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1 Introduction

The concept of radio frequency identification (henceforth referred to as RFID) has been researched and studied in a number of contexts. However, it is first in rather recent years that the technology has become a real alternative for logistics companies. Technological advancement, new methods of production, as well as increased competition among producers has decreased the costs associated with adopting the technology for actors in the supply chain.

Pan Nordic Logistics (henceforth referred to as PNL) is considering adopting RFID and integrates the technology into its current logistics chain. As a large provider of goods services with a rather extensive logistics process, the company is exploring opportunities to rationalize and optimize this process. For PNL, the RFID technology offers a number of unique advantages compared to the so-called barcode technology currently used.

This thesis is aimed primarily at guiding PNL in its assessment on whether an RFID implementation is feasible or not, as well as on how the technology could affect the organization.

This study has been conducted in close cooperation with representatives from the PNL organization as well as with Combiport; a Jönköping based provider of RFID related solutions within logistics and security.

By closely examining the logistics processes of PNL in general as well as one of three so-called HUB in particular, a broad understanding of the organization has been achieved. Empirical findings at PNL have been interpreted from a theoretical perspective and in relation to the RFID technology in general. The outcome of this study will aid PNL representatives at all levels within the organization to understand and assess the feasibility of RFID.

1.1 Problem

This study takes an 'opportunity perspective'. RFID represents a technological opportunity with potential to refine and optimize supply chains. Representatives from PNL have expressed interest in the technology and how it could enhance current operations. This study explores the potential for implementing RFID into the logistics process of PNL.

1.2 Purpose

The purpose and overall goal of this study is to determine whether or not an implementation of RFID technology in the case of PNL is feasible or not. The target of the study is managers and process owners at PNL. The purpose is defined as follows:

- To determine how RFID could best be implemented into the existing logistics process of PNL.
- To determine the financial consequences of implementing and integrating RFID into the existing logistics process of PNL.

1.3 Research questions

In order to respond to the purpose and overall mission of this study as presented above, the following three research questions has been posed:

- Where in the PNL logistics process is RFID suitable to implement?
- What benefits are associated with an implementation of RFID?
- How can these benefits be financially evaluated?

1.4 Disposition

The thesis guides the reader through the complex concept of RFID and applies the technology to the organization of PNL as well as its logistics process. This report follows the following structure:

- *Background.* Chapter two presents relevant background in regards to PNL as an organization as well as RFID as a technology.
- *Frame of reference.* Chapter three presents a relevant framework for further presentation and analysis of empirical findings. A crucial part of this study is the identified benefits the RFID technology. These are presented, applied to PNL, and analyzed in chapter five. The financial dimension also introduces the framework for financial assessment. A short summary of other cases is introduced as a base for later discussion. Finally, the frame of reference presents the so-called 'balanced scorecard', later used as a tool for presenting areas in need of further measurement.
- *Methods.* Chapter four presents relevant methods used in the study and in this report. Furthermore, a short discussion is held on how an empirical understanding has been achieved, and on how data has been analyzed. Also, the methodological chapter contains the delimitations and a general discussion in regards to limitations of this study.
- *Results and analysis.* Chapter five presents empirical findings and analyzes these. The framework for presentation of benefits and risks (as presented in chapter three) is maintained and applied to PNL. Analysis is being performed directly in the empirical section and is thus combined with relevant findings.
- *Conclusions and recommendations.* Chapter six presents a concluding discussion on an overall level in regards our findings and the purpose of this report. Furthermore, a balanced scorecard is being used as a tool for presenting proposed areas of future measurement and concern. Overall, this framework serves to show how RFID as an overall concept is aligned towards the current strategy of PNL.

2 Background

The following chapter presents relevant information regarding PNL as a company, as well as the RFID technology in such. Though some findings in this chapter are of empirical character, they are presented as a relevant background in order to strengthen the logical flow and readability of this thesis.

2.1 Pan Nordic Logistics

PNL was launched in 1997 by three Nordic postal companies; Post Denmark, Posten Norge, and Posten Sverige. The company was primarily formed as a joint venture in order to relieve the three owners of package handling, allowing them to strictly focus on the delivery of letters and small parcels. However, in 2003 Posten Sverige withdrew from the venture. (PNL, 2007)

PNL today has developed an extensive Nordic network by utilizing logistics network of and buying services from its two owners, as well as by cooperation with postal companies in Estonia, Finland, Greenland, Iceland, and Sweden. The Swedish network is developed and maintained by PNL in cooperation with partners such as Box Delivery. (Årsrapp. 2005, PNL)

PNL is focusing mainly on business-to-business parcels (B2B), with its *CarryOn Business* portfolio. It is estimated that around 90% of the goods flow is made up by B2B products. A great deal of the B2B shipments is high value goods. Also, PNL offers business-to-customer (B2C) solutions such as the *CarryOn HomeShopping* portfolio. The B2C goods are mainly made up by shipments from the Swedish e-trade business. Customer-to-customer solutions are offered in Denmark and Norway. (Årsrapp. 2005, PNL)

The Nordic logistics market in which PNL operates could be characterized as highly competitive. A number of established logistics companies are present, such as DHL, FedEX, and Schenker. Also, indirect actors such as messenger carriers and companies specializing in B2B goods are present. PNL has been in business for around a decade with its well-developed logistics network as a primary competitive advantage.

PNL has managed to turn recent growth into positive numbers and increased turnaround. The turnover of last fiscal years exceeded 1,2B SEK, with a positive cash flow. It is the ambition of the company to use the accumulated strength in order to grow and expand. The company is looking into expanding its logistics network by cooperating with European and Asian actors. Also, it is the objective to increase overall goods flow with up to 100%. In order to increase goods flow, but also to absorb increased flow with minimal demand on investment, it is ideal to look at the current logistics process and how it could be optimized. (Årsrapp. 2005, PNL)

2.1.1 Strategy and vision

This section serves to identify the overall strategy, goals, and visions of PNL. As part of our analysis, perceived RFID opportunities will be understood from a strategy impact perspective in order to understand how the technology in such aligns with values of PNL. Identifying and understanding strategy and values of PNL in relation to RFID is key in evaluating the overall suitability of an implementation vis a vis PNL strategy.

The following quotes represent vision and overall strategy of PNL:

"We shall maintain our position as the leading Nordic logistics company on the parcel market." (PNL, 2007)

"We shall increase our customers competitiveness. This is why PNL offers the CarryOn products and the Nordic regions most comprehensive parcel distribution, linked to the rest of the world. Consequently, companies and individuals receive distribution that is reliable, easy to use and generates added value." (PNL, 2007)

"By always starting with our customers needs and using these to create physical and electronic products and services, we do not just deliver shipments, but also security and additional value." (PNL, 2007)

The overall strategy of PNL as presented above could be translated into the following three core values:

- *Growth*. According to the 2006 annual report, PNL is aiming at international growth as well as expansion on the Nordic arena. As part of this growth, it is necessary to increase capacity in terms of goods flow. The RFID technology has a number of features that could enhance the overall logistics process of PNL
- *Quality*. As presented in the abovementioned quote, PNL identifies quality in terms of products and a comprehensive distribution network as a way to add value for the customer. As previously identified, RFID has potential to increase the quality of logistics operations and can thus further empower the quality dimension.
- *Lean*. As previously identified, PNL is using Lean as a core concept to enforce quality and to reduce system waste in different forms. As concluded in the empirical findings in this study, RFID holds substantial potential in terms of enhancing current processes and to reduce waste. An implementation of the technology can thus be a facilitator for further Lean thinking.

2.1.2 Lean thinking

The following section provides a background on Lean thinking. This concept is used at PNL as a strategic tool. It is therefore relevant to understand Lean in order to assess and understand how the RFID technology is relevant in relation to the overall PNL strategy.

Lean thinking as a concept is originally developed by Japanese car manufacturers. In short lean thinking is a way of eliminating/minimizing waste in all aspects of a business through optimization of business processes. It is seeking process perfection and emphasize that the customers should not pay for waste in the supply network. (Harrison & Hoek, 2005). To achieve this, four principles are used together with an interpretation of their meaning to PNL´s business.

Lean thinking refers to the efforts to achieve perfection by involving four principles: Specify value, identify the value stream, make value flow, and pull scheduling. Those principles are then mapped against *the seven wastes* (Harrison & Hoek, 2005). *Lean thinking* involves using a customer perspective and can be compared to the value that PNL´s logistics process creates through seeking perfection, i.e. minimize waste and create customer value

- *Specifying Value;* "By always starting with our customers needs and using these to create physical and electronic products and services, we do not just deliver shipments, but also security and additional value" (Pan Nordic Logistics, 2007)

- *Identifying the value stream;* PNL is mapping their processes and activities along the logistic chain to identify constrains such as security issues and time wastes.
- *Making value flow*; Minimizing delays, defects and downtime. Seeking simplicity and visibility in the logistic process. Those things are among PNL´s core values.
- *Pull scheduling;* This is referred to in the literature at the "big JIT" (Just In Time) which is also the "fifth" dimension of *Lean thinking* - seeking for perfection. It also implies making information visible throughout the value chain, for customers as well as within the company. PNL is constantly striving to reach perfection, and are constantly looking to improve their business processes, among other things by looking at an RFID implementation.

