in investing on it, and the technology competence of the factory. After the meeting, author was also invited to visit the factory and he realized that their system was more complex than the other one (i.e. automated detection of the quality of the oranges in pre-calibrating process). Besides, they already had RFID technology set up in the plant. In fact, during a large conversation with them, the author of this Master Thesis had to switch the focus on the interview when they explained that they were already using RFID. The new approach of the interview basically aimed to main aspects: on the one hand, investigate all about their RFID practices and their satisfaction with the system, and on the other hand carry out an interview regarding the adoption in the outbound flow.

It is important to point out that they were very satisfied with the existing RFID implementation, as it had allowed them to have almost a 100% rate in reading accuracy at the entrance of the production line. This has also led monitor the stock efficiently and to reduce labor cost and time needed to mitigate the errors associated to bar code readings that this company also has to deal with (i.e. entrance of pre-calibrating). This duality allows them to compare the potentiality of RFID technology against bar codes, and they are very satisfied in general with the implementation that took place in 2005. They have never thought in implementing RIFD in the outbound flow, but due to the same reasons exposed before, they appreciated the possibility to infuse their RFID system to more points in the factory as they already have RFID software in place. They could also benefit in the outbound by eliminating manual inventories to check fulfilled orders. RFID expertise both at employee level and at top management level, and the constant search for innovation of the owners of the factory makes the potential adoption in this company more reliable than in the other case. They had an estimated idea about how can this infusion could cost, and they say that despite this is too much money, they could afford it right now.

Inés and Pablo said that the main problem considering a RFID adoption in its outbound flows is that the amount of RFID tagged pallet is too little (around 6% in this case). This will lead to attach smart labels which contain a RFID tag to every non-tagged-pallet. Their opinions were in line with the other company responds regarding the complexity of this duality. However, and because of their RFID and technology expertise, this complexity perception was lower than in the other case. They remarked that they don’t see that this will lead to increase their competitive advantage in terms of customer satisfaction. This is because of rarely a pallet doesn’t reach it final destination and because of none of their customers will benefit at this moment for the RFID tag it potential supply chain advantages to traceability. They already have readers to install in one loading dock an also have a system to associate the orders to encapsulated tags (not for pallets). Associating the orders to RFID grey pallets will only require software adjustments and modifications and joining GS1.

They also were informed about the project of implementing RFID in the inbound flow of Swedish wholesalers. They said that since Swedish market is such an important market for them, they will implement RFID in its outbound flow if necessary and required by Swedish market or any other important market. Since they already have quite expertise regarding RFID, their responds are suitable to be more realistic than in the other interviews. They were also asked to fill the tables about barriers for infusing their current RFID system (Figure 5.5), internal benefits already reported because of their RFID system (Figure 5.6), and the potential SC benefits (Figure 5.7).

BARRIERS	SCALE
Perceived benefits	4
Complexity of the system	2
Organizational compatibility	1
Top management support	2
Organizational readiness	1
External factors	4
Technology competence	1
Firm scope	4
Size of the company	3
Low level of communication between partners (to reach an agreement)	4
Low level of RFID implementations downstream your company	5
Low percentage of RFID pallets that your company handles	4
Financial and economic situation	3

Figure 5.5 Ripoll & CIA perceived barriers

INTERNAL BENEFIT	SCALE
Reduce labor costs	5
Reduced time needed in the process	5
Increase accuracy in the process	3
Improve the management control within your company	4
Reengineering your previous process	3

Figure 5.6 Ripoll & CIA perceived internal benefits

SUPPLY CHAIN BENEFIT	SCALE
Improve assets accountability	2
Rental cost reduction for pooling model	4
Efficiency of trading partners ´management account (i.e. invoicing)	2
Optimize exchange with partners through a better visibility	2

Figure 5.7 Ripoll & CIA perceived SC benefits

5.3.2 Findings

QUESTIONS	Ripoll & CIA
Does Ripoll & CIA know that they handle RFID-tagged pallets?	*This company was not informed and didn't know that they are handling RFID pallets.*
What is the level of knowledge about RFID technology of Ripoll & CIA?	*The level of knowledge about RFID technology was very high in this company, as RFID is already in place in their processes.*
What is the level of awareness about RFID technology of Ripoll & CIA?	*The level of awareness was also high, as they know the potentiality of the technology and how to take advantage of it within the plant. However they were not aware enough about adopting RFID in the outbound and the possibility sharing the information recorded in the tags with SC partners.*
What is the willingness of Ripoll & CIA in investing on this technology?	*They were previously willing in investing on RFID. Associating the orders to the pallet tags, reading those pallets in the outbound flow and sharing the information in a supply chain network will require some adjustments in the current system and they will be willing to do it if Swedish market needs them to do it.*
What is their attitude of Ripoll & CIA regarding the RFID adoption?	*The attitude was positive, as they were familiar with the technology appreciated that much the idea of this adoption. However, they remarked the lack of use of this technology downstream their plant.*
What are the economic factors that will potentially impact on a RFID adoption in Ripoll & CIA?	*Economic figures of this company and it financial situation are good. This factor has not been considered as a factor that could hinder the adoption in the outbound flow.*
What are the technological factors that will potentially impact on a RFID adoption in Ripoll & CIA?	*This company is very technology innovative. It can be exemplified by the fact that they are the only one that already uses RFID. Special automatic system for identifying the quality of oranges had allowed them to differentiate from some competitors. So technological factors would not hinder the adoption.*
What are the organizational factors that will potentially impact on a RFID adoption in Ripoll & CIA?	*Due to its size, this company also is highly dependent on external companies technology services (Mesurasoft). Owners support in technology changes is very high if it is viable.*

5.4 Anecoop (Cheste Agraria Cooperativa)

5.4.1 Analysis

This cooperative belongs to Anecoop group which is the world's leading citrus fruit exporter. The interview was held at Anecoop main offices in Valencia. Nacho Juarez, who is the Commercial Responsible of Anecoop for Swedish market, was the person interviewed. He had a previous knowledge about RFID technology, but he didn´t know that SRS pallet contains a RFID tag and that one of their clients (Nowaste Logistcis) has already implemented RFID in their outbound flow.

He was very enthusiasm about gaining technology understanding as long as he appreciated the potential benefits this technology. He also expressed the dissatisfaction with the bar code system that get dusty and dirty as a consequence of the factory conditions. Although they don't use RFID, they have some technology expertise (i.e. EDI invoicing system) and they are not reluctant to take technology initiatives if they appreciate that this will report benefits for the company. In line with what the other interviewees commented, he also saw potential benefits in reduce human labor and time consuming.

Since Anecoop is a mother company of 79 cooperatives that form Anecoop group, Nacho said that if Swedish or other market imposes the use of RFID in the outbound flow of their suppliers, a RFID trial could be done in one of the cooperatives. After that, they could expand this knowledge and technology to other cooperatives of the group if the system works properly. In that sense, he was the only interviewee that shows interest and willingness to cooperate and collaborate in SC initiatives like the adoption of RFID. Moreover, the RFID investment in one of the cooperatives is affordable for the group taking into account the economic figures of the group.

As in the other cases, Nacho said the greatest problem for adopting RFID in Anecoop cooperatives at this moment is the lack of uniformity among the pallets that Anecoop handles in a year: SRS RFID tagged pallets contribute only to the 2% of the total pallets amount. Nacho also said that is very noteworthy the lack of RFID initiatives in their clients, are this group exports to 60 different countries and the only RFID pallets they handle are the Svenska Retursystem ones. He also argued that at this moment this will not lead in a competitive advantage of the group regarding their customers.

Nacho, as the other interview respondents was informed about RFID implementations in Nowaste Logistics (one of their clients) outbound flow, and their intention to expand this system in their inbound flow by starting trials with Swedish suppliers in this summer. The author gave a copy of RFID implementation at Nowaste Logistics warehouse in its outbound flow to Nacho, as he was really interested in expanding his knowledge and getting a wider picture of how a RFID implementation is. He was also informed about GS1 EPCglobal Network among supply chain partners and the benefits that this network offers to supply chain participants.

The scores of the barriers and benefits of Nacho were very limited because of the limited knowledge of the technology he had. Nacho was asked to complete a table scaling the importance of RFID barriers (Figure 5.8), RFID internal benefits (Figure 5.9) and RFID external benefits (Figure 5.10) for Anecoop.

BARRIERS	SCALE
Perceived benefits	2
Complexity of the system	3
Organizational compatibility	3
Top management support	2
Organizational readiness	2
External factors	3
Technology competence	3
Firm scope	3
Size of the company	1
Low level of communication between partners (to reach an agreement)	2
Low level of RFID implementations downstream your company	4
Low percentage of RFID pallets that your company handles	5
Financial and economic situation	2

Figure 5.8 Anecoop (Cheste Agraria Cooperativa) perceived barriers

INTERNAL BENEFIT	SCALE
Reduce labor costs	3
Reduced time needed in the process	3
Increase accuracy in the process	5
Improve the management control within your company	3
Reengineering your current process	3

Figure 5.9 Anecoop (Cheste Agraria Cooperativa) perceived internal benefits

SUPPLY CHAIN BENEFIT	SCALE
Improve assets accountability	3
Rental cost reduction for pooling model	5
Efficiency of trading partners ´management account (i.e. invoicing)	2
Optimize exchange with partners through a better visibility	3

Figure 5.10 Anecoop (Cheste Agraria Cooperativa) perceived SC benefits

Basing on the previous analysis and qualitative scores of this company regarding perceived benefits and barriers of adopting RFID, and also considering the predisposition of Nacho Juarez from Anecoop regarding the adoption, next table (Figure 5.13) has been completed:

5.4.2 Findings

QUESTIONS	Anecoop
Does Anecoop know that they handle RFID-tagged pallets?	*This group was not informed and didn't know that they are handling RFID pallets.*
What is the level of knowledge about RFID technology of Anecoop?	*Nacho Juarez had previous knowledge about what RFID technology is and its basic principles.*
What is the level of awareness about RFID technology of Anecoop?	*Nacho knew several things about the potential advantages and practical applications for RFID in the operational layers within the plants (automatic readings, time and labor savings...). However, the RFID possibilities to exchange information through a special network among SC trade partners were absolutely unknown for him.*
What is their willingness of Anecoop in investing on this technology?	*The will be willing to invest on one of the member plants if any client require them to associate orders to RFID tags.*
What is their attitude of Anecoop regarding the RFID adoption?	*The attitude was positive regarding this adoption and the possibility to prove this technology in one of their plants. But this is not in their priority list at that moment.*
What are the economic factors that will potentially impact on a RFID adoption in Anecoop?	*As a market leader in the world, Anecoop group´s financial and economic figures are very good, and the group has the capacity to invest in RFID in one factory at this moment. So these factors enable the adoption.*
What are the technological factors that will potentially impact on a RFID adoption in Anecoop?	*Anecoop constantly looks for optimizing processes and resources and hence streamline costs (i.e. EDI, single computer management system in the member cooperatives, setting up of sole product marketing groups). So all of these technological initiatives reinforce the idea that technology is not a barrier.*
What are the organizational factors that will potentially impact on a RFID adoption in Anecoop?	*Top management support in technology initiatives is high if it is interesting for the group. According to its website, this group strives for a "model of business excellence and improvement" and "is a facilitator of change". Big size of the organization makes them more independent and enables the capacity to appoint a project team for changes.*

5.5 Spanish Producers cross-analyses

Cross-analysis will be performed to generalize and point out the major potential barriers and benefits of the RFID adoption for oranges sector in general. It will be based on the interviews, the conversation with responsible of the companies and the scores they gave when they were asked. Figure 5.11 reflects a comparison between the normalized scores of the data collected in the interviews regarding RFID barriers, internal benefits and external benefits from the perspective of each company. Normalized scores have been calculated by summing all the scores and dividing by the maximum possible total score of each section.

