Pre-requisites for a successful supply chain integration –
A case study of how RFID usage in the transport process can contribute

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Master Thesis

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ABSTRACT

This Master thesis has been made for Volvo Group Trucks Operations, Logistics Services (VGLS) in Gothenburg. Other companies within the Volvo Group and Volvo Car Corporation (VCC) have been involved during the process, including Volvo Trucks Umeå (VTU), Volvo Trucks Tuve (VTT) and Volvo Cars Body Components (VCBC) in Olofström.

The thesis has examined activities within the supply chain process between three factories, VCBC – VTU – VTT. The different companies at each location serve different purposes in the supply chain, ultimately leading to a finished truck. To get a complete truck it takes different types of resources and thus an effective and well-functioning infrastructure to cope with the transportation of resources in an efficient way. VGLS is the provider of logistics services between the factories, meaning VGLS is in charge of the transportation process between the locations and take care of related transportation issues.

A few years ago a project was started with the participation of VGLS with the aim to identify different types of objects better, via Radio Frequency Identification (RFID), aiming to create a more efficient supply chain. VGLS now wants to further exploit this technology as future implementation of RFID is soon ahead of them. According to the possibilities and opportunities related to RFID this thesis has critically examined activities in the supply chain process and its underlying problems, trying to create the right conditions for VGLS in order for them to better cope and utilize a near future RFID implementation.

The main result of this study indicates that the problems of the transportation flow don’t derive from the physical transportation of material, but rather in the information flow between the actors. The results indicate that more emphasis should be placed on creating new ways to achieve more efficient information sharing, which in some cases can be facilitated through the use of RFID.

Keywords: RFID, supply chain, transportation flow, information flow, information sharing, IT-system, information integration
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1 INTRODUCTION

This chapter provides a brief introduction to the thesis and explains the purpose and areas of examination. Further information will be given about the involved actors and Volvo’s previous RFID initiative.

1.1 Background

Supply Chain Management (SCM) is an area that is crucial for most businesses as SCM refers to the synchronization of a company’s process to match the flow of materials, services and information on demand (Krajewski & Ritzman, 2002). The attention on the area has intensely increased the advancement and development of new technology within the area. One such technology is RFID, a technology enabling the process of identifying objects automatically, without human interference.

Pålsson (2009) describes RFID as a technology that enables wireless identification on many unique identities simultaneously. Reading of the identities takes place by means of radio waves which enables the identities recorded not needing to be in line of sight.

RFID has in the past few years become of great interest for Volvo Group Trucks Operations, Logistics Services (VGLS). VGLS, Volvo Cars Cooperation (VCC), Trafikverket (TRV) and Green Cargo (GC) have together created an infrastructure that through RFID automatically will gather data related to the movement of rail wagons and thus enable process quality improvements for all actors.

In 2010 a project involving VGLS, VCC, Starbright Consulting, TRV and GC was started. The reason for the start of the project was the initiative from TRV to establish a Swedish and Europe standard for RFID identification of rail wagons. The main focus of the project was the transportation flow between VCBC and VCC in Torslanda, Gothenburg. The aim was to create an improved transparency and insight in the rail service. Another purpose was to produce an infrastructure and information base through the setup of RFID readers along the railway, tagging of wagons and a traceability application. A pilot test was included in the project and the technology proved itself to be highly reliable and functional. The collected data from the different readings via RFID was of high quality. The deviations that appeared during the pilot test were mainly connected to administrative routines between the actors in the supply chain.
With the successful pilot test VGLS decided to continue their efforts towards a fully developed RFID infrastructure and further investigate the various benefits and opportunities generated via RFID. Various transportation flows where future RFID implementations will appear are to be investigated in order to maximize the use and functions that RFID allows. The investigated transportation flow studied in thesis is rather small compared to other flows, making it a great starting point to investigate. Since RFID is a relatively new area with respect to transports, it has automatically followed with lack of documentation regarding its impact on the logistics methods, in this case rail transport. Today there’s also lack of data and documentation concerning the physical transportation flow and information flow, where the physical transportation flow only refers to the transportation of material between the factories.

The thesis treats activities in the supply chain process between VCBC – VTU – VTT, more specifically the activities in the transportation flow by rail between the factories. The supply chain process will most likely experience an RFID implementation in a soon future, meaning that new type of information will be readable, and a number of activities within the supply chain will be automated.

This thesis will try identifying the factors and parameters that create the right conditions for a potential RFID implementation and a more efficient supply chain, i.e., how does the transportation flow look like in reality, what are the current problems in the transportation flow and what could potential solutions to the existing problems be?

1.2 Problem discussion

To be able to analyze the transport processes and the effects that an RFID implementation may contribute with, a study of how the transportation process looks like in its real-life context must be conducted. Both the physical transport and information exchange between the actors should be examined. Through a mapping of the transport process, problems and efficiency areas within the process will be identified and analyzed. The problems and improvement areas identified will be further studied and solved through the use of RFID. Problems identified with no direct connection to RFID will be addressed as well, as long as the solutions to each problem in some way are allied with the RFID.

In order to map the transport process between the factories, the authors will conduct a case study, creating the empirical framework. The case study will be done through visits at the different factories where observations and extensive interviews will be carried out. The
interviews will initially be open in order to obtain an understanding of the transportation process. Once the authors have received a holistic view of the transportation process, the interviews will proceed by becoming more closed, asking specific questions about the area explored. The theoretical framework created will be compared with the empirical findings and create the foundation for the analysis. The analysis will address the problems and efficiency areas encountered; also presenting solutions for each encountered problem.

The authors believe that identified problems will both be shown in the physical transport and in the information exchange, where RFID can contribute to a solution in both cases. Since RFID is based on the distribution of information it’s necessary with a well-functioning information exchange between the actors. Emphasis may be needed on the information exchange if the information exchange between the actors in the supply chain doesn’t flow in an optimal way.

1.3 Purpose

The purpose of the thesis is to convey a study to VGLS examining the transportation flow between VCBC – VTU - VTT. The aim of the purpose is to identify areas of improvement in the supply