By mapping processes through the logistics chain, it is possible to sort value adding processes from those that does not add value (Harrison & Hoek, 2005). When mapping those processes the *lean thinking* concept focuses on *the seven wastes,* these are as follows: (Harrison & Hoek, 2005)*;*

- The waste of overproduction
- The waste of waiting
- The waste of transporting
- The waste of inappropriate processing
- The waste of unnecessary inventory
- The waste of unnecessary motions
- The waste of defects

The above mentioned wastes are relevant to PNL in that they provide an understanding of current limitations within the existing system. As later concluded, (see chapter five) RFID hold potential to reduce or remove some of these wastes. This will serve to improve and enhance the performance of PNL logistics processes.

2.1.3 Goods Flow

In order to understand the potential of RFID technology and how it could enhance the logistics process of PNL, it is important to look at the current process and its key components. The logistics process could be understood as a constant flow of packages and parcels in which a number of scans are being performed.

The purpose of these scans is to input logistics data into the PNL computerized system, in order to keep track of goods. At present, these scans are performed manually, or in a few cases automatically, using bar-code technology. The empirical relevance of these scans is briefly summarized below in order to provide the reader with an overall understanding of the process. The logistics chain and scans constitute the core in this study and it is here that the advantages of RFID technology could be fully deployed.

Within the PNL logistics process, two major types of business units can be identified:

- DIP – The DIP has two main functions in the logistics chain, to input goods in the system, or to deliver it to the end-customer. Goods are either received

from, or transferred to the main HUB for further distribution. Most DIP stations are run by subcontractors to PNL. Currently there are 29 DIP station in Sweden.

- HUB – A freight terminal where goods from the different DIP stations are collected, sorted, and redistributed according to its final destination. There are three main HUBs in Sweden located in Stockholm, Malmö and Jönköping. The Jönköping based HUB is currently the largest and the base of our study. However, the three HUBs work in much the same way.

Throughout the logistics flow ten forms of scans have been identified. The letter combinations describe where in the system the scan is taking place. The logistics flow is illustrated and explained first as an overview and then into more detail with a flowchart in the analysis section of the thesis.

Figure 1 The Pan Nordic Logistics goods flow

- A – The first scan at goods level. Goods arrive at the DIP and are scanned manually by a clerk. Each individual package is scanned and entered into the PNL logistics data system
- AY – A fictive scan at pellet level. The pellet as a whole is scanned and entered into the system. Individual packages in such are not scanned.
- CX – A fictive scan at pellet level in order to confirm that the pellet has arrived at HUB-level. By fictively scanning the entire pellet, PNL assumes that all packages and parcels included have arrived at the HUB and are intact.
- D – Primary scan. All goods are scanned and entered/updated in the system. This scan constituted the base for invoicing.
- DY – Fictive scan at pellet level. The goods are assumed to leave the HUB.
- IX – Fictive scan at pellet level. The goods are assumed to arrive at the exit-DIP.
- G – Scan verifies that goods have arrived to a DIP. All goods are scanned.
- GY – The truck leaves the DIP to end customer (! Is this really a scan?)
- H/I – Final scan in the process. Depending o whether goods have been delivered or not an H or I scan is performed. H=Has tried to deliver goods (will be an A-scan), I=Delivered (Final delivery)
- DZ– Regret-scan. Used in special cases.

Goods flow

During a 24-hrs period, some 10,000 packages are delivered through the PNL system. The company has far reaching plans and expectations that this number will dramatically increase within the next three years.

HUB

The so-called 'D-scan' is of major importance in that it constitutes the base for invoicing. Goods are measured, weighted, and sorted for further distribution. In order to further analyze and evaluate the feasibility for RFID in this and other parts of the logistic chain, the process of the HUB in Jönköping will be described in more detail:

- Goods arrive at the terminal in Jönköping (arriving from DIP) on loading pallets or in steel construction cages. The goods are transported on a number of trucks, and brought in to the facility through a number of gates.
- Goods are loaded onto three different tracks where the goods barcodes are manually scanned with a barcode reader. The goods have to be turned in the right direction in order to be able to scan the barcode. Sometimes the barcode is difficult to read and therefore a second barcode is being printed and placed on the goods for further scanning in the process. This is part of a recent effort from PNL in order to reduce reading errors, to standardize, and to gain better accuracy.
- When barcodes (numbers) are scanned, the information is sent to a database where it is matched with existing information on the customer. This appears on a screen in PNLs system Cargoscan. This information is the base for invoicing. It contains information such as customer name, postal address, customer number and so on.
- If the information is complete and looks correct, the information is approved and an invoice is ready to being sent through EDI (Electronic Data Interchange). If there is anything that is unclear the goods is sorted as "reject" and will be dealt with next day. About 10% of the goods are rejected and needs to be completed later.
- After the goods has been approved and labeled with a new barcode, it is put on the goods line with the barcode pointing either upwards or to the left (for the next machine to be able to scan the goods again and add weight and size to the invoice.
- The MPS machine that scans the goods a second time is unattended. If this machine encounter any problems with the barcode scan, the goods is sorted as "not machine sortable". This goods has to be taken care of manually.
- On the other side of the line goods is taken of the goods line and sorted according to destination.
- Goods is sorted on trucks according to destination (DY-fictive scan)

A flowchart if this process is presented in chapter five, as well as how the process could be improved using RFID.

2.2 Radio Frequency Identification

The RFID concept first emerged as a military technology during the 2nd world war, as a way of identifying friendly aircrafts using radar echo. The technology has developed and gone through substantial refinement. However, it is first in rather recent years that is has been made commercially feasible. RFID as such is of a very broad nature and can be applied to a multitude of contexts, making it a potential technology and an area of possible growth.

Recent development has made the so-called RFID tags cheaper, thus enhancing its overall financial feasibility. The technology can be used in order to improve business processes, cost-effectiveness, and to remove waste and loss revenue. In terms of logistics, the technology could be used to more accurately track parcels and packages, thus rationalizing the logistics process. However, in order to understand the feasibility of implementing RFID in the PNL logistics process, it is key to understand the technology, its technical strengths and weaknesses. These constitute a major core issue in this thesis and will be presented further below, as well as in chapter five.

The RFID technology is constituted by two main parts, the so-called interrogator unit and the tag (transponder) forming a rather complex process. The interrogator unit transmits an electromagnetic pulse that is absorbed by an internal antenna in the tag. The pulse generates enough energy to activate an internal chip in the tag containing a factory-encoded

number. The pulse is transmitted back, containing the serial number that is then received by the interrogator unit. In much, the RFID technology resembles the already existing bar-code technology. However, RFID enables scanning tags that are not in the line of sight and thus enables a more effective logistics process.

Three forms of RFID are in use today. So-called passive, semi-passive/active, and active tags are available providing different areas of utilization and unique benefits further discussed below. The passive tag does not have an internal power source embedded and can thus be smaller in size. However, the lack of an internal power source does not enable the tag to amplify the signal; as a result, the passive technology provides less scanning range. Active RFID tags contain a small battery and a microprocessor enabling amplification of the signal and the ability to scan over longer distances. Furthermore, active tags can be combined with different forms of sensors and other input devices, opening for new ways to utilize the technology.

The price has traditionally been a limiting factor in the implementation of RFID, both in terms of active and passive technology. However, technological development, refined production methods, and increased competitiveness have made both tags and other equipment more affordable. The market price for passive tags today is around SEK 0, 6-2.

3 Frame of reference

This chapter describes the frame of reference relevant to this report and how it will be applied in later sections of the thesis to the case of PNL.

3.1 Classifying RFID benefits

In order to sort the different dimensions and the impact RFID may have on organizations, the benefits are divided in the below categories to monitor possible effects and benefits on different levels of the organization and its customers. Parts of this framework is influenced by Shari Shang and Peter B. Seddons ideas on how to develop a framework for "Assessing and Managing the Benefits of Enterprise Systems: The business Manager's Perspective" (Seddon, Shanks & Willcocks, 2003). This is by no means covering all beneficial aspects or implications that RFID may have on PNL, but will serve as a base for further discussion and analysis in later sections of the thesis. The similarities of impact from ERP systems (Enterprise Resource Planning Systems) and RFID are in many areas the same and the proposed framework dimensions are quite broad and general, hence serving the purpose of a benefit evaluation framework for PNL.

The target audience for this thesis is top management at strategic level, managers and "process owners" (Hammer & Champy, 1993) at the managerial level. An RFID implementation in PNL will also affect operations and customers. Process owners refer to middle managers that are responsible for management control and tactical planning issues. In combination with an awareness of, and alignment with, overall business strategy they serve as a link between business strategy and business operations.

Another important aspect before suggesting a framework is the time frame employed. PNL is looking at RFID from both a long term and a short term perspective. Customers and competitors actions also play a significant role when evaluating value creation from RFID. Of that reason, a broad frame for benefit evaluation is used and may serve both the long-term and the shorterm perspective.

It also has to be addressed where and in what context an RFID implementation is considered. While this study is focusing on a possible implementation at, in first hand, the HUB in Jönköping, there are several other areas where RFID may be beneficial. It is reasonable to assume that once implemented, an awareness of its possible benefits and areas of use will be developed internally and may lead to further use of the technology. Of that reason the framework is developed to create a holistic view on possible benefits with RFID alongside with a more in-depth analysis of process improvement through implementation at the HUB in Jönköping.