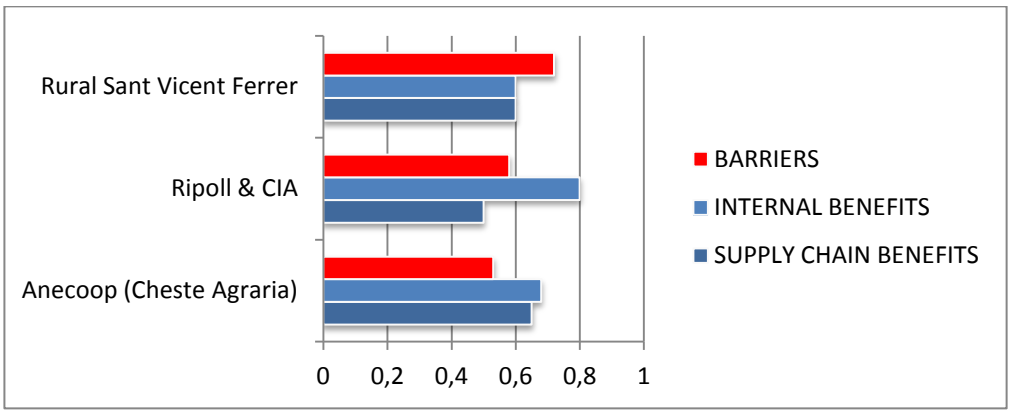


Figure 5.11 Normalized scores of companies' interviews

5.5.1 Cross-analysis: Barriers for the adoption

Regarding the barriers for a RFID adoption, Rural Sant Vicent Ferrer Cooperativa has the highest score, which means that this is the company that appreciates the adoption more complicated because of the barriers analyzed in the interviews. This makes a lot of sense, since it's financial and economic situation, the size of the company and the organizational technological compatibility of the company are three important factors that would limit the adoption of a new technology like RFID. Meanwhile, Ripoll & CIA and Cheste Agraria Cooperativa have similar scores.

Justification of the low barrier scores can be found in the size of the company and financial and economic situation of Anecoop (which is the mother company of Cheste Agraria Cooperativa) and in the organizational readiness and compatibility with the current system in the case of Ripoll & CIA. As long as the last already uses RFID and the adoption in its outbound flow will be the easiest among the three cases considering those aspects. Another important barriers are the scarce of RFID implementation downstream the supply chain and that the percentage of RFID pallets they handle are very little. As all the respondents mentioned, this actually is one of the major factors that hinder a RFID adoption.

Thus, the lack of uniformity of the pallets and the issue that the amount of RFID pallets is too little make printing and attaching smart labels to the outbound pallets the only way they can put this technology in place. If all the pallets they handle would be tagged with RFID tags as in the case of SRS grey pallets, only hardware and software installations will be required and therefore the payback period for recovering the initial investment will be shorter.

5.5.2 Cross-analysis: Internal benefits of the adoption

Internal benefits were much more appreciated than external benefits, because all of them considered that this adoption will no add value for their customers at this moment. So many authors argue that RFID will lead the decrease the empty EURO-pallet shrinkage. EURO-pallets are returnable pallets that are managed different than the pooling pallets: every time a truck driver arrives to their facilities, he is supposed to leave in the plants the same amount of empty EURO-pallet that filled pallets he loads in the truck. In the meetings, interviewees were also asked about that issue, and all of them said that there is also a current problem for them.

This is because of they have no total control of the pallets that truck drivers leave in the factory mainly because of the limited time of the employees to do these inventories. RFID could control very efficiently how many filled pallets are loaded on each truck, but this is already done by reading the bar codes of the orders at the loading docks. However, none RFID potential solution for companies studied and their particular applications could automatically provide an inventory control of incoming EURO-pallets as long as they are not RFID-tagged. So that is why this point was not included in the internal benefit analysis.

It is significant and relevant that the highest score regarding potential internal benefits is the score given by the company which has already implemented RFID in its internal processes. This can be explained by the fact that despite interviewees knew about the internal benefits that RFID technology brings, benefits are better rated when the company is currently is taking advantage of it in a satisfactory way. All of the respondents appreciated the potential cost and time savings, the potential better and easy control in the outbound inventory, and the possibility increase accuracy by mitigating the reading errors associated to bar codes.

5.5.3 Cross-analysis: *Supply chain benefits of the adoption*

Considering supply chain potential benefits, none of the suppliers appreciated so much the enhanced traceability among partners that this technology promises to bring. Nevertheless, they perceive very attractive the potentiality of this technology among supply chain partners to have a better tracking control of the pallets. But since no one of their clients (except Nowaste Logistics in the case of Anecoop) has joined GS1 network for RFID, the scores considering this point are so low.

The only high-rated score for the three companies considering supply chain improvements was the possibility to reduce the rental costs of Svenska Retursystem pallets. The RFID solution will provide them with an exact accountability about how many SRS pallets leave the factory at any time, and no inventories will be needed.

5.5.4 Findings comparative

A comparison between findings regarding the potential adoption of RFID will be done as follows. Once again, the table (Figure 5.12) follows the framework proposed for the analysis and will reflect different findings of question proposed to reach the purpose of this thesis. But in this case it will be done in a shorter way, adopting a cross-view that allows the reader to compare the results easily:

QUESTIONS	Rural Sant Vicent Ferrer	Ripoll & CIA	Anecoop
Do Spanish Suppliers know that they handle RFID pallets?	*No*	*No*	*No*
What is their level of knowledge about RFID technology?	*Scarce*	*High*	*Normal*
What is their level of awareness about RFID technology?	*Internally: Low S. Chain: Low*	*Internally: High S. Chain: Low*	*Internally: Normal S. Chain: Low*
Are they willing in investing on this technology?	*Only if important market need it*	*Yes if viable and if important market need it*	*Yes if viable and if important market need it*
What is their attitude regarding the RFID adoption?	*Negative*	*Positive*	*Positive*
What are the economic factors that will potentially impact on a RFID adoption in these companies?	*Moderate and limited economic situation*	*Good situation, capable to invest*	*Good situation, capable to invest*
What are the technological factors that will potentially impact on a RFID adoption in these companies?	*Technology delayed*	*Technology innovative*	*Technology innovative*
What are the organizational factors that will potentially impact on a RFID adoption in these companies?	*Small size, external tech. dependency*	*Small size, external tech. dependency*	*Big size, capacity to appoint a project team*

Figure 5.12 Findings comparative

5.6 Additional analysis

5.6.1 Decision making in the cooperatives

Technological adoptions require the commitment and support from the top management level and can success by addressing discipline project management in place and an excellent project leadership (Stank et al. 2011). RFID adoptions require the willingness of the owners of the companies, which are the ones that will finance the implementations and that are exposed to lose their money. The way that decisions are taken differs a lot between the three cases studied during the visits and depends a lot on the ownership structure of each plant. These structure (Figure 5.13) and the decision making process (Figure 5.14) will be shown as follows:

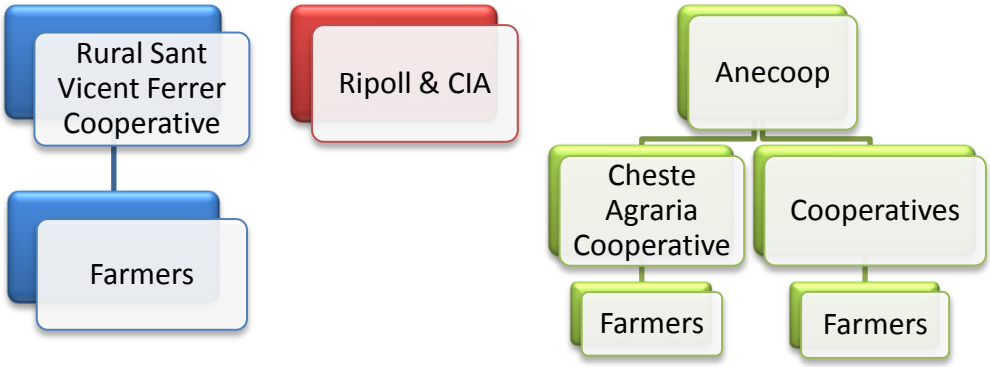


Figure 5.13 Ownership structure of each oranges plant (own elaboration)

COMPANY	DECISION MAKING
Rural Sant Vicent Ferrer Cooperativa	In the case of Rural Sant Vicent Ferrer Cooperativa, decisions are made among the consensus of the different farmers that form the cooperative.
Ripoll	In the case of Ripoll & CIA it is a decision that ultimately only depends on the family that owns the company.
Cheste agraria	In this case Anecoop is the mother company of this cooperative, which is at the same time owned by the farmers that work for Cheste Agraria. Anecoop is the one that set up the rules and guidelines of the companies that this company embraces.

Figure 5.14 Decision making of the oranges producers

5.6.2 Rough payback periods

The payback time for RFID investment can't be calculated accurately at this moment as it depends on a lot on the application and use of the technology. Intangible benefits like customer satisfaction by increasing reading accuracy or positioning as an innovative manufacturer can't be assessed accurately with non RFID clients. Since SP are the ones will fight the risk of failure, it has been assumed that if Swedish warehouses might one day want their suppliers to adopt RFID, they could help SP by paying more money per kg until the investment is recovered. This has been assumed that would lead to increase 0, 01 Euros the price per kg of oranges sold to this market. Calculations of running profits with this assumption are shown in Appendix 2. Moreover, and due to the ignorance of all the companies interviewed about downstream practises, it has been assumed that there is no more RFID implementations downstream this factories.

All cooperatives have 3 loading docks in their outbound process. Price estimations for hardware and server are based on IKEA and Arla Foods case study (Hellstrom, 2007). Costs for implementing RFID in the cooperatives have been weighted proportionally regarding the smaller size of those comparing to IKEA and Arla Food´s cases. Ripoll & CIA already owns three RFID readers, previously utilized in the cooling chambers, so there will be no investment on readers for this company. Is has been assumed that 2 antennas per reader will be enough to guarantee a 100% satisfactory readings. At least one handheld reader per plant will be needed for identifying tagged objects (i.e., checking inventory) and for associating the orders to the pallet's tags. Hardware cost for printers is based on www.shopping.com.

A possibility for Ripoll & CIA could be to expand it current RFID process for pre-calibrating to the outbound flow. This process was explained in Ripoll & CIA subchapter. However, this way for adopting RFID in the outbound flow was discarded as long as those tags have to be removed after reading and reused again. Pallets would be loaded on trucks without the RFID tag and consequently hindering the potential benefit of reading the tag downstream if more actors implement RFID as well.

That is why the calculations for Ripoll & CIA payback time as been done considering smart labels attached to the outbound pallets for those which are not SRS tagged pallets. Regarding training an education costs, it was assumed to be 50% lower for Ripoll and CIA as long as their employees and managers are already familiar with this technology. Payback times are approximated and software calculations and depend on the RFID applications. Running costs from electricity consumption are based on the average electricity levels of RFID equipment.

Membership for GS1 for using EPC Tag Data Standard is around 2000 Euros in a year per company; this is a huge amount of money for Ripoll and CIA but not for Anecoop which is composed by 79 cooperatives and could benefit for it. By implementing a RFID system in the loading docks, an important workload decrease for the operators could be achieved: on the one hand, time for reporting inventories of filled and tagged pallets that are prepared to leave the factory could be reduced by using a hand-held reader that facilitate the capture the data needed; on the other hands, RFID systems eliminate the reworks induced by human mistakes. The exact amount of costs saved by implementing this automatic system is very difficult to calculate. But relying on the visits to the plants and the conversations with the managers of several companies, it has been assumed that this savings are 20.000 Euros per year.

Check-in time could be reduced by 60-93% with RFID technology. It has also been estimated that RFID could yield labour savings of up to 36% in order picking and a 90% reduction in verification costs for shipping processes (Keith et al., 2002). Based on that information, calculations for the labour saving costs are shown in the Appendix 3. Despite of the fact that cooperatives order the number of SRS to palletize the orders that they receive from ICA, these cooperatives have a buffer of SRS tagged pallets in their factories. A buffer stock of empty RTI is required to match production schedule. Without RTI moving the finished products, it might be necessary, in some cases, to stop the production line (Bowman et al., 2009).

A potential decreasing in SRS pallets inventory at cooperatives has been assumed to be 50% by controlling the number of incoming pallets and reporting automatically with RFID system when they leave the plant; this will affect only to the variable fee that cooperatives pay in terms of days of use per pallet as it was mentioned previously more in detail (price is 0, 03 Euros per pallet per day). SRS RFID tagged pallets are not the only pallets managed by a pool operator both in those cooperatives. However, in order to simplify the calculations, it was assumed that the new system wouldn’t affect the cost for using those pallets (Appendix 4).

Rough payback periods for each company are shown in Appendix 6. Results of this calculations reflect that the years needed for recovering the initial investment will be 4.5 14 1.8 respectively. These years are an approximation and they are based on installing RFID readers in the all loading docks that each cooperative has. However, initial investment depends a lot on the application, and will be lower if they only install RFID in one dock just to satisfy orders for Swedish markets in the future (associate a order to a tag with hand-held readers and read the orders when leaving the factory only through one gate). This duality was shown more complicated and then less attractive by the cooperatives.

5.7 Intra and inter-organizational alignments of RFID adoption analysis

At some extent, the outcome of this thesis will result in a stepping-stone in spreading insights about the use of RFID technology and its potential advantages among actors of a concrete supply chain When it comes to a new technology, collaboration among supply chain partners and good relationships with suppliers is essential for a supply chain to be competitive (Attaran, 2012). Regarding a supply chain perspective, most companies don't worry about the behavior of their supply chain partners. Instead, they expect the supply chain to work efficiently without interference. This lack of collaboration in technology initiatives can be exemplified in this master thesis; in spite of the fact that RFID technology brings great business opportunities by boosting the supply chain efficiency, there were no company aware of they handle RFID pallets and the RFID implementations downstream their factories (Nowaste Logistics in the case of Anecoop).

Supply chains perform well only if the risks, costs, and rewards of doing business are distributed fairly across the network. That is why it was assumed the potential increase in the price of oranges because of its positive repercussion increasing logistics efficiency and customer satisfaction by reduce the number of errors reported. Companies often look for their own interests ignoring those of their network partners and then supply chains performed poorly. They can improve alignment by adopting revenue-sharing contracts, using technology to track previously hidden information, or working with intermediaries to build trust among network partners (Narayanan and Raman, 2004).

Companies must align the incentives of all the key decision makers in their supply chains. Implementing collaborative change initiatives in supply chains presents various challenges (Hellström, Johnsson and Norrman, 2011) both in intra-organizational and inter-organizational layers. Therefore, it is important to evaluate how risks and gains sharing distributed among Spanish producers, Svenska Retursystem and Swedish wholesalers.

In order to asses initiatives to mitigate the risk of the adoption, a model for evaluating risk and gain sharing for supply chain participants proposed by these authors in 2011 was used. These authors came up with the conclusion that intra- and inter-organizational risk and gain sharing is critical to adopting RFID technology across organizations and established a framework to asses both risk and gain sharing between companies. There proposed framework comprises a table with the distribution of risk and gains for all the SC actors and identifies their alignments and misalignments in green and red colour respectively (Figure 5.15). There is a limitation in these figures for lack of quantitative data on the magnitudes. Letter G means gain, R means risk, and ◔◑◕● symbolize magnitudes with the latter as the highest. Figures 5.16, 5.17 and 5.18 reflect the analysis of the potential alignments and misalignments considering the adoption at strategic, business and process organizational layers respectively.

Business Layer	*Risk Source*	*Spanish Producers*	*SRS*	*Swedish warehouses*
STRATEGIC	*Integration*	*R*	*G*	*G*
	RFID interoperability	*G*		*G*
	Long term relationships	*G*	*G*	*G*
	IT investment prioritized	*R*	*G*	*G*
BUSINESS	*High cost*	*R*		
PROCESS	*Insufficient performance*	*R*	*R*	*R*
	Automated data capture	*G*	*G*	*G*
	Improve info management	*G*	*G*	*G*
	Improve readability	*G*		*G*
	Increase pallet utilization	*G*	*R*	
	Increase process control	*G*		

Figure 5.15 Identified sources of alignments and misalignments

STRATEGIC	**INTEGRATION**
	Integration refers to the increased degree of dependency among companies making renegotiating contracts and changing the supply chain trade-partners more difficult. This could be a risk for the Spanish Producers since the level of dependency of SRS pallets will rise up since the installations will be more aligned with this pooling model. On the contrary, Svenska Retursystem will benefit a lot as the revenues of the company come from renting pallets and crates, son the more use of its pallets, the more money they make. Swedish warehouses will potentially benefit of this adoption if they are RFID users. This is exemplified in the case of Nowaste Logistics, since this technology adoption will be perfectly compatible with its current RFID system in the outbound flows and its future RFID system also in the inbound flow. So as these wholesalers mainly focus on logistics efficiency, the upstream adoption will report benefits giving a competitive advantage to those wholesalers that are RFID users.
	RFID INTEROPERABILITY
	RFID interoperability refers to the possibility to transfer the technology to other applications. The adoptions in the outbound flow will bring the opportunity to expand RFID technology within SP plants, allowing automatic captures in the important reading points or reengineering their processes (Ripoll & CIA model, for instance). It doesn't apply to SRS, as this technology is already in place in its facilities. Due to the upcoming implementation of RFID in Nowaste Logistics inbound flow following Gen2 GS1 standards for RFID, a wider implementation among the upstream supply chain partners will have a great impact on this company (and in more wholesalers that use RFID).

STRATEGIC	**LONG TERM RELATIONSHIPS**
	Long term relationships would scarcely benefit SP, since they are not interested in using those pallets; the Swedish clients are the ones that impose this use. However, if SP implements RFID in its outbound flow, a better control over the pallets will be possible for SRS, and this might imply a small reduction in the pallet rental costs. The more interested in establish a long term relationship is without doubts SRS, as it was discussed before, all the incomes of this company come from renting pallets and crates. Of course wholesalers RFID users will also benefit having long term relationships with those suppliers, as their incomes come from doing logistics services and the more pallets this company handles the greater profits for them. This long term relationship can be boosted by having a common and accurate RFID structure for capturing data and having real time information at every moment.
	IT INVESTMENT PRIORITY
	IT investment are not a priority in SP, as long as their only aim is to keep their prices as low as possible, and an IT investment will require a lot of funds that normally are not affordable at this stage of the SC. Despite the fact that this is neither a priority for SRS, it has been considered that the more SRS RFID plastic pallets users, the easier upgrades and improvement of the RFID system regarding SRS perspective. As a logistics services providers, IT investments that bring more efficiency to the processes (as RFID is supposed to do) are in the priority lists of Swedish wholesalers. This has been proved in Nowaste Logistics case with the RFID previous and upcoming investment.

Figure 5.16 Alignments and misalignments at strategic layer

BUSINESS	**HIGH COST**
	High cost of the system, as it has been said a lot of times, is the major barrier for RFID adoption. Due to the fact that this only affects the oranges producers, this is the one that assumes all the high risk associated to the cost of the adoption. However, as in line with was assumed in the analysis, this risk could be mitigated by renegotiating prices both with SRS and Swedish suppliers interested in the adoption until the initial investment has been fully recovered. More initiatives among trade-partners beneficiaries of this adoption could be taken in order to do this investment more attractive to those parts that have to bear the economic risk and effort.