Using both a broad perspective on RFID impacts and creating a business case with a RFID implementation in Jönköping serves several purposes. RFID is, as previously mentioned, affecting more than merely operations. It is a strategic choice and a tool to carry out tactics. Further the perspectives points out the many interconnected variables that make a benefit evaluation complex. A RFID implementation must address many of those variables simultaneously to be able to fully appreciate the value creation that is possible. The narrow perspective shows that even an initial implementation at the shop floor in Jönköping, needs to take into account aspects like strategy and vision, company goals, structure, information systems development, skills and managerial commitment. *Therefore, a return on investment calculation at the HUB in Jönköping can be misleading if it is taken out of its context.*

The purpose of the framework is therefore; strategic, managerial, operational, customer, and financial.

3.1.1 Strategic

By integrating actors in the supply chain, as well as by providing transparency and increased tracking capabilities, RFID supports business from a strategic perspective. As further described in chapter 3.1 and from a general understanding of RFID (as previously presented), it appears that the technology is versatile in that it can be combined and integrated with a variety of other solutions, providing overall benefits from a strategic perspective.

The following seven strategic improvements have been interpreted from the framework provided by Seddon and others (2005).

- Support business growth
- Support business alliance
- Build business innovations
- Build cost leadership
- Generate product differentiation and customization
- Build external links with customers and suppliers
- Built common visions

These possible and general benefits will be further discussed in the analysis section relation to findings at PNL and how an RFID implementation is likely to influence a strategic perspective at this firm.

3.1.2 Managerial

When looking at RFID from a managerial perspective, it appears that the technology has a number of benefits to offer. RFID offers increased coverage in terms of goods flows and can provide management with a better base of decision by registering goods at individual levels. The managerial approach has been briefly illustrated in section 3.1. For example, by implementing RFID, hospital staff was able to gain a better understanding of resources in general by keeping track of assets.

The following managerial improvements have been interpreted as important aspects from the framework provided by Seddon and others (2005).

- Better resource management
- Improved decision making and planning
- Performance improvement

These possible and general benefits will be further discussed under chapter five in relation to findings at PNL and how an RFID implementation is likely to influence the managerial perspective at this firm.

3.1.3 Operational

At the operational level, IT has for a long time been contributing to cut costs and help in the automation of processes. Research proves that IT investments help to speed up processes as well as automate transactions. (Seddon, Shank & Willcocks, 2005). At an operational level, the following benefits could be expected:

- Cost reduction.
- Cycle time reduction
- Productivity improvement
- Quality improvement
- Customer services improvement

These possible and general benefits will be further discussed under chapter five in relation to findings at PNL and how an RFID implementation is likely to influence the operational perspective.

3.1.4 Customer

RFID should be viewed as a tool to integrate supply chain. The general benefits of the technology can not only be applied and beneficial for the 'core business' in such, but also has positive effects for other actors on both sides of the supply chain. In much, the customer benefits share many of the characteristics that could be expected to benefit the 'core business'. The fact that the technology also is strongly beneficial from a customer perspective could serve to enhance the overall relationship between actors in the supple chain, and thus create a better foundation for business. The customer specific advantages have been identified:

- Further integrated supply chain perspective
- Process transparency
- Improved service
- Customer specific solutions
- Strengthen alliances
- Enhanced security perspective

These possible and general benefits will be further discussed under chapter five in relation to findings at PNL and how an RFID implementation is likely to influence a customer perspective at this firm.

3.1.5 Financial

The purpose of the financial dimension and assessment in this study is to provide a general understanding of whether RFID could be feasible for PNL or not. The reader will be guided through factors related to a possible implementation and provided with a framework for further assessment of RFID. This financial section is important in that it provides

a relevant context in regards to why RFID should further be evaluated on financial grounds.

Considerations regarding gains and costs

In order to determine how RFID will affect the PNL organization on a financial level, it is key to first determine where in the supply chain RFID is to be implemented. As for now, detailed plans have not been made neither by Combiport (as a possible supplier), nor by PNL on where and how RFID should be implemented. Therefore, supply chain as well as organization has been mapped out in order to determine where RFID is most suitable. Chapter five deals with the current supply chain of PNL. The current process at the HUB in Jönköping is illustrated in a flowchart. A second flowchart illustrates the proposed process using RFID. Many of the impacts (in the form of costs and benefits in general) could be applied to the organization as a whole. As previously described, this study aims primarily at assessing an implementation at HUB level in Jönköping.

Most of the benefits/effects, in general terms and applied to PNL, are likely to have some form of financial impact, either in terms of increased revenue or reduced costs. Two types of benefits/effects have been identified and should be considered when assessing the financial feasibility of a RFID implementation.

- *Directly visible, of operational character*. Benefits that can be translated into numbers and monetary gain with relative ease and are directly visible. These are primarily of operational character and are determined by looking at how a possible implementation could be carried out at PNL, what changes are made, and how these changes will enhance or influence financial performance. Chapter five presents a recommended RFID solution at HUB level in Jönköping. By looking at the specific operational improvements gained, it is possible to determine a financial gain.

- *Hard-to-measure*. Benefits that are hard-to-measure or of non-financial character. It is reasonable to assume that these benefits/effects will have some form of financial impact on the organization. However, in order to extract a monetary value, one must view these from a time perspective involving multiple points of measurement in order to assess performance over time. *Only by considering a performance perspective over time is it possible to assign a reliable financial value*. A framework is provided on how to further analyze and assess 'hard-to measure/non-financial' benefits.

3.2 Managing risk

The authors realize that this study will portray RFID in a predominantly positive way. This is inevident due to the nature of the technology and how it has performed in the past. RFID offers a number of promising advantages, both in terms of potential for cost savings and added value. Furthermore, RFID has come to serve others industries and has proved to be financially feasible for many. However, an investment of this magnitude should be thouroughly investigated from many perspectives before considering investing. The following section provides a brief risk perspective on IT-investments in general. Furthermore, a number of perceived risks are identified in appendix two. The empirical/analysis section (see chapter five) presents a number of perceived risks applied to PNL.

Though the risk perspective is important, it is not possible to fully cover and forecast all risks. A brief risk perspective is included in this thesis in order to provide the end user with an understanding that risks are important to consider and manage, especially when invest-

ing in complex and new IT-technology. In this thesis, risks are presented in order to provide an initial understanding.

3.2.1 IT Productivity paradox

It has been suggested by Willcocks & Lester (1999) that despite massive investments in IT-technology, there appears to be little pay of. This phenomenon is often referred to as *The IT productivity paradox, or simply the productivity paradox*. The RFID implementation highlighted in this thesis is of an IT character and is thus relevant in relation to the productivity paradox.

IT-investments could, according to Willcocks et al. (1999) either serve as an organizational transformer or as a sink hole where invested money is lost. The rate of IT-investments is increasing rapidly and often accounts for large parts of organizations budgets. Information technology in general has become somewhat of a rule rather then an exception and is no longer an exclusive feature reserved for a few actors. However, although IT-technology is being increasingly integrated into organizations and operations in general, it is according to the productivity paradox, not resulting in the investment-to-productivity ratio one might expect. In a study by Strassman, correlation between computer investments and enhanced productivity as well as financial benefits was found to be zero. Though the validity of this study could be questioned due to *limitations in the ability to measure* and confirm effects of IT-investments, the productivity paradox should be taken seriously. (Willcocks et. al, 1999)

According to Willcocks and others, it is crucial to continuously evaluate the performance of IT-investments, both in financial and non-financial tems. (Willcocks et. al, 1999) The analytical tools provided in this thesis, provides a good framework for understanding the impact of RFID, both in the immediate timeframe and over a longer period.

3.2.2 IT Project failures

The 'chaos report' by the Standish group (1994), researched IT-project failures in the United States during the early 90s. The report takes a strictly financial stance and does not consider factors such as organizational learning and experience gained from failed projects. Nevertheless, any manager considering investing in IT should consider these findings.

According to the Standish group, an alarmingly high part of IT-investments in general fail due to various reasons.[1] These investments tend to be capital intensive, making failure a costly option for most companies. According to the report, 31,1% of American based IT-project will be canceled before ever getting completed. Approximately 52,7% will exceed allocated budgets with at least 189%. It is estimated that only 16,2% of the projects will be completed on-time and on-budget. For large companies and organizations a mere 9% manage to stay within allocated time- and budget frames. (The Standish Group, 1994)

The report also finds that smaller companies tend to be more successful in achieving set specifications of the investments and to implement these in general. Of the completed projects in larger firms, only 42% deliver the originally proposed features and specifications. For smaller organizations, this rate is 78,4%. (The Standish Group, 1994)

[1] For further information, see "The Chaos report" by the Standish Group, 2004.

Failing IT-investments are costly. In the US alone, over $81 billion was spent on canceled projects in 1995. Around, $59 billion for projects exceeding the original budget. (The Standish Group, 1994) It could be argued that the RFID investment is still in a reasonable early phase. Any firm considering making this type of investments should consult results and experience of previous actors in order to minimize the risk and in order to gain a better understanding of critical success factors.

3.3 Literature review and case studies

The potential in terms of benefits and performance enhancements appear to be promising for companies in a wide array of industries. Many who have already embraced and integrated RFID into current business processes have discovered and gained a number of advantages including a competitive edge towards other actors.

It is relevant to understand how RFID have influenced and affected others. In fact it can be considered crucial for most business managers to understand the impact of RFID on supply chains as a whole. The case studies described hereafter serve to provide a brief understanding of how RFID have been used by other firms and what benefits the technology has provided.