Figure 5.17 Alignments and misalignments at business layer

PROCESS	**INSUFFICIENT PERFORMANCE**
	Insufficient performance associated to RFID technology is another risks to think about. RFID technology is only a way to trace and track items which has practical implications in logistics. Logistics performance is more dependent on how data are utilized rather than how data is captured. In reality, managers use to think that the more reading points along the supply chain, the better this technology is for their companies; and that is absolutely false. The essence of a good performance of RFID technology doesn't lay on the way that data is captured; it lays on the way that relevant data are managed and shared among trade-partners in order the get an exploit the whole benefits of this technology. In this context, the highest risk regarding insufficient performance of the technology is taken by SP, as long as this affects to these companies both at internal and at supply chain layers. For SRS and Swedish wholesalers RFID users this will also imply risks, but only at supply chain layer level.
	AUTOMATED DATA CAPTURE
	This will be an enormous source of gains for all the parts involved. Especially SP will be able to gain benefits both from the cost and human labor intervention reductions and from joining the GS1 network for exchange real time information among partners. Expand this network at supplier level will potentially affect positively to SRS and Swedish wholesalers.
	IMPROVE INFORMATION MANAGEMENT
	This can be exemplified with the pallet information. Pallet information is concerned with tracking and tracing the location of pallets. Current information availability merely relies on exchanging information about location, time data and quantities, but this is often received after several days and not in real time. From SRS perspective, if all the users of their pallets would be equipped with RFID and use standardized event data like EPCIS, pool systems will be able to optimize the cycle times of their pallets, minimizing the pallets buffer at depots and maximizing the utilization of the pallets capacity avoiding imprecise pallet counts. This will lead to a potential gain for the other actors that will be higher if the number of RFID tagged pallets they handle would be higher. SP can benefit doing accurate automatic counts of outgoing pallets, reducing human intervention and management efforts related to reporting inventories manually.
	IMPROVE READABILITY
	Improving readability is one of the process benefits more appreciated by the managers of the cooperatives. Due to the particularity of this sector, current bar codes sometimes get dirty and unreadable. Factories have several bar code reading points along the processes. Nevertheless, there is always a risk related to the capacity and reliability of RFID readings. This source of risks can be reduced by doing a trial to test, verify the results and adjust the system consequently. SRS and Swedish wholesalers interested in the adoption can also collaborate sharing their expertise. So clearly the actors most beneficiated of this issue will be SP but this will also have a positive impact downstream.

PROCESS	**INCREASE PALLET ULILIZATION**
	Increasing pallet utilization is one of the misalignments identified in the previous table. If SP would have access to the incoming pallets via a standardized even data to control pallets that leave SRS facilities, the pallet utilization will increase by reporting automatically the pallets that leave the factory. This will to reduce the pallet inventory stored at the producers plants to avoid stopping the production line because of out of stocks of those pallets. The repercussion of this better utilization will implicate a costs reduction for SP in hiring SRS pallets, and the consequent decrease of SRS incomes.
	INCREASE PROCESS CONTROL
	This applies only for SP. A typical process of this cooperative was exemplified in the process description parts of the case studies. Adopting RFID is a clear gain for Spanish producers, but in order to get greater process control benefits like controlling assets location and the routes within the plant, monitoring the dwell time at each step of the process or automatically knowing the amount of oranges in terms of its size and quality, more RFID reading points and a more complex software system will be required. This is the reason why this potential increasing in process controlling will not be achieved by only adopting RFID in the outbound flow so this has the minimum gaining score.

Figure 5.18 Alignments and misalignments at process layer

6 Results and discussions

During this chapter several things will be done. Firstly, important aspects that impact on the RFID potential adoptions will be reviewed and applied for the case studies. Secondly, the RFID adoption will be examined in Spanish oranges industry. And finally, as a final contribution, the most suitable supplier for the RFID trial will be selected in order to help SRS and Swedish wholesalers when deciding to contact one of them for implementing this technology at supplier level.

6.1 Important aspects for RFID adoptions

As a result of the RFID adoption exploration, it can be concluded that level of knowledge and awareness, especially regarding supply chain RFID opportunities, were really scarce. There was also a relationship between the level of knowledge and the level of awareness of those companies; the more knowledge about RFID, the more aware the company was. Another result is that willingness to invest and the attitude of the companies towards the adoption are closely related to its economic situation and thus to the capacity to invest on it. Nevertheless, Swedish clients are very important for all the companies interviewed and they will always try to satisfy their needs. So they will be open to talk to SRS and Nowaste Logistics (only Anecoop) and then to consider this opportunity for future collaborations. Technological, organizational and economic aspects that will have an impact on the RFID adoption in Spanish producer's plants have been analyzed as follows. Main results considering these three layers are: technology aspects will not restrict that much the adoption and can be mitigated by collaborating with SC RFID partners; some organizational aspects like the size of the company (Anecoop), the technical know-how and easy decision making (Ripoll & CIA) and external pressure have been identified as an adoption enablers; cost is the most important aspect to look at since the adoption will be require an investment all the companies were worried about this.

6.1.1 RFID adoption technological aspects

Technological aspects	*Complexity:* RFID technology was perceived complex in 2 of the cooperatives studied. Ripoll & CIA was the only one that appreciated less complexity due to the know-how that this company has acquired along this 8 years using RFID technology. (Complexity restricts adoptions).
	Compatibility: RFID technology will be compatible only with the IT infrastructure of Ripoll & CIA, as this company already uses RFID in its internal processes and has installed and special software for RFID technology. But this compatibility will still require software adjustments. (Compatibility restricts adoptions).

Technological aspects	*Perceived benefits:* Greater perceived benefits were time savings, labor cost reductions, increase accuracy and reduce the rental cost of grey pallets. No supply chain benefits with tracing and tracking purposes were appreciated that much at this moment, were RFID implementations downstream this plants still being scarce (Greater perceived benefits enables RFID adoptions).
	Standardization: Standards for RFID were only discussed with Ripoll & CIA personnel because of the moderate knowledge about RFID of the other companies. SRS (in all the cases) and Nowaste Logistics (in Anecoop´s case) will be only beneficiaries in the short term if any Spanish producers adopt RFID (more wholesalers could potentially benefit in the same way if adopt RFID). Nowaste Logistics set up some specifications and standards for the tags that could coexist with SRS grey pallets and work with pallets that contain fruits. In accordance with to Israelsson & Norlund (2009) those specifications and standards for tags adopted are: be passive, endure cold temperature, contain a memory of at least 96 beats, follow EPCglobal´s standards, contain a SSCC number, withstand careless treatment, have a strong and washable adhesive. In line to these specifications and standards adopted in the tags used by Nowaste Logistics and in line with SRS grey plastic pallets, Ripoll & CIA encapsulated tags also contain an EPC identifier and follow Gen2 Standards. The standard is voluntary to use, but by using them organizations will be able to read tags from other companies of the SC (Common standards enables RFID adoptions).
	Collision: Attempting to read several tags at the same time may result in signal collision and ultimately to data loss. This is not a problem for applying RFID at a pallet level, since rarely two pallets pass through a RFID reader at the same time because pallets are loaded one by one on the trucks in all the cooperatives (Collision might not restrict RFID adoptions).
	Frequency: The optimal choice of frequency depends on several technical factors (i.e. properties of the tagged goods). UHF is the most appropriated frequency for Supply Chain applications as it can be read from long distances and at high speed. UHF presents a low resistance to interfaces from liquid which are very common in fruits, and this can lead to. Since tagging is done on pallets and not on the individual products, careful tags placement should eliminate this problem (Israelsson & Norlund, 2009).The results of UHF selection for operating with fruits are positive both in Nowaste Logistics and Ripoll & CIA. As long as SRS, Nowaste Logistics and Ripoll & CIA´s tags operate in this frequency, interoperability of the technology is guaranteed considering this aspect (Frequency might not restrict RFID adoptions).

Technological aspects	*Quick technology obsolescence:* Technology is continuously evolving and new protocol standards, faster and more fault-tolerant readers quickly outdate their predecessors. It is very difficult to assess the impact of that issue, as it depends both on the evolution of the technology and on the behavior of SC RFID partners (only SRS and Nowaste Logistics at this moment) towards updating (Quick technology obsolescence restricts RFID adoptions).

6.1.2 RFID adoption organizational aspects

Organizational aspects	*Organization size:* Cases show that the biggest company has more financial resources which are necessary to explore and decide whether or not to adopt RFID. Then, this company is more likely to achieve economies of scale and is more capable of reducing the risk of adoption failure (Bigger size enables RFID adoptions).
	Top management support: Top management support in technology initiatives was present in some way in 2 of the 3 cases studied However, it is difficult to quantify as it depends on several aspects. (Top management support enables RFID adoptions).
	Presence of a champion: A “champion” is an owner or manager that realizes the usefulness of a new technology to the organization and leads the adoption within the company. Again, this presence was significant for several reasons only in 2 of three companies (The presence of a champion enables RFID adoptions).
	Technical know-how: Companies that have knowledge about RFID have the ability to better evaluate the projects. Technical know-how varies in the companies studied as only one has RFID know-how (Technical know-how enables RFID adoption).
	Resistance of employees: RFID reduces manual labor. However, employees weren´t reluctant to the previous RFID implementation in one company (Resistance of employees restrict RFID adoption).
	Decision making: According to case studies, company with easiest decision making is the most technology innovative (Simple decision making process enables RFID adoptions).
	External pressure: Competitive environment in process efficiency and potential mandates of supply chain partners (i.e. Nowaste Logistics and SRR) can be a reason why these suppliers decide to adopt on RFID. All of them will invest on RFID if any important market requires this in the future (This enables RFID adoptions).

6.1.3 RFID adoption economic aspects

Economic aspects	*Cost*: The initial investment requires an important investment. On the contrary, important cost savings can be reached by using RFID (out of stock, minimized inventory losses, reduced labor cost…) Rough payback calculations was performed, and results indicated that the years for recovering the investment would be 4.5, 14 and 1,4 respectively. These rough calculations varies a lot depending on the RFID application, the assumptions taken into account, the ignorance of more downstream clients using RFID... Cost is also a limitation that some oranges producers can't afford at this moment (High cost restricts RFID adoptions).

6.2 RFID adoption impact on oranges sector

Agro-food sector in Spain is still being a traditional sector in some way. The key for succeed in this sector doesn´t rely that much on the level of technology or automation as it could be in the case of the automotive industry. Moreover, a lot of job positions in this region depend directly and indirectly on this sector, especially in the case of oranges. That is why employees and probably authorities will show resistance to automate the processes if this occurs in a large scale. What oranges producers persuade is to satisfy and fulfill their customer needs and requirements keeping the lowest price possible. In addition and due to the economic crisis that hits Spain over the lasts years, technology adoptions have been decreased severely. Traceability is extremely important in agro-food sector and oranges producers are forced by law to trace oranges from the crop to truck loading process. Despite the potential of RFID technology to improve supply chain performance, it has been proved along this thesis that other ID technologies such bar codes are far more common in agro-food industry.

Besides, the use of RFID is restricted to certain internal practices within the companies that also aim to improve the efficiency and the accuracy of the processes. Managers of these agro-food companies are not reluctant to RFID technology per se; they were enthusiastic with the potential benefits that this technology can bring both for their internal operational processes and for strengthening the accuracy of the exchanges among downstream RFID partners like between Anecoop and Nowaste Logistics. Nevertheless, the main constraint for them is the lack of RFID downstream implementations and the economic risk of a possible failure could bring. Adopting RFID might one day mean to become a market leader, especially if this is adoption is viewed positively from the client's perspective. So many authors and researchers have written about this first-mover advantage dilemma, arguing that the first adaptor will be the one that most benefit from the adoption of a new technology. However, competing environments caution against treating such benefits as guaranteed (Barney, 1991). All interview respondents supported this line of thinking, basically saying that probably in the future RFID technology might be more spread and becomes crucial for the company survival in the market.