3.3.1 United States Defense logistics

The US. Government Accountability Office (GAO) together with the Department of Defense (DOD) is investigating how RFID can be implemented in supply chains throughout the various defense-branches. Currently, active tags are being used to track large and bulky assets overseas. However, the plan is to invest over $500 million in a full implementation of passive technology throughout the supply chains.

The DOD estimates that RFID technologies can reduce system loss, waste, and theft. By allowing for hands-off identification of assets, the DOD can develop a more transparent inventory management system and increase visibility. Passive RFID technology is described by the DOD as 'promising', both for logistics operations in the military, as well as commercially. (US. GAO, 2005)

3.3.2 RFID receiving systems at Paramount farms

Paramount farms, one of the largest suppliers of pistachios worldwide, implemented RFID on the receiver end of the supply chain in order to increase goods visibility. Trailers from suppliers were tagged and the Paramount facility was equipped with readers. The system allowed for automatic data entry, ensured accuracy and a more effective logistics process. Before implementing RFID, employees handled data entry, and goods check manually; a time consuming process, sometimes resulting in errors.

Paramount noted that RFID speeded up the goods receiving process significantly. Loading times were shortened with up to 60%, and trailer usage was reduced with about 30%, enabling the company to meet increased production goals without investing in new assets or increasing workforce. (Barua, Deeoa & Andrew, 2006)

3.3.3 Lahey clinic managing healthcare assets using RFID

Lahey clinic Medical centre, a medium sized medical facility in Boston has some 1,500 pieces of movable medical equipment. The hospital implemented an RFID based tracking system in order to keep track of its assets. Equipment was tagged with passive reflectors and readers were installed at key points throughout the facility.

The hospital noted significant improvements in tracking equipment throughout the facility. Staff utilized time more effectively, in that less time had to spend finding equipment. Also, the increased effectiveness reduced problems with overstocking and allowed for increased asset utilization and use of investment. Finally, equipment maintenance routines were optimized in that the asset tracking system of the hospital was linked with the database of its providers, allowing for responsive maintenance. (Barua *et. al.*, 2006)

3.4 Measuring performance

When companies in general measure performance, financial performance measurements like profitability, result, costs and sales are dominating, and are, according to several studies the most significant ones (Ax, Johansson & Kullven, 2002). However the last few years an increased interest in non-financial measurements has been noted. The arguments for a non-financial perspective are mostly focused on the shortcomings with the pure financial perspective. Some of the shortcomings with financial measurements are, according to Ax et. Al. (2002):

- Tend to focus on past occurrences.
- The use of financial measurements often leads to short-term solutions.
- Are often too rough to give signals about cause of the problems, deviations from plans or information on areas of improvements.
- Does not include aspects on how companies interact with their stakeholders, for example with customers and suppliers.
- Gives too little input on what is creating future value, for example profitability or a lean supply chain.
- Gives little input on how a company's strategic vision can be achieved.
- Are hard for employees to understand in relation to own work.

The purpose of performance measurement takes its ground in the fulfillment of a company's goals. The overall goal is divided in intermediate goals. To reach those intermediate goals, performance has to be measured and attended. Quality, customer satisfaction, market share or process excellence is examples of non-financial measurements used to obtain intermediate goals. *Hence, the purpose of performance measurement is strategy implementation*, or in short; Strategy → Operations planning → Performance measurement. (Ax et al. 2002).

Depending on strategy, companies measure different things. If quality and customer satisfaction are expressed as focal areas, processes are run-through and customers are surveyed. If cost of production is too high, then cost will be monitored. *Because companies have unique strategies, different areas for performance measurements will have to be set up individually.*

3.4.1 Using Balanced Scorecard to measure and monitor performance

A good way of monitoring and measuring performance is the balanced scorecard (Kapland & Norton, 1992). We have used balance score card for the following reasons:

- Balance score card takes both the financial and non-financial dimensions of performance into consideration.
- Balance score card allows companies in general and PNL in particular to customize what to measure.
- Also, in this report, Balanced Scorecard is used as an illustrative tool in order to present possible areas of future measurement.

In this report, Balanced Scorecard serves a multitude of purposes. The following structure of the scorecard will be maintained. The arrows from Vision and strategy show that the different perspectives are used to carry out strategy. The double ended arrows show that the subordinate goals together contribute to fulfill vision and strategy.

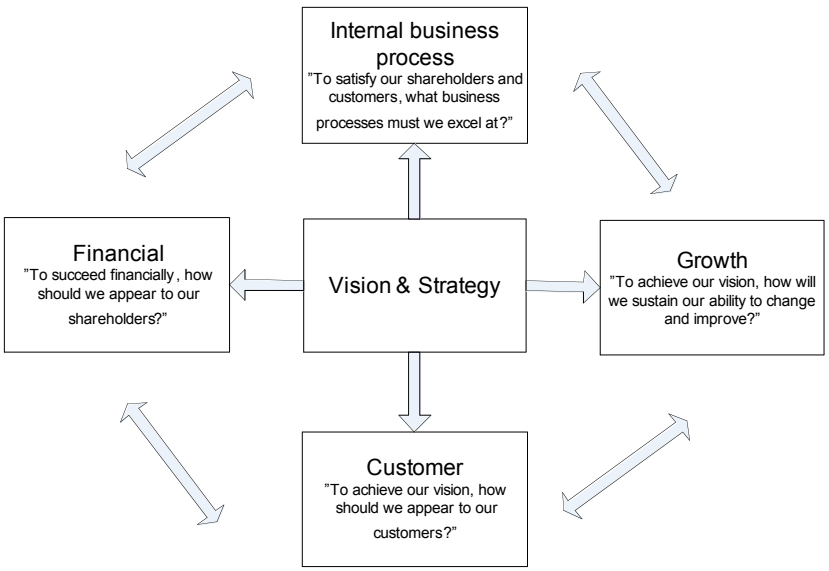

Figure 2 Using the Balanced Scorecard

The Balanced Scorecard exemplifies how different performance dimensions of a firm ca be illustrated. The construction of the scorecard allows for both financial and non-financial considerations to be made and it is for this reasons suitable in this case. As previously mentioned, an RFID implementation in the case of PNL is likely to bring both financial and non-financial benefits. The Balanced Scorecard allows these to be 'combined' and provides an integrated view on the firm.

Note that the scorecard can be used for different purposes; the scorecard presented above is an example on how it can be used as a strategic management system (freely rendered from Collier, 2005). The figure illustrates chosen areas for monitoring and measurements. The two-way arrows illustrate how the different areas are complementing each other to fulfill the overall vision and strategy. Each area consist of a number of decided measurements that are carefully monitored and followed up to see deviation from plans, time lags etc. A problem with balanced scorecard is that *it has to be implemented in order to measure performance.*

In other words, *it is not possible to make accurate performance calculations without the actual measurement results*. In a traditional return on investment (ROI) calculation, *known gains and costs are used mainly from operational outcomes*. Since benefits from RFID can be found from a number of non-financial (or hard to measure) benefits, these has to be accounted for to give a fair view of real value creation. In Balanced Scorecard, ideally, strategies, measures and targets are decided, RFID is implemented and outcomes are measured. If done in this order the value creation from RFID can be stipulated to a higher degree. Since this is not possible within the timeframe for this report, Balanced Scorecard will be dealt with to show what measures that is important and how PNL can deal with a number of benefits from suggested framework and then place them in the context of Balanced Scorecard to succeed with value measurements.

Some of the benefits with balanced scorecard include:

- Supports long term values and goals (Collier, 2005)
- Is a way to carry out strategy through monitoring of performance.(Ax *et. al.*, 2002)
- Gives information about how the short-term perspectives fit into long-term planning and fulfillment of goals (Ax *et. al.*, 2002)
- Is a mean to motivate employees and managers(Ax *et. al.*, 2002)
- Gives early signals about deviations from plans (Ax *et. al.*, 2002)
- A foundation to benchmarking of performance between departments and/or competitors (Ax et al, 2002)
- Gives information about effects of for example a cost reduction program (Ax et al, 2002)

4 Methodological considerations

This chapter introduces the methodological framework used in this study as well as in this thesis. The following methodological topics have been considered:

- *Delimitations*. This thesis is subject to a number of delimitations. These are identified and motivated.
- *General methodological considerations*. A number of general methodological issues are identified and discussed.
- *Empirical data*. An empirical framework for data identification and empirical issues is presented and discussed.
- *Interpretation and analysis*. This thesis relies on a number of interpretations and analyses. A final section concludes the methodological discussion of this thesis by identifying and motivating how analyses have been performed.

Overall, this thesis serve a practical purpose, namely to investigate the feasibility and suitability of RFID for PNL. This hands-on approach is reflected in the frame of reference considered as well as in methodological considerations. The overall purpose is to add value to PNL in terms of providing an understanding of RFID.