6.3 Supplier selection out of the three companies for a trial

Author has considered interesting to find out an answer to the next question:

"If I were a Swedish company interested in RFID, which one of the three companies studied in this thesis would I select to kick off a RFID trial at supplier level?"

-*Rural Sant Vicent Ferrer Cooperativa*:

Rural Sant Vicent Ferrer´s analysis was the most disadvantageous for the adoption comparing with the other two companies. Technological adoptions require the commitment and support from the top management level and can success by addressing discipline project management in place and an excellent project leadership (Stank et al. 2011). At this point, and despite the commercial responsible of the company appreciated the operational benefits that RFID brings to its applicants, he didn't show any interest regarding the adoption and he argued that this company would only consider the adoption if any important client like ICA forces them to associate orders to RFID tags. The small size of the company makes the adoption more vulnerable and risky if failure occurs. The difficulty to get funds to finance the investment in Spain for small companies is also a key factor that would limit the adoption there. Moreover, lack of technology competence and low willingness to invest on process innovations lead to discard this company for a trial.

-*Ripoll & CIA:*

Ripoll & CIA analysis positioned this company favorably to be a good candidate for being the most suitable supplier out of these 3 companies for the adoption. But at the same time, as long as this company already has more RFID reading points within the factory, this adoption would bring the opportunity to infuse the current RFID system for re-engineering and automating its processes (i.e., by controlling assets location and the routes within the plant, by monitoring the dwell times..). These benefits couldn't be assessed economically in its payback time, but would have a great positive impact on it. This company is also very suitable for the trial as long as they already have RFID hardware needed for it and also their current RFID system follow the same standards that the standards used by Svenska Retursystem. They will only have to invest on the web service and software adjustments. Ripoll & CIA´s organizational innovative culture and employees' expertise in RFID technology are also two favorable factors. Inconveniences are the small size of the company and the fewer number of clients that will potentially incorporate this technology in the future comparing to bigger sized organizations. Moreover, consequences of failure will be worse than in bigger-sized companies.

-Anecoop:

Anecoop group ´s analysis was good in general and indicated that this company and Ripoll and CIA would be the most suitable suppliers out of the three visited for adopting RFID. As a market leader in the world in citric exportations, Anecoop group commercial and economic figures outperform over the other two companies. The fact that this group is logistically innovative in its use of technology (i.e. EDI, a single computer management system in the member cooperative, the R&D laboratory…) potentially affects positively the willingness to adopt RFID. Larger organizations generally have extra capacity to devote to find new technologies and generate economies of scale from them (Patterson et al, 2003). If the trial succeeds, the know-how and expertise gained by Anecoop during this period can be expanded to more companies of the group. As long as this company is formed by 79 cooperatives, the financial risk of failure associated to the investment could be reduced considerably if the trial takes place in only one of the cooperatives of the group (i.e. Cheste Agraria Cooperativa). This company is already capable to invest money on the RFID adoption on one of the plants of the group. Due to the size of the group, Anecoop would be also capable to assign a project team in a trial to gain understanding of new processes and exploring the potentials of the technology. As it was discussed before, commitment, support and motivation from the top management layers are a key factor to succeed in technology adoptions. The respondent from Anecoop was appreciated the idea that might be one day they could have this system in place and it reports large benefits to the company. The positive attitude of the respondent was also present due to the fact that this interviewee was the only one that asked more information about RFID to the author. Moreover, Anecoop is the only Spanish supplier that delivers to Nowaste Logistics which will probably ask their suppliers to try to implement RFID in a near future. So Anecoop group will be the only Spanish supplier that can benefit doubly from the adoption (SRS grey pallet and the potential satisfaction of Everfresh if they associated the orders to RFID smart labels in the future).

Based on the results of this sub-chapter, author considers Anecoop as the most appropriated supplier for the RFID adoption out of the 3 the companies of this work.

Figure 6.1 Supplier selection

7 Concluding remarks

This master thesis arose from the idea of expanding RFID technology use to Spanish oranges producers that export to Sweden. Oranges are transported in RFID pallets provided by a pool operator and distributed to ICA warehouse. But apart from this, one of the companies involved in these case studies also delivers oranges in wooden pallets to Nowaste Logistics, a third party logistics provider which is going to expand it current RFID system also to inbound flows. Therefore, there were two major reasons for exploring a potential RFID adoption in Spanish supplier's plants that will enable the possibility of having common standards for future traceability systems among supply chain trade partners. Visits and interactions with the managers of the companies were really valuable to understand and comprehend the interest and concerns of the companies of this sector. Main concluding remarks are:

-Traceability procedures are very important in oranges sector. Today there are several technologies, procedures and standards to assure a complete traceability for safety and compliance within agro-food industry. Despite some inconveniences of bar codes reported by managers to the author, Spanish producers were satisfied with this traceability system in general. Indeed, this is the most accepted and spread system for traceability purposes within agro-food industry as long as all downstream partners of the cooperatives are still using this system.

-RFID promises several benefits to their users like more accurate readings for a better traceability control or human labour and time savings. Those benefits were appreciated when talking to Ripoll and CIA managers about their RFID internal application results. In line with this, all the managers asked during the thesis agreed upon the idea that implementing RFID in the outbound flow could impact very positively on their processes mainly in the operational layer (i.e. by automating procedures that reduce human intervention), time and costs.

-Spanish oranges suppliers were not aware of RFID supply chain benefits. It is also remarkable the ignorance of this companies about the fact that there are trading partners that are taking advantage of this technology at this moment (at least SRS and Nowaste Logistics). This fact and the scarce use and SC partner's mandates regarding RFID in Spain justify why all these companies have never thought about the RFID adoption.

-It is difficult to generalize theory from case studies. This is because despite all companies belong to the same context, each cooperative has its own peculiarities, framework and technology competence that will have different impact in the adoption. However, some commonalities regarding RFID technology have been identified. For example, the more knowledge about RFID a company has the more level of awareness of it. It was also proved that the economic situation of a company has a direct impact in the willingness and attitude towards technology initiatives, which are few in this traditional sector.

-Lack of collaboration in technology initiatives among SC partners has been identified during this work. This was especially noticed when talking to the managers of cooperatives. Supply chain technological initiatives require collaboration among different actors in order to mitigate risks and to search for common goals and interest. No one was informed that SRS pallets contain a RFID tag and thus that there is an opportunity to use that technology and to potentially improve supply chain performance as RFID technology and the proper management are expected to do.

It is important to remark that even thought the author was in constant contact with personnel for all the companies involved in the thesis, there is also too many information supported in theory that might doesn't fully fit the reality. As a final statement, author wants to make a recommendation for all the actors involved in this SC in order to shape the way of further collaboration and co-operation in RFID initiatives. Apart from the reading of this thesis, author specifically recommends:

-*Recommendation for Swedish wholesalers:*

Due to its expansion at supplier level, author strongly recommends Nowaste Logistics and other wholesalers interested in investing on RFID to get in touch with SP. According to Robert Davstedt (Project IT controller from Nowaste Logistics) the expansion of its current system to inbound flows especially needs the collaboration of those suppliers that use RFID pallets. For instance, by getting in touch with Anecoop, Nowaste Logistics could share its concerns, its RFID expertise in handling fruits vegetables, and its future plans about the RFID expansion at supplier level.

-*Recommendation for Spanish Suppliers:*

Author recommends Spanish suppliers to be receptive for receiving all RFID information and plans motioned above from supply chain partners. To explore if they have more RFDI clients downstream that might be satisfied by the adoption in the future and author also encourages them to investigate the potentials of this technology by themselves.

-*Recommendation for Svenska Retursystem:*

Author recommends this company to share their knowledge, expertise, information and potentials about RFID grey plastic pallets with Spanish suppliers. It would be great if they also facilitate information about GS1 EPCglobal network for RFID with those suppliers. It can be done by sending a PowerPoint presentation to the suppliers.

List of references

Ampatzidis, Y.G., Whiting, M.D., Scharf, P.A. and Zhang, Q. (2012) "Development and evaluation of a novel system for monitoring harvest labor efficiency" *Computers and Electronics in Agriculture*

Asher, C., Morgan, G., Swan, R., Traub, K. (2007) "EPCIS (Electronic Product Code Information Service) Frequently Asked Questions" *EPCglobal 2007*

Attaran M. (2012) "Critical Success Factors and Challenges of Implementing RFID in Supply Chain Management" *Journal of Supply Chain and Operations Management, Volume 10, Number 1*

Bacharach S.B. (1989) "Organizational Theories: Some criteria for evaluation" *The Academy of Management Review*

Bagchi U., Guiffrida, A., O'neil L., Zeng, A. and Hayya, J. (2007) "The effect of RFID on inventory management and control" *Springer Series in Advanced Manufacturing*

Barney, J.B. (1991) "Firm resources and sustained competitive advantage" *Journal of Management*

Beth Davis-Sramek and Brian S. Fugate (2007) "State of Logistics: A Visionary Perspective" *Journal of Business Logistic*

Bettencourt, L.A. & Ulwick, A.W. (2008) "The customer-Centered Innovation Map" *Harvard Business Review*

Bowman P., Ng J., Harrison M., Illic A. (2009) "Reusable Asset Management Model" *Building Radio frequency Identification for the Global Environment*

Carrasco-Gallego, Ponce-Cueto (2008) "An overview of radiofrequency identification systems (RFID) in Spanish industry" *Production and Operations Management Society*
Carrasco-Gallego, Ponce-Cueto, 2009 "Case studies on the adoption of radiofrequency identification (RFID) systems in Spanish companies" *16th International Annual Euroma Conference*

Carrasco-Gallego, Ponce-Cueto, 2011 "Closed-loop supply chains of reusable articles: a typology grounded on case studies" *International Journal of Production Research*

Coff, C., Barling, D., Korthals, M., and Nielsen, T. (2008) "Ethical Traceability and Communicating Food" *The International Library of Environmental, Agricultural and Food Ethics Vol. XV*

David C. Wyld (2006) "RFID 101: The next big thing for management" *Management Research News*

Davis, F., Bagozzi, R. and Warshaw, P. (1989) "User acceptance of computer technology: a comparison of two theoretical models" *Management Science 35*

D.W. Engels and S.E. Sarma, (2001) "The Reader Collision Problem," *IEEE International Conference on Systems, Man and Cybernetics*

FEPEX (Federación Española de Asociaciones de Productores y Exportadores de Frutas, Hortalizas, Flores y Plantas Vivas) (2013) *www.fepex.es*

FAO (2012) "Cost-Effective Management Tools for Ensuring Food Quality and Safety" *FAO training materials for agricultural, management, marketing and finance*

Gutafsson, K. (2008) "From vision to decision" *Department of Design Sciences of Lund University Report*

Handley, C.B. (2003) "Validity and Reliability in Research" *Maryland: Transplant Resource Centre*