4.1 Limitations and delimitations

Due to empirical limits, timeframe, and the fact that RFID has not in any form been implemented or applied to PNL, it is not possible to investigate the full impact of RFID. This study will serve only to provide a first insight in how the technology could affect PNL. The following delimitations have been made:

- *Width and depth*. The PNL organization has a rather extensive Nordic logistics network. Though this network is rather standardized, a number of variations in terms of different subunits and solutions exist. It is simply not possible to evaluate the organization as a whole. Instead, the so-called HUB (centralized goods sorting unit, explained in chapter two) in Jönköping is selected to represent the organization as a whole. This choice is logical in that the HUB in many ways is comparable to the organization as a whole. Findings in terms of effects related to the HUB, financial impact, as well as proposed changes in the logistics process could with some modifications be applied to the organization as a whole.
- *Financial*. As later concluded, the benefits and effects of RFID are directly linked with the financial value of an implementation and could be characterized in two different ways: as directly visible benefits with a direct monetary value, and as benefits with a 'hidden' monetary value that is hard to measure. In order to understand the full impact of RFID, *both forms of benefits need to be measured and considered*. This thesis is limited in that it does not perform an actual calculation. Benefits and effects are identified and incorporate into a suggested framework for how to measure these benefits in the future. *Thus, this thesis identifies whether RFID is financially feasible or not, however, in order to fully understand the financial impact it is necessary to measure performance before and after an implementation throughout the organization.*

- *Competitors*. This thesis does not take into consideration a competitors stance on RFID. This perspective could be relevant when taking an overall decision on whether to implement RFID or not.

4.2 General methodological considerations

The following model illustrates the empirical process in this thesis:

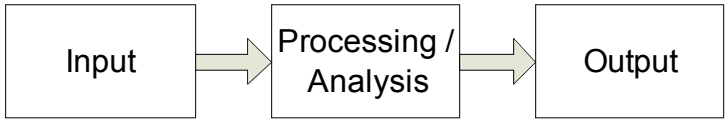

Figure 3 Input, processing/analysis, output

Input in the form of relevant empirical findings and data is collected and presented. Findings are processed and analyzed in line with the overall purpose and objectives of this study. Finally, findings and conclusions are presented.

- *Input*. The data gathering process is critical in that it constitutes and provides all empirical findings used in the process. It is crucial to employ a successful strategy for finding, collecting and interpreting relevant data. Inaccurate data could otherwise corrupt the entire process.

- *Processing / analysis*. Processing and analysis of gathered data form a major part in this study. It is crucial to employ a successful strategy when interpreting data in order come up with reasonable conclusions.

- *Output*. Interpretation and analysis is presented.

The above presented functions are relevant in order to understand both how this study has been performed as well as how the thesis is outlined. Data is identified, analyzed, and presented. The three stages involve interpretation and analysis in some form. A special emphasis has on explaining and motivating selections and interpretations made throughout this thesis.

4.2.1 Empirical findings and analysis

The following section presents how empirical information has been gathered throughout the process of this study. Primarily, two sources of data have been used:

- Official information such as documents, internet-sources, intranet-sources, and PNL documents have been utilized in develop a relevant understanding of both PNL and RFID.

- A large number of contacts, meetings, and interviews have been performed throughout the process of this study. These contacts have been a frequent and regular part throughout this process.

As previously concluded, this thesis is of a predominantly practical nature. It is the purpose to add value to PNL rather then to provide an extensive and possible irrelevant methodological and theoretical framework. Transparency and discussion is used as an overall tool to ensure accuracy. End users of this thesis, such as PNL representatives, are provided with a framework for further interpretation and evaluation.

By combining a number of empirical sources, a cumulative understanding of RFID and PNL has been achieved. Frequent communication with representatives throughout the process of this study ensures quality and information accuracy. A special emphasis on transparency has been maintained in that necessary interpretations and findings are motivated and discussed. Also, empirical findings are presented with relevant background and in its overall context in order to allow the reader to take a personal stance and to understand underlying logic in interpretations and analysis.

Throughout this study, a number of representatives from PNL have been contacted. Their accumulated input adds to an overall cumulative view on RFID in relation to PNL. Contact has been maintained throughout this study and their contribution should therefore be seen as a continuous empirical resource rather then a one-time source of data. Thus, it is not feasible to refer in detail to specific meetings or sessions.

The following individuals have been interviewed and are contributors towards a cumulative understanding of RFID in regards to PNL:

- PNL, HUB Jönköping – Head of Security PNL,
- PNL Stockholm – Vice President
- PNL Stockholm – Chief Financial Officer
- PNL, HUB Jönköping – HUB/Floor manager
- PNL, HUB Jönköping – Chief Information Officer

4.3 Interpretation and analysis

A number of interpretations have been performed throughout this study. The following concerns should be taken into consideration:

- Analyses and interpretations in this thesis should be viewed in line with the intentions of this study. The overall goal is to provide a general insight on how RFID could enhance the current logistics process of PNL. The objective is to provide general insight on the technology rather than to estimate details.
- RFID is in an early phase and has not yet been implemented into the PNL organization. Thus, it is not possible, nor feasible, to perform a detailed study of financial value. Instead, added value is provided in guiding the company in further evaluation and implementation of the technology.
- By motivating interpretations and analysis, the authors intend for the reader to form her or his own view on the matter. Transparency is maintained throughout the thesis in that decisions, interpretations, and analyses are motivated.
- Effects and advantages with the RFID technology might not be perfectly clear. Interpretations in this thesis serve to highlight the main features of the technology only and to provide an initial base of decision for PNL.

The fact that RFID has not yet been implemented into the PNL organization and is still under development by Combiport makes it hard to fully calculate and exactly determine a number of factors in this study. For example, it is neither possible, nor feasible to fully determine the full financial impact of the technology. Doing so could possible mislead PNL

in its future evaluations. Therefore, this study takes on a more broad and general perspective. Also, a strong emphasis on motivating interpretations and analysis has been maintained in order to allow for the reader to take a personal stance.

5 Results and analysis

The following chapter combines empirical findings and results from performed interviews and other relevant sources of information. An accumulated understanding is presented and applied to PNL in specific.

5.1 Evaluating benefits and risks

Following the previously outlined framework for RFID benefits and risks, findings at PNL are here presented accordingly. In appendix 1 and 2 is an evaluation of the benefits and risks that are evident for PNL. In this chapter the most prominent benefits and risks are emphasized and discussed. The purpose of this discussion is to establish a foundation of values that are worth measuring and monitoring to be able to fully comprehend the value creation from an RFID implementation.

The grading of benefits and risks are given values according to impact and probability. A scale from 1 to 5 is used where 1 represents the lowest value (of impact and probability) and 5 the highest. Impact and probability are then multiplicated to have a rating of importance for each specific benefit or risk to be monitored. As evident in the appendices, many of the benefits are overlapping and occur in more than one dimension. Those benefits are put in parenthesizes. Multiple occurrences show that impact is evident on more than one level in the organization (strategic level, managerial lever and operational level) and/or have a customer or financial impact as well.

The subjective grading is based on findings at PNL as well as contemporary research on general IT investments and RFID specific advantages or drawbacks. The most important for PNL is the attached framework (appendix 1 and 2) that can be used to outline what values that is most important for PNL. *Those values should be aligned with business goals and visions and finally measured to assess added value.*

A practical use of Balanced Scorecard (see below) may use any dimensions for monitoring but are merely used as a tool in this report to highlight important impact that should be measured in one way or another. The dimensions that are used here are what are considered the most common and basic areas for performance measurements in balanced scorecard.

The key learning from assessing value on a future RFID implementation is that it is hard, if not impossible, without an established vision on what values are most important to the company at hand. The values that are decided will then *have to be monitored and measured both before and after the implementation to be able to fully calculate the real value derived from RFID.*

The dimensions used for this specific purpose reflect the dimensions that have been used throughout the report, (i.e. strategic, operational, managerial, customer and financial dimension) but are translated to fit in the context of Balanced Scorecard. It is possible to use the previous outlined dimensions as well, but using some of the more common measurement areas (for Balanced Scorecard) strengthens the feasibility to use Balanced Scorecard for organizational performance measures. *As discussed earlier, measuring financial business factors alone does not give management a good view on how the organization is doing.* PNL may use the concept as a whole or chose other areas for monitoring, according to RFID adoption level.

It is important to point out that the impact from an RFID implementation in PNL are dependent on the level of adoption, expected outcome and what is considered worth measur-

ing in terms of performance. While generally presenting possible areas of implementation and areas for performance measurements, it also has to be considered crucial to reflect on time perspective as well as general RFID development, competitors development and what kind of performance measurements that are decided upon and in what context (i.e. for example security area, process improvements, service and customer perspective etc) an implementation is considered. *Therefore suggested framework should be viewed upon as a broad outline that can be used by PNL when level of adoption as well as important values for PNL is established.*

5.1.1 Strategic

RFID from a strategic perspective comprise some benefits that are hard to prove and measure. One main assumption here is that RFID will manage to scan larger batches of goods seamlessly integrated with existing systems, allowing for timely and reliable information. With such an integration it is also assumed that the operational outcomes from an RFID implementation would be at least status quo including cost of implementation. RFID technology is not the universally prevailing solution to obtain all of the below stated benefits at the strategic level, yet important to consider and account for when evaluating value creation from RFID.

- RFID supports business growth by – 1) Increasing transaction volume (through automation in scanning and in combination with an automated conveyer belt). 2) Allowing for the creation of new business products or services in present as well as new markets. 3) Help to cope with industry changes and increased competition.
- RFID supports the customer perspective through – JIT information and transparency of workflow.
- RFID can strengthen the PNL brand. Working with up to date technology will also increase the possibility to work with customers that rely on the same technology.
- RFID helps in integrating the supply chain by utilizing the technology throughout the whole supply chain.
- Through adoption of RFID technique, PNL is prepared (first mover advantage?) for new and innovative customer solutions.
- RFID contributes to encourage the creation of new business innovations.
- RFID fits with implemented "lean thinking" strategy in the strive for low waste and optimization of processes.
- RFID can help in the building of cost leadership through economies of scale.
- RFID can provide customized customer solutions.
- RFID can bring PNL closer to the customers through e-solutions with direct feedback and interactive services (Not RFID unique, but a facilitator).
- Increased IS/IT capability
- Supports continuous improvements in processes (lean).
- Proactive in problem solving (through real scans).
- Adopts a customer and market focus.