Hedgepeth, W. (2007) "RFID Metrics: Decision making tools for Today´s Supply Chains" *CRC Press*

Hellström, D., Johnsson, C and Norrman, A. (2011) "Risk and gain sharing challenges in interorganisational implementation of RFID technology" *International Journal of Procurement Management*

Hellström, D. (2009) "The cost and process of implementing RFID technology to manage and control returnable transport items" *International Journal of Logistics: Research and Applications*

Intermec (2007) "Case-study: Naranjas con denominación de origen" http://www.intermec.com/public-files/case-studies/es/csCosiva_ES.pdf

Israelsson J., and Nordlund M. (2009) "The road to RFID: An implementation at a third party logistics provider" *Master Thesis at Division of Packaging Logistics (Lund University)*

Johansson, O., and Hellström, D. (2007) "The effect of asset visibility on managing returnable transport items", *International Journal of Physical Distribution & Logistics Management*

Johansson, O., and Påalsson, H. (2009)"The impact on logistics performance: A benchmarking survey of Swedish manufacturing industries" *Benchmarking: An international journal*

John R., (2012) "International Food Safety: The Importance of Temperature Monitoring" www.intelleflex.com

Jones, P. (2004) "Radio frequency identification in the UK: opportunities and challenges" *International Journal of Retail & Distribution Management*

Katherine J. Klein and Andrew P. Knight (2000) "Innovation Implementation: Overcoming the Challenge" *CDIR Journal*

Kathleen M., "Building Theories form Case Study Research" *The academy of management review Vol. 14*

Katz, Michael L. and Carl Shapiro. 1985. "Network Externalities, Competition, and Compatibility." *The American Economic Review*

Keith, A. et al. (2002) "Focus on the Supply Chain: Applying Auto-ID within the Distribution Center" *IBM Business Consulting Services, Auto-ID Center, Massachusetts Institute of Technology*

Kidder, T. (1982) "Soul of a new machine" *New York: Avon*

Kroon L. and Vrijens G. (1994) "Returnable containers: an example of reverse logistics" *International Journal of Physical Distribution and Logistics Management*

LogicaCMG, (2004) "Making waves: RFID adoption in returnable packaging"

Mandeep Kaur, Manjeet Sandhu, Neeraj Mohan and Parvinder S. Sandhu (2011) "RFID Technology Principles, Advantages, Limitations & Its Applications" *International Journal of Computer and Electrical Engineering*

MacMillan, 1930 "The Encyclopedia of Social Sciences" Vol. IX

Marshall, P. (1997) "Research Methods: How to design and conduct a successful project" *Plymouth: How to Books*

Narayanan, V.G. and Roman A. (2004) “Aligning incentives in supply chains” *Harvard Business Review*

Ngai, E. and Gunasekaran, A. (2009) “RFID Adoption: Issues and Challenges” *International Journal of Enterprise Information Systems*

Nicole Schadewit and Timothy Jachna, 2007 “Comparing inductive and deductive methodologies for design patterns identification and articulation” *International Design Research Conference IADSR 2007 Emerging Trends in Design Research*

Official Journal of the European Union (2006) “Community framework for state aid for research and development and innovation”

OnTrace (2007) “Traceability Backgrounder” www.ontraceagrifood.com/documents/TraceabilityBkgder-Apr07.pdf

OSLO Manual (2005) “Guidelines for Collecting and Interpreting Innovation Data” *Organisation for Economic Co-operation and Development*

Papetti, P., Costa, C., Antonucci, F., Figorilli, S., Solaini, S., & Menesatti, P. (2012)”A RFID web-based infotracing system for the artisanal Italian cheese quality traceability” *Food and Bioprocess Technology Vol. VI*

Patterson, K.A., Grimm, C.M. and Corsi, T.M. (2003) “Adopting new technologies for supply chain management” *Logistics and transportation review*

Pinfueld, L. (1986) “A field evaluation of perspectives on organizational decision making”*Administrative Science Quarterly*

Rogers. E (1962) “Diffusion of innovations” *4th edition*

Soosay, C. A., Hyland, P., W., & Ferrer, M. (2008) “Supply chain collaboration: capabilities for continuous innovation” *Supply Chain Management*

Steven J. Kline and Gnathion Rosenberg (1986) "An Overview of Innovation" *The Positive Sum Strategy, National Academy Press*

Theodore P. Stank, J. Paul Dittmann and Chad W. Autry, 2011 “The new supply chain agenda” *International Journal of Physical Distribution and Logistics Management*

Tornatzky, L.G., Fleischer, M. (1990) “The Processes of Technological Innovation” *Lexington, MA: Lexington Books*

University of Cambridge, AT4 wireless, BT Research, SAP Research, ETH Zurich, GS1 UK (2007) "Requirements document of serial level lookup service for various industries" *Building Radio frequency Identification for the Global Environment*

Venture Development Corporation, (2007) "Global RFID market overview"

Vican, A. (2009) "Implementation of solutions based on GS1 and EPCglobal standards for Asset Management" *Building Radio frequency Identification for the Global Environment*

Wang, L., Ting, J., Ip, W.H. (2013) "Design of Supply-chain Pedigree Interactive Dynamic Explore (SPIDER) for food safety and implementation of Hazard Analysis and Critical Control Points (HACCPs)" *Computers and Electronics in Agriculture*

Weiss, R.S. (1968) "Issues in Holistic Research" *Institutions and person*
Yin, R. (2003) "Case study Research: Design and Methods" *Applied Social Research Methods Vol. V*

Wikipedia (2013) *http://en.wikipedia.org/wiki/Electronic_data_interchange*

Wikipedia (2013) *http://en.wikipedia.org/wiki/ICA_AB*

Wikipedia (2013) *http://en.wikipedia.org/wiki/SWOT_analysis*

Appendices and Abbreviations

Appendix 1: Master Thesis Spanish Suppliers Interview

-What is the name of your company?

-What is your name?

-What kind of activities you are responsible for within your company?

-Approximately, how many employees are in your organization?

-How many different geographic locations does your company have?

-Are there business drivers in your sector for traceability? What?

-Which of your internal processes is affected by this?

-What is the finest level of granularity required by these drivers for tracking?

- Product
- Crate
- Pallet
- Container

-Are there legislative/regulatory drivers in your sectors for traceability?

-Are there Global/European/National?

-At what level of granularity do you currently store information about your products?

-Typically how many companies (including logistics providers) are involved in the process of delivering products from your company to the end user of the products?

-Typically how many countries are involved in the process of delivering products from your company to the end user?

-How many countries does your company export to?

-What is the level of awareness of your company about RFID?

-What are the barriers which would hinder a RFID adoption in your company? (Scale the importance from 1(small barrier) to 5(big barrier)).

- Perceived benefits
- Complexity of the system
- Organizational compatibility
- Organizational readiness
- Top management support
- External factors
- Technology competence
- Firm scope
- Size of the company
- Low level of communication between partners (to reach an agreement)
- Low level of RFID implementations downstream your company in the supply chain
- Low percentage of RFID pallets that your company handles
- Financial and economic situation

-Which problems do you predict will occur during a RFID implementation?

-What kind of internal benefits would you expect for an RFID implementation? (Scale the importance from 1(no important) to 5(very important)).

- Reduce labor costs
- Reduced time needed in the process
- Increase accuracy in the process
- Improve the management control within your company
- Reengineering your current process

-How many pallets does your company handle every year?

-Which kind of pallets does your company use?

- Wooden pallets: ……. %
- Plastic pallets: ……. %
- Plastic pallets with RFID: ……. %
- Others: ……. %

-What is the way by which those pallets are managed by your company?

- SRS pallets
- Other pallets

-How often is it reported that a pallet has not reached its destination? Where in the supply chain are those problems originated?

-Is your company responsible for paying the lost pallets?

-Are you familiar with GS1 EPCglobal standards for RFID?

-SRS RFID tagged pallets follow this international standard, which enables the participants in GS1 network to catch real-time information of the tagged items. The fee of the membership is around 2000 Euros a year. What kind of benefits would you expect for implementing RFID and joining GS1 network? (Scale the importance from 1(no important) to 5(very important)).

- Improve assets accountability
- Rental cost reduction for pooling model
- Efficiency of trading partners ´management account (i.e. invoicing).
- Optimize exchange with partners through a better visibility
- Others

-As far as you already know, you are handling RFID tagged pallets. In the Swedish market, some warehouses as Nowaste Logistics are already equipped with RFID technology (readers, antennas, middleware, IT systems...). The scope of those existing implementations was on their outbound flow. However, they are thinking in incorporating RFID technology in its inbound flow (first with Swedish suppliers and later on with suppliers that deliver goods in SRS pallets). In order to implement RFID in the inbound flow of RFID-equipped warehouses, a RFID implementation will be needed in the outbound flow of their suppliers.

- Would you be able to cooperate and collaborate with your clients if they require RFID downstream implementations at supplier level?
- Are there any warehouse/logistic provider that handle your oranges and vegetables downstream in the supply chain thinking about implementing RFID in their inbound flow?

Appendix 2:

These calculations reflect the possible positive impact in the price of oranges sales to the Swedish market considering the assumption of higher satisfaction of Swedish clients and the supply chain benefits downstream Spanish plants in that market.

-Rural Sant Vicent Ferrer Cooperativa:

3000 SRS pallets are exported to Sweden every year (ICA Helsingborg).

Each pallet contains around 800 kg of oranges.

The kg of oranges costs 0, 27 at cooperative level (production costs is 0, 24 Euros/kg)

If the money they receive per kg from the Swedish customers increases 0, 01 Euros:

3000 (pallets/year)*800(kg/pallet)*0, 01(extra money/kg) = 24.000 Euros (extra money/year)

-Ripoll & CIA:

1200 SRS pallets are exported to Sweden every year (ICA Helsingborg).

Each pallet contains around 800 kg of oranges.

The kg of oranges costs 0, 27 at cooperative level (production costs is 0, 24 Euros/kg)

If the money they receive per kg from the Swedish customers increases 0, 01 Euros:

1200 (pallets/year)*800(kg/pallet)*0, 01(extra money/kg) = 9.600 Euros (extra money/year)

1200 (pallets/year)*800(kg/pallet)*0, 01(extra money/kg) = 9.600 Euros (extra money/year)

-Cheste Agraria Cooperativa (Anecoop):

2200 SRS pallets are exported to Sweden every year (ICA Helsingborg) and around 3000 are also exported in wooden pallets (Nowaste Logistics).

Each pallet contains around 800 kg of oranges.