- Supports organizational change in processes through flexibility.
- Organizational culture benefits - creates a consistent vision at different levels in PNL

From a strategic perspective, an RFID implementation can be looked upon from the following model inspired by a study from ERP systems benefits (Shanks *et al.*, 2005).

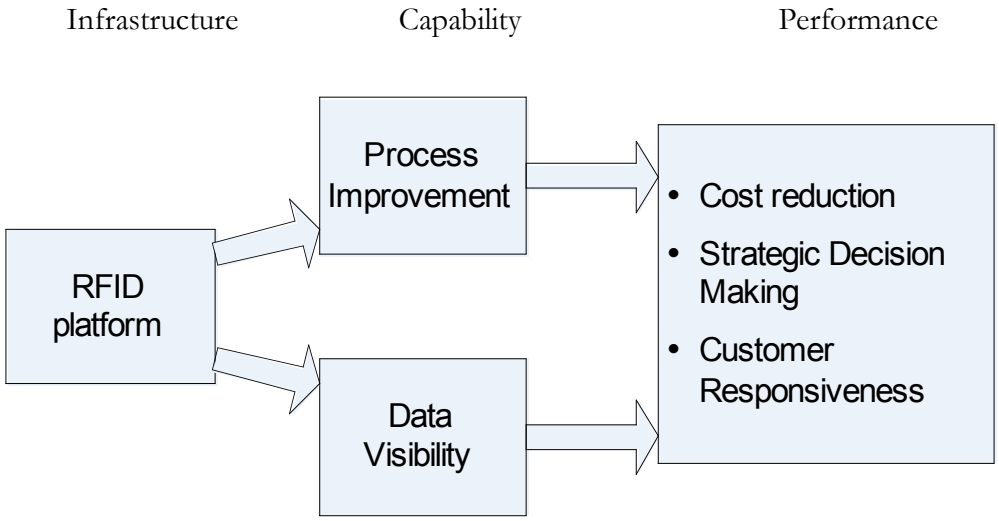

Figure 4 RFID from a strategic perspective

5.1.2 Managerial

- Information from a real scan (in contrast to a fictive scan) can facilitate better resource management. RFID can make a scan seamless at arrival and at departure
- RFID can help in optimizing the supply chain and work flow scheduling.
- RFID scanning can be the foundation for better decision making and performance improvements in different operating tasks (customer service, security issues, invoicing etc). An additional finding is the opportunity to utilize the RFID tag for the handling of invoices of bulk goods that pass through the HUB in Jönköping. The real scan will provide a document to compare to the waybill (Can be handled via EDI).
- Employees concentrate on core work
- Higher employee efficiency.

5.1.3 Operational

Possible benefits:

- Cost reduction by automating basic repetitive operations – The unloading of goods at the HUB in Jönköping could benefit from RFID implementation reducing the necessity for printing barcode labels.

- Cost reduction by speeding up processes – The overall operation to unload-sort-reload goods should benefit time wise from an RFID implementation.
- Cost reduction by substituting labor – 1) A successful RFID implementation would reduce the need of one person at every conveyer belt station where goods is being unloaded and loaded on to the conveyer belt. 2) Sorting the goods according to destination takes manpower. Labor could be reduced if this task is automated (Possible with RFID but not RFID unique).
- Allow for increased operation volumes – Streamlining the process with the help of RFID would allow for a higher flow of goods.
- Improved quality of operation – 1) RFID can help to raise quality of operation running in parallel with present solution. Accuracy will be better and the number of "Not Machine Sortable" goods will decrease. 2) Implementing RFID at steel case level before goods is loaded (and scanned) on trucks will help to prevent sending goods to the wrong destination. 3) "Real scans" at arrival and before departure allow for better quality from customer service department. The transparency of the logistics chain is increased internal as well as external. 4) The security is increased as the goods is scanned, hence preventing theft as well as increasing information accuracy and speeding up processes.
- Waste reduction (time, processes, resources) – General waste reduction by saving time, streamlining processes and use resources efficiently.

5.1.4 Customer

The following section identifies how customers of PNL could benefit from implementing RFID in the supply chain. As previously described, PNL has ambitions to become the leading logistics company in the Nordic region. (PNL, 2004) A customer perspective focusing on quality is key in developing and maintaining this position. RFID could contribute positively towards the overall business as well as to enhance the customer portfolio.

Many of the abovementioned benefits (strategic, managerial, and operational) could influence the customer dimension positively. Benefits and effects are likely to vary depending on whether RFID is implemented on the customer side of the supply chain. In this case, it has been assumed that customers are not using RFID.

- RFID is likely to increase logistics quality. By allowing PNL to minimize goods delay, improve accuracy, and increase goods flow, customers will benefit in terms of increased overall shipping quality.
- RFID is likely to increase quality in terms of customer service and problem solving capacity. By increasing the overall goods flow transparency of PNL by strengthening track and trace capacity (replacing fictive scans with real scans), the problem solving capacity of PNL is likely to increase and thus allow for better overall quality of the PNL products and services.
- RFID allows for the design of customer specific solutions. The technology feed existing systems with more accurate data allowing actors in the supply chain to better grasp the flow and to thus customize it.

- RFID utilizes real scans instead of fictive scans and will thus increase the track and trace capacity of the customer. Using the existing web-interface (MyPNL), customers will be able to track parcels using existing routings, but will gain increased tracking accuracy.
- RFID is likely to become a competitive advantage from a customer perspective. The technology in such benefits all actors throughout the supply chain. Customers of PNL will be able to use RFID shipment as an argument to their customers and towards the end-users of the supply chain.
- RFID provides increased track and trace capacity, as well as better accuracy. Such a factor is likely to decrease theft and other forms of waste by providing accountability in the logistics chain as a whole. System loss is likely to decrease on a proactive base. Furthermore, if loss occurs, PNL and its customers can identify the source of problem (to a higher extent). Many of the existing customers of PNL are shipping high value goods, further emphasizing the importance of the security dimension.
- Implementing RFID in the PNL supply chain creates incentive and common ground to further strengthen business alliances. RFID creates 'compatibility' and allows actors to integrate systems in order to fully harvest the benefits of the technology.

5.2 Balanced Scorecard used on business opportunities

Thus far, this study has focused on empirical gatherings from interviews, identifying general value creation related to RFID as well as specific values related to PNL at different levels of the organization. Benefits have been graded according to impact and probability of occurance. The overall strategy of PNL has been outlined as well as Lean philosophy that is relevant to the organization. This part of our framework serve to connect the different dimensions and to suggest how value can be assessed for opportunities identified at PNL. This assessment is made using Balanced Scorecard as a framework for presenting findings. The following flowchart illustrates how different parts relate and are relevant in assessing value of RFID for PNL.

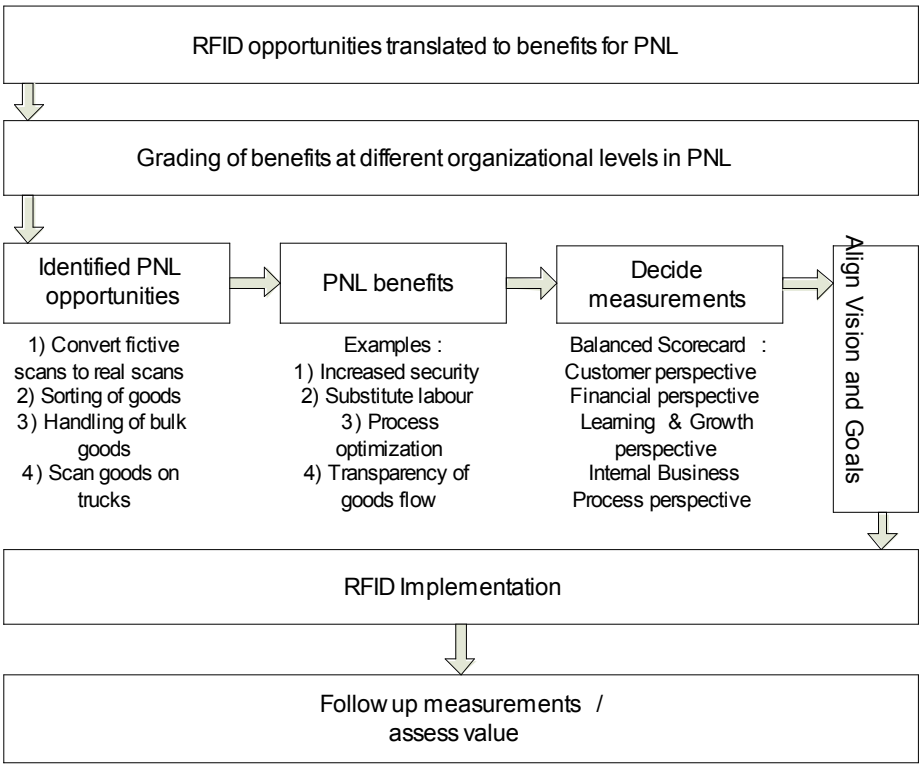

Figure 5 Assessing the value of RFID for PNL

As seen from the illustration above, the previously used dimensions (strategic, managerial, operational, customer and finance) are now replaced by the dimensions used in balanced scorecard. The previously used dimensions served the purpose to look at benefits across organizational levels. The Balanced Scorecard measures performance aligned with strategy which is crucial for a successful value assessment.