The kg of oranges costs 0, 27 at cooperative level (production costs is 0, 24 Euros/kg)

If the money they receive per kg from the Swedish customers increases 0, 01 Euros:

5500 (pallets/year)*800(kg/pallet)*0, 01(extra money/kg) = 44000 Euros (extra money/year)

Appendix 3: Labor cost savings calculations

For these calculations, it has been assumed that 10 seconds are needed to read the bar codes attached to the outbound pallet and that the total cost of an operator for a company is around 1500 Euros per month. Considering that a normal employee in Spain works 8 hours a day:

-Rural Sant Vicent Ferrer Cooperativa:

25000(pallet/year)/12(month/year) =2083(pallet/month) = 2083(reads/month)

1500(Euros/month)/172(working hours/month) =8, 7(Euros/working hour)

8, 7(Euro/working hour)/3600(seconds/hour) = 0, 0025 (Euro/working second)

If RFID technology saves 90% of the cost for shipping processes,

2083(reads/month)*9(second saved/read) =18747(second saved/month)

0, 0025(Euro/second)*15000(second/month) =46, 86(Euros saved/month)

46, 86(Euros/month)*12(month/year) = 562(Euros saved/year)

-Ripoll &CIA:

20000(pallet/year)/12(month/year) =1666(pallet/month) = 1666(reads/month)

1500(Euros/month)/172(working hours/month) =8, 7(Euros/working hour)

8, 7(Euro/working hour)/3600(seconds/hour) = 0, 0025 (Euro/working second)

If RFID technology saves 90% of the cost for shipping processes,

1666(reads/month)*9(second saved/read) =15000(second saved/month)

0, 0025(Euro/second)*15000(second/month) =37, 5(Euros saved/month)

37, 5(Euros/month)*12(month/year) = 450(Euros saved/year)

-Cheste Agraria Cooperativa (Anecoop):

22000(pallet/year)/12(month/year) =1666(pallet/month) = 1833(reads/month)

1500(Euros/month)/172(working hours/month) =8, 7(Euros/working hour)

8, 7(Euro/working hour)/3600(seconds/hour) = 0, 0025 (Euro/working second)

If RFID technology saves 90% of the cost for shipping processes,

1833(reads/month)*9(second saved/read) =16500(second saved/month)

0, 0025(Euro/second)*16500(second/month) =41.2(Euros saved/month)

41.2(Euros/month)*12(month/year) = 500(Euros saved/year)

Appendix 4: Decreasing in SRS pallets inventory

Despite of the fact that cooperatives order the number of SRS to palletize the orders that they receive from ICA, these cooperatives have a buffer of SRS tagged pallets in their factories. A potential decreasing in SRS pallets inventory at cooperatives has been assumed to be 50% by controlling the number of incoming pallets and reporting automatically with RFID system when they leave the plant; this will affect only to the variable fee that cooperatives pay in terms of days of use per pallet as it was mentioned previously more in detail (price is 0, 03 Euros per pallet per day). Calculations are shown below:

-Rural Sant Vicent Ferrer Cooperativa:

Average inventory level: 50 pallets (buffer) + pallets for upcoming orders.

50(pallets)*365(day/year)*0, 03(Euros/ (pallet*day)) = 550 Euros for inventory buffer

550*0, 5= 275 Euros saved for inventory buffer

-Ripoll &CIA:

Average inventory level: 50 pallets (buffer) + pallets for upcoming orders.

50(pallets)*365(day/year)*0, 03(Euros/ (pallet*day)) = 550 Euros for inventory buffer

550*0, 5= 275 Euros saved for inventory buffer

-Cheste Agraria Cooperativa (Anecoop):

Average inventory level: 50 pallets (buffer) + pallets for upcoming orders.

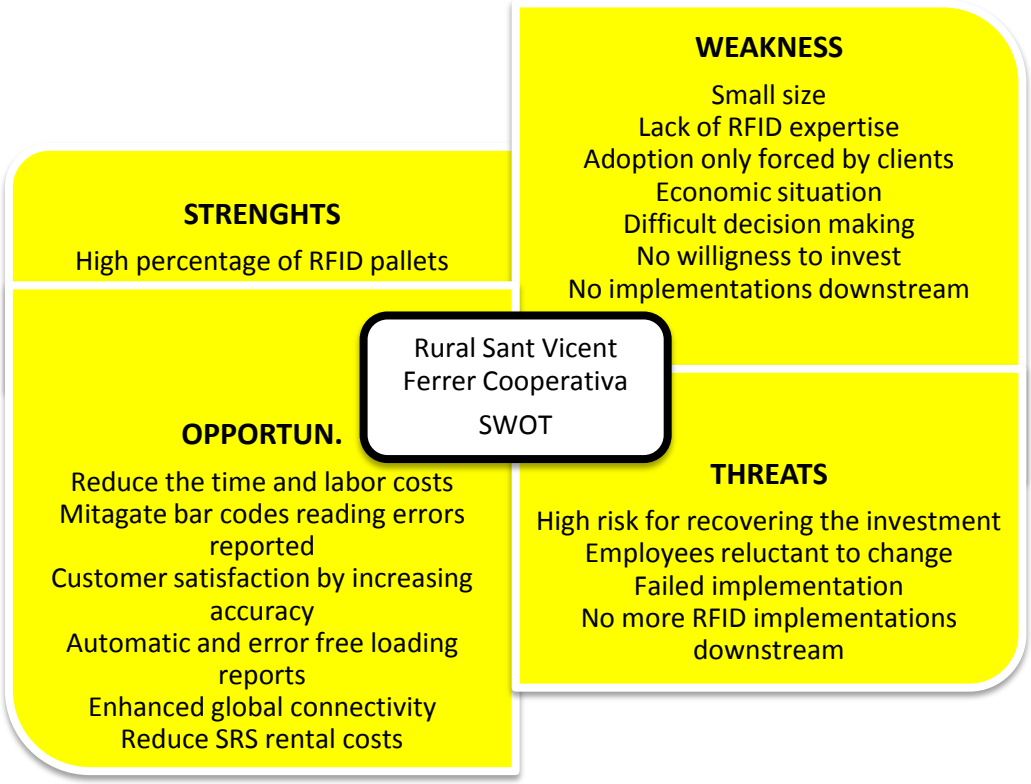
50(pallets)*365(day/year)*0, 03(Euros/ (pallet*day)) = 550 Euros for inventory buffer

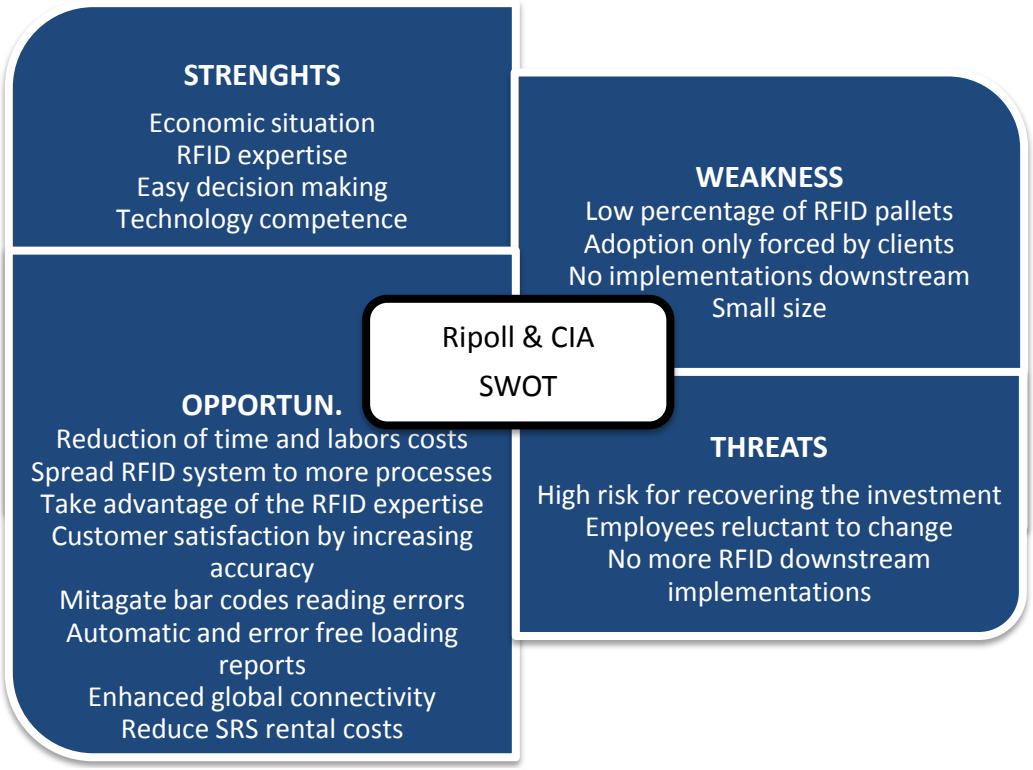
550*0, 5= 275 Euros saved for inventory buffer

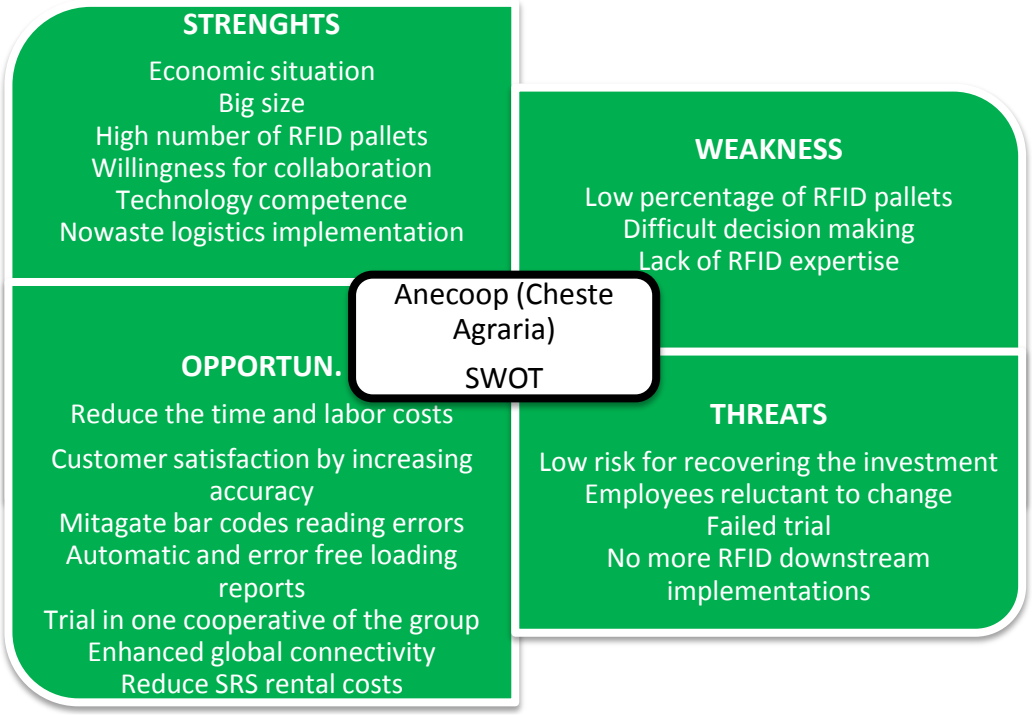
Appendix 5: SWOT Analysis

SWOT analysis (alternatively SWOT Matrix) is a structured planning method used to evaluate the strengths, weaknesses, opportunities, and threats involved in a project or in a business venture. A SWOT analysis can be carried out for a product, place, industry or person. It involves specifying the objective of the business venture or project and identifying the internal and external factors that are favourable and unfavourable to achieving that objective.

Identification of SWOT is important because they can inform later steps in planning to achieve the objective. First, the decision makers should consider whether the objective is attainable, given the SWOT. If the objective is not attainable a different objective must be selected and the process repeated. Users of SWOT analysis need to ask and answer questions that generate meaningful information for each category (strengths, weaknesses, opportunities, and threats) to make the analysis useful and find their competitive advantage (Wikipedia, 2013). Based on the previous analysis and findings about a RFID adoption in the outbound flow, a SWOT analysis will be performed to display these 4 features of each case graphically.




STRENGHTS
Economic situation
RFID expertise
Easy decision making
Technology competence
WEAKNESS
Low percentage of RFID pallets
Adoption only forced by clients
No implementations downstream
Small size
Ripoll & CIA
SWOT
OPPORTUN.
Reduction of time and labors costs
Spread RFID system to more processes
Take advantage of the RFID expertise
Customer satisfaction by increasing accuracy
Mitagate bar codes reading errors
Automatic and error free loading reports
Enhanced global connectivity
Reduce SRS rental costs
THREATS
High risk for recovering the investment
Employees reluctant to change
No more RFID downstream implementations


STRENGHTS
Economic situation
Big size
High number of RFID pallets
Willingness for collaboration
Technology competence
Nowaste logistics implementation
WEAKNESS
Low percentage of RFID pallets
Difficult decision making
Lack of RFID expertise
Anecoop (Cheste Agraria)
SWOT
OPPORTUN.
Reduce the time and labor costs
Customer satisfaction by increasing accuracy
Mitagate bar codes reading errors
Automatic and error free loading reports
Trial in one cooperative of the group
Enhanced global connectivity
Reduce SRS rental costs
THREATS
Low risk for recovering the investment
Employees reluctant to change
Failed trial
No more RFID downstream implementations

Appendix 6: Rough payback periods

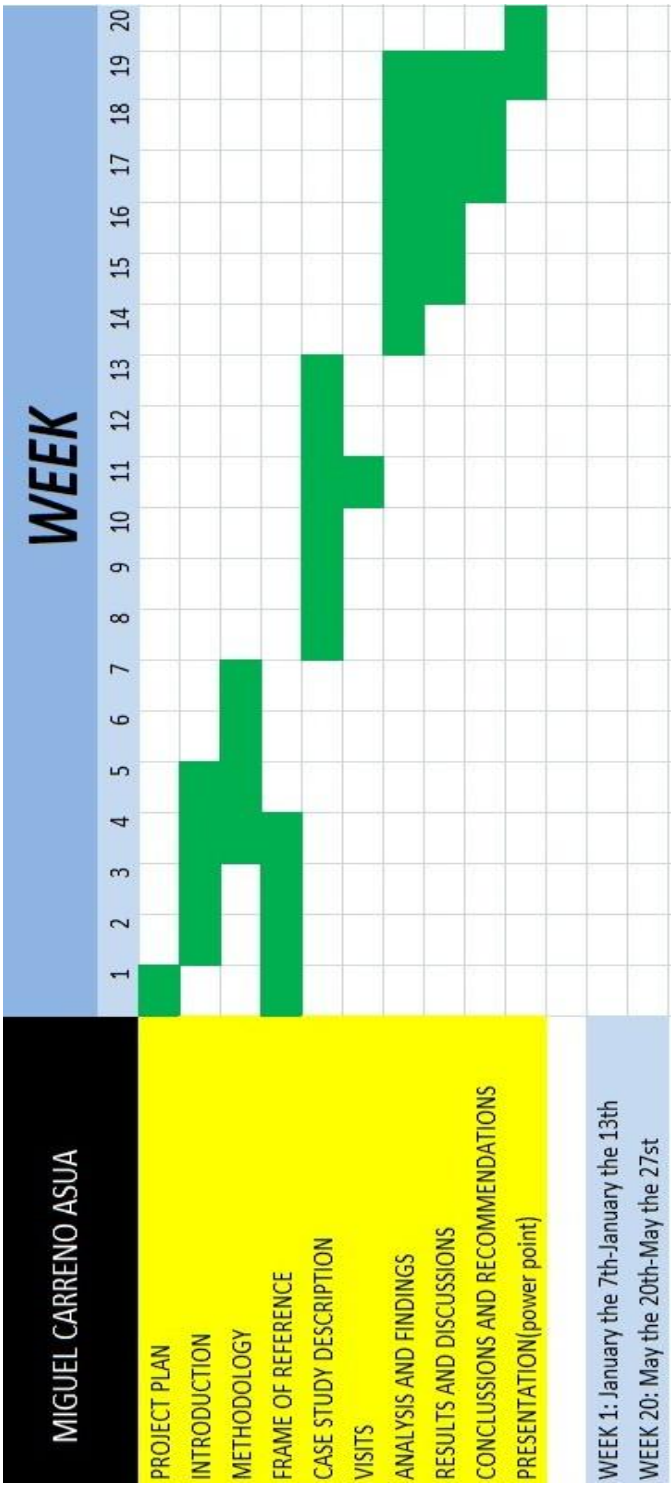
COST FOR RURAL SANT VIC.		AMOUNT	UNIT COST	COST
HARDWARE	Readers (Gantry)	3	100	300
	Readers (Control Unit)	3	2000	6000
	Readers (Antennas)	6	500	3000
	Readers (Traffic lights)	3	50	150
	Speakers (Readers)	3	50	150
	Handheld reader	1	1200	1200
	Printer	1	2300	2300
	Server	1	1000	1000
	Cables and switches	1	2000	2000
	Hardware installation	1	1500	1500
SOFTWARE	Readers	3	1500	4500
	Printers	1	5000	5000
	Server, data base (upgrading)	1	15000	15000
	Web service	1	15000	15000
	Integration	1	10000	10000
T & E	Training and education	1	2000	2000
INITIAL INVESTMENT				69100 EUROS
RUN COST	Electricity consumption (kWh)	5000	0.13	650
	Maintenance	1	1500	1500
	Software updates	1	2000	2000
	Smart labels	22000	0.2	4400
	GS1 membership fee	1	2000	2000
	License (Gates)	3	3000	9000
	License (Server and data base)	1	10000	10000
YEARLY RUNNING COSTS				29550 EUROS
PROFIT	Swedish market increased price	2400000	0.01	24000
	Labour costs	1	1	562
	Workload decrease	1	1	20000
	SRS pallet fee costs	1	1	275
YEARLY RUNNING PROFIT				44837 EUROS
PAYBACK TIME (YEARS)				**4.5**

.

COST FOR RIPOLL & CIA		AMOUNT	UNIT COST	COST
HARDWARE	Readers (Gantry)	0	100	0
	Readers (Control Unit)	0	2000	0
	Readers (Antennas)	0	500	0
	Readers (Traffic lights)	0	50	0
	Speakers (Readers)	0	50	0
	Handheld reader	1	1200	1200
	Printer	1	2300	2300
	Server	0	1000	0
	Cables and switches	1	2000	2000
	Hardware installation	1	1500	1500
SOFTWARE	Readers	0	1500	0
	Printers	1	5000	5000
	Server, data base installation	1	3000	3000
	Web service	1	15000	15000
	Integration	1	10000	10000
T & E	Training and education	1	1000	1000
INITIAL INVESTMENT				41000 EUROS
RUN COST	Electricity consumption (kWh)	5000	0.13	650
	Maintenance	1	1000	1000
	Software updates	1	1000	1000
	Smart labels	18800	0.2	3760
	GS1 membership fee	1	2000	2000
	License (Gates)	3	3000	9000
	License (Server and data base)	1	10000	10000
YEARLY RUNNING COSTS				27410 EUROS
PROFIT	Swedish market increased price	960000	0.01	9600
	Labour costs	1	1	450
	Workload decrease	1	1	20000
	SRS pallet fee costs	1	1	275
YEARLY RUNNING PROFIT				30325 EUROS
PAYBACK TIME (YEARS)				**14**

COST FOR CHESTE AGRARIA		AMOUNT	UNIT COST	COST
HARDWARE	Readers (Gantry)	3	100	300
	Readers (Control Unit)	3	2000	6000
	Readers (Antennas)	6	500	3000
	Readers (Traffic lights)	3	50	150
	Speakers (Readers)	3	50	150
	Handheld reader	1	1200	1200
	Printer	1	2300	2300
	Server	1	1000	1000
	Cables and switches	1	2000	2000
	Hardware installation	1	1500	1500
SOFTWARE	Readers	3	1500	4500
	Printers	1	5000	5000
	Server, data base installation	1	15000	15000
	Web service	1	15000	15000
	Integration	1	10000	10000
T&E	Training and education	1	2000	2000
INITIAL INVESTMENT				68100 EUROS
RUN COST	Electricity consumption (kWh)	5000	0.13	650
	Maintenance	1	1500	1500
	Software updates	1	2000	2000
	Smart labels	20500	0.2	4100
	GS1 membership fee	1	80	80
	License (Gates)	3	3000	9000
	License (Server and data base)	1	10000	10000
YEARLY RUNNING COSTS				27330 EUROS
PROFIT	Swedish market increased price	4400000	0.01	44000
	Labour costs	1	1	500
	Workload decrease	1	1	20000
	SRS pallet fee costs	1	1	275
YEARLY RUNNING PROFIT				64775 EUROS
PAYBACK TIME (YEARS)				**1.8**

Appendix 7: Project Plan



Abbreviations

-B2B: Business to business

-EDI: Electronic Data Interchange

-EPC: Electronic Product Code

-EURO pallet: European standard of wooden pallets

-FEFO: First Expired First Out

-FIFO: First In First Out

-Gen 2: Denotes ISO/IEC 18000-6C-RFID air interface standard for the UHF band

-HF: High Frequency

-IEC: International Electro-technical Commission

-ISO: International Standard Organization

-IT: Information Technology

-LF: Low Frequency

-ONS: Object Name Service

-RFID: Radio Frequency Identification

-ROI: Return of Investment

-RP: Reusable Products

-RPM: Returnable packaging materials

-RTI: Returnable Transport Items

-SC: Supply Chain

-SCM: Supply Chain Management

-SP: Spanish Producers

-SRS: Svenska Retursystem

-SSCC: Serial Shipping Container Code

-UHF: Ultra High Frequency