5.3 Business opportunity 1 – The HUB in Jönköping

The following business case exemplifies how RFID technology could benefit PNL. Two flowcharts illustrate the current goods flow and how the process could be revised and enhanced using RFID. A discussion is held on the potential impact of the technology. Finally, a balanced scorecard is applied and used to align the RFID concept with the existing strategy and vision of PNL. The following illustration of the processes serve to provide understanding of the current goods flow as well as to answer the following research question: "Where in the PNL logistics process is RFID suitable to implement?"

Figure 6 Current goods flow process of the HUB in Jönköping

The flowchart illustrates the current goods flow process at the HUB in Jönköping. According to PNL representatives, this process is in much identical to that of other HUB facilities of PNL. Therefore, this business case is not only relevant to the HUB in Jönköping, but also to other facilities, both in Sweden and abroad.

The flowchart illustrated above follows standard EPC structure[2]. Three major scans are performed throughout the process. As previously concluded (see chapter 2.1.2), only the 'D-scan' is 'real' in that every parcel is scanned. The CX- and DY-scans (arrival and departure) are fictive in that only the steel cages are scanned, not the actual goods loaded in the cages. This represents a major drawback that limits the awareness of where in the system the individual parcel is.

The core of the HUB process is the so-called MPS machine that weights as well as measures goods. This data is integrated into cargoscan and form the base of invoicing. Goods are loaded onto the conveyer belt and scanned in the MPS machine. However, in order for

[2] EPC (Event-driven process chain). Red squares = goods flow events. Green squares = functions connected to the event. Yellow 'Kaizen-burst' symbol = RFID implementations in the goods flow. XOR = point in the goods flow there direction of goods is decided.

the machine to be able to register the passing parcels (using automatic bar-code scan), a second bar-code label is attached manually. This process is time consuming and labor intensive.

The so-called 'DY-scan' registers goods before departure from the HUB. However, this scan is fictive and does not cover parcels at individual levels. Before leaving the HUB, goods are manually loaded onto steel cages and later scanned at cage level. Currently, it is possible for goods to be loaded onto the wrong cage and thus sent to the wrong destination. Furthermore, as mentioned, the fictive 'DY-scan' does not provide full coverage of the parcels.

The following flowchart follows the same structure previously used to present the current process at the HUB in Jönköping. The below illustrated flowchart introduce RFID into the goods flow and outline effects and improvements of the implementation. The RFID implementation is outlined in yellow.

Figure 7 Proposed goods flow process after RFID implementation

By implementing RFID, the fictive scans are replaced with 'real' RFID scans and coverage at individual parcel level. The scan is somewhat of a corefeuture of RFID. Using real scans, goods flow effectiveness could be enhanced.

When arriving at the HUB facility in Jönköping, goods are instantly scanned when arriving at the HUB facility. This scan occurs automatically and does not require manpower. The RFID scan provides full goods coverage at individual parcel level to be compared with the fictive scans, only 'assuming' that the goods inside the steel cage have arrived. Thus, when implemented into the PNL computer systems, RFID allows for complete coverage and

traceability of goods. Instead of scanning the steel cages, all parcels are scanned and accounted for.

As previously outlined, in order to use the MPS machine, a second bar-code label has to be attached to the parcels. This process is not only time consuming, but also labor intensive. By utilizing RFID technology, parcels can be loaded directly onto the conveyer belt and can be feed directly through the MPS machine. Also, RFID would decrease scanning problems related to the bar-code label. An RFID implementation, will however not improve the process in terms of some non-machine-sortable parcels. If address information in the computer system is not accurate, it will still require manual correction.

An RFID implementation would be beneficial when goods leave the HUB facility in Jönköping. The current process relies on fictive scans. An RFDI implementation would allow for exact knowledge of whether goods have left the terminal or not. As previously mentioned, goods could be prevented from being sent to the wrong destination by integrating the 'DY-scan' with a computerized warning system. This system would trigger a response if goods were to exit the facility in the 'wrong cage'.

As of today, the automatic RFID scan can not fully replace the barcode scan. However, it is possible to run RFID in parallel with present bar-code systems and 'switch' over time. Benefits noted from an implementation at the HUB in Jönköping are:

- Security is increased through more accurate information from real scans.
- Increased track and trace capacity for the customer service department (or for customers through internet)
- Fully implemented RFID will contribute to substituting labor
- Supports the used "lean thinking" concept by minimizing waste (in processing, time and resources)
- Allows for a higher flow of goods.
- Reduces (and over time replaces) the necessity of printing barcodes.
- Allows for higher employee efficiency.

5.4 Applying balanced scorecard on business opportunity 1

The above mentioned benefits are directly linked to the proposed implementation at the HUB in Jönköping and can be fairly easy to identify (and measure). Following the reasoning with a broader perspective, it is also likely that a number of non-measurable (or hard to measure) benefits are derived from an RFID implementation. Examples of these can be seen in appendix 1, which is a framework for grading impact and probability of occurrence of benefits. Depending on the level of RFID implementation the grading of benefits will also be different. Therefore the framework should be regarded as a tool to find out what needs to be monitored in order to confirm value creation. Below follows the different dimensions of a Balance Scorecard that are chosen to evaluate the business opportunity with RFID at the HUB in Jönköping and what has been identified as important measures and objectives for PNL. The scorecard is here used solely as a tool to monitor what needs to be measured related to an RFID implementation.

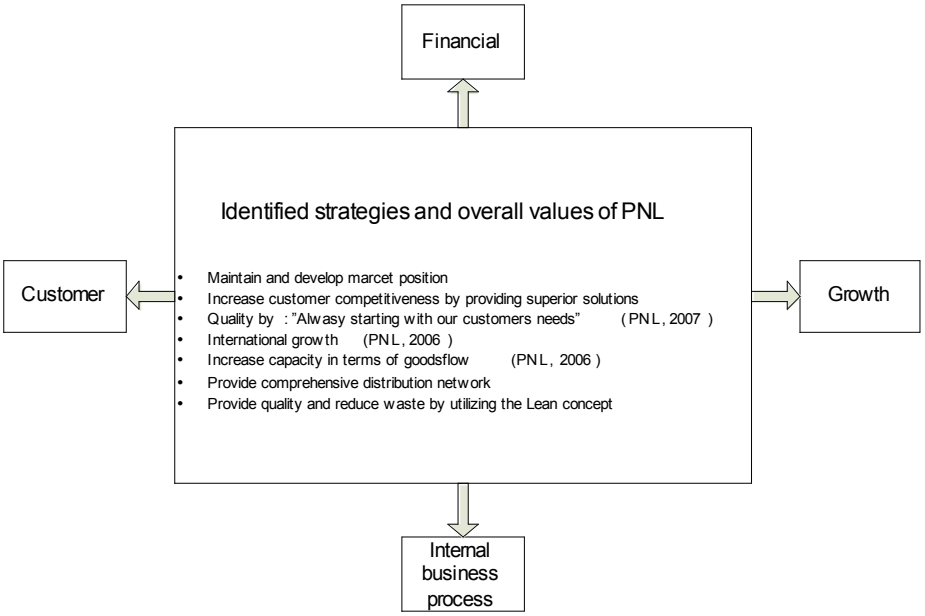

Figure 8 Identified strategies of PNL in relation Balanced Scorecard

The abovementioned figure serve to illustrate how the strategies and visions of PNL determines what to measure and monitor within the different dimensions in order to reach strategic goals. RFID is thereby a facilitator to carry out and strengthen these goals. The suggested areas of measurement as presented below are related to how RFID can contribute to carry out visions and strategies of PNL:

CUSTOMER – "To achieve our vision, how should we appear to our customers?"			
Objectives	Measures	Targets	Initiatives
Increase security.	Use customer service department statistics. Number of security classed goods.	Decrease lost goods and complains. Attract customers with security classed goods	Use RFID for real scans.
Increase track and trace accuracy.	Measure accuracy before and after RFID implementation.	Allow for 100% traceability throughout the logistics process.	Integrate RFID scanning information into logistic system.

With customers in focus, the adoption of front-edge technology is a proactive behavior from PNL that can result in new innovations and areas of use that are not even considered at this time. When implemented it is a sales argument as it supports the lean thinking strategy with minimal waste. Minimized waste is equal to lower costs and a possibility to compete on price.

As RFID adoption in general is increasing, it may contribute to integrate the whole supply chain and information will be transparent throughout the logistics process.

INTERNAL BUSINESS PROCESS – "To satisfy our shareholders and customers, what business processes must we excel at?"			
Objectives	Measures	Targets	Initiatives
Minimize waste.	Measure throughput time, resource utilization and process time.	Process excellence.	Use lean thinking concept – minimize waste in processes, time and recourses.
Increase employee efficiency.	Required number of employees at the conveyer belt.	Minimize cost by substituting labor.	Implement RFID according to attached proposition (see flowchart)

From an internal improvement perspective, RFID contributes to decrease goods throughput time by allowing for a seamless scanning of goods. This in turn will (over time) substitute labor and improve accuracy of information.

A risk that is obvious from an internal perspective will be the parcels that are not registered at the scan. If those parcels are not provided with a barcode as well, they will be hard to identify and will take a considerable time to register.

GROWTH – "To achieve our vision, how will we sustain our ability to change and improve?"			
Objectives	Measures	Targets	Initiatives
Increase goods capacity.	Measure increase of goods flow capacity.	Allow for increased goods flow to desired level.	Utilize RFID to enhance and automate scanning capacity.

A bottleneck from a growth perspective is the capacity for goods throughput. Adapting and developing RFID technology at an early stage is a proactive behavior that enhances the ability to adapt to competitors actions. RFID is also very suitable from an organizational learning perspective. To develop a tacit knowledge concerning the use and ability of RFID stress the importance of being prepared for organizational change, hence supporting the growth perspective. Furthermore, by implementing RFID, PNL can gain a first mover advantage towards its competitors.

FINANCIAL – "To succeed financially, how should we appear to our shareholders?"			
Objectives	Measures	Targets	Initiatives
To monitor financial impact from RFID implementation	Return on investment (ROI), Sensitivity analysis on RFID tags (SA)	To achieve or exceed neutral balance from investment (only considering operational costs and benefits	To implement and monitor effects of suggested RFID solution
Minimize labor cost at conveyer belt.	Goods flow efficiency.	Increase profit	Implement RFID and measure outcome

From a financial perspective, RFID will contribute to value creation at many levels in the organization as well as for customers. The above reasoning to achieve, at minimum, a neutral balance from the implementation at operational level, follows the initial calculation made by Combiport AB, that the gains and costs will balance (as a minimum). From a broader perspective RFID will then contribute to value creation seen in other areas monitored above.

Perceived risks:

The following risks have been identified and are presented as empirical findings. By including a risk dimension, the authors aim to stress the importance of further risk evaluation and considerations rather then to provide a detailed understanding. A number of risks have been identified and estimated in appendix two. However, it is not possible to forecast and account for all risks that might possible occur in relation to an RFID implementation.

- *Tag price*. The price of RFID tags appears to be constantly decreasing. However at this time, the price for a single RFID tag is estimated to somewhere between SEK 0, 6 - 2. The range is dependent on what hardware that is used and where cost is taken for this investment. The RFID tag unit price consists of: RFID tag cost, shipping label cost, printer/printing costs and the cost for attaching the label. The tag price is relevant in that it could determine the financial feasibility of an implementation.

- *Technological failure*. RFID is still under development, it is possible that the technology to some extent might not function as indented.

- *Budget overrun*. As concluded, the RFID technology is still in an early phase. Though the hardware itself has been developed (to some extent), the software integration between hardware and existing business systems of PNL has not been completed. It is possible (and perhaps likely) that the hardware costs in this case only accounts for a small part of the overall price for the solution. Since the software solution has yet to be designed and implemented, the risk over not being able fully understand the total costs and to exceed a set budget appears to be great. RFID is a complex holistic solution rather then only a hardware solution. It is therefore important to bay for the solution as a whole, rather then only for pieces of hardware.

- *Compatibility*. In order to fully take advantage of the benefits associated with RFID, it is important that adoption of the technology is performed both upstream and downstream in the supply chain. By not implementing a uniform solution, compatibility issues might arise that could affect the financial feasibility and operational quality of RFID. The technology is still in an early phase and no uniform standard in terms of hardware-to-software integration exists.

5.5 Other business opportunities

This chapter will discuss additional opportunities with RFID identified in the PNL organization. They will here be mentioned briefly for further evaluation. A deeper analysis is not performed, but can be evaluated using the same framework for assessing value as in the case with what is called "business opportunity 1".

5.5.1 Bulk goods

Bulk goods that arrive to the hub in Jönköping are not split up to smaller packages. The waybill connected to the pallets is the base for invoicing. This is done by the customer! It is not optimal that this process is in the hand of the customers. A real scan of bulk goods that has arrived to the terminal in Jönköping would enhance the invoicing process and increase security by proving what the bulk actually contained.

5.5.2 Steel Cages

Before goods are transported from the terminal it is sorted into steel cages before it is loaded on trucks. To provide the steel cage with an active RFID tag and match the information from that tag, with the tags on the parcels, would enhance the security that goods is sorted correctly according to destination. In addition, a RFID tag on the steel cages would identify them as belonging to PNL.

5.5.3 RFID as facilitator for an automated conveyer belt

Today, the conveyer belt at the HUB in Jönköping is not using an automated sorting function. The information from an RFID tag could be used to sort goods according to destination. It has to be noted that this is in no way RFID unique, but can be argued to be a good way of using the technique in more than one way, once implemented.

5.5.4 RFID at a customer DIP

RFID could enhance security and speed up the logistics process at large DIP´s situated at the customers. From one of the interviews, we learned that one of PNL´s larger customers has an automated conveyer belt that sorts goods to a small area (the DIP) where PNL takes care of the goods for further transport. An RFID scan would provide the possibility to better use the area at hand as it helps to speed up the process. Invoicing could further be connected to this process via EDI (Electronic Data Interchange).

5.5.5 RFID on the trucks

To provide the trucks with a hand held RFID scanner could be beneficial for many applications. One of the most evident ways a scan would serve a purpose is for the occasions that

goods is returned to sender or has a damage. Today, this routine is not transparent for either customers or PNL. It is possible to send the information from the scan via GPRS to the database system at PNL. This would be a step in optimizing the visibility of goods through the whole logistics chain. It has to be noted that this is not RFID unique, but could be made by a barcode scan as well.

6 Conclusions and recommendations

The overall purpose of this study has been to determine whether or not RFID is feasible in the case of PNL. The following research questions have been posed:

- Where in the PNL logistics process is RFID suitable to implement?
- What benefits are associated with an implementation of RFID?
- How can these benefits be financially evaluated?

Pan Nordic Logistics in general and its logistics process in particular have been studied and mapped out. Benefits and effects of RFID have been applied to the company in order to understand how the technology 'fits' with the company in terms or strategies, processes, and visions.

By taking a holistic approach and combining empirical understandings of PNL as well as the technology in general, a number of opportunities have been identified. These opportunities illustrate the multifaceted nature of RFID and how the technology could be used in a number of ways to enhance supply chains and thus add value to the company.

The so-called HUB in Jönköping has been selected for further assessment. The goods flow process has been mapped out in detail. Based on this understanding, an assessment has been made on where in the logistics process that RFID could be implemented in order to provide optimal impact.

The proposed implementation of RFID would take place at three levels within the HUB; at goods arrival, at D-scan, and at goods departure. This solution would provide benefits on at least five different dimensions within PNL; strategic, operational, managerial, customer, and financial. In order to understand the direct financial impact of the technology, it is crucial to further measure and evaluate what impact RFID might have on performance.

This thesis presents Balanced Scorecard as a tool to identify relevant areas that are affected by RFID as well as how to successfully measure these. Only by measuring the impact of the technology is it possible to compute its direct financial value.

A number of risk factors have been presented. It is possible, if not likely, that the technology to some extent will pose problems or fail. Therefore an implementation should be carried out in a small scale in order to first test the technology, both in terms of hardware, software, and overall alignment towards PNL. The framework presented in this thesis serves to aid PNL in this process.

Financially, RFID will most likely provide a rate of return that will cover or exceed costs of the implementation at the HUB. Most of the benefits presented in this thesis are likely to bring some form of financial value. Further measurement is required in order to fully understand the financial feasibility of the technology. However, benefits of RFID can be financially estimated and understood with relative ease, given that a performance impact perspective is applied. The framework presented in this thesis serves to add value to PNL by providing such a tool. It could be argued that RFID is financially feasible with further potential that is yet to be determined.

The following recommendations have been made:

If implementing RFID it is wise to start the implementation on a smaller scale. As previously concluded, RFID is a rather complex solution that has not yet been tested in the PNL organization. If implementing the technology, it would be a suitable approach to start the technological integration as well as trials in a smaller scale. Applying a narrow scope appears to be logical for the following reasons:

Financial. By starting out in small scale, PNL could measure the impact of RFID according to the suggested framework of measurement provided. By implementing a series of points of measurement, PNL could determine whether the technology is really feasible or not. In order to successfully evaluate the financial feasibility, it is necessary to measure the impact in terms of process improvements and other core benefits after the implementation.

Technological. It is necessary to determine that the technology is meeting set specifications. RFID is still in an early phase and is currently being implemented in a number of industries and contexts worldwide. However, the solution provided by Combiport is still in a prototype phase. Furthermore, a large amount of work is yet to be done in terms of integrating RFID with the current business software used by PNL

Minimize complexity. In an initial phase, it is necessary to minimize different forms of complexity related to implementing the technology. It appears to be logical to go small and in stages, rather then fully implementing the technology directly. This point appears to hold relevance both from a managerial, strategic, and operational perspective. Furthermore, in order to fully take advantage of the positive effects associated with RFID, it is necessary to implement the technology throughout the supply chain. One possible solution might be to implement customer trials in order to try the technology out and evaluate how successful it might be in integrating the supply chain as a whole.

Top management support. Management is key in implementing RFID. Support from all levels in the organization is required, especially from top management. RFID is a strategic and complex technology in an early phase. The technology is likely to fail to some extent. Continuous commitment is required in order to successfully implement the technology.

Standardized solution. A uniform RFID standard has not yet been devised on an overall industry level. In order to open for future integration of the supply chain, it is important to standardize the RFID solution.

Continuous processes. It is not feasible, nor possible, to perform a direct switch to RFID technology. In the case of an implementation, the currently used bar-code solution must exist side-by-side with RFID until the technology has been fully implemented throughout the supply chain.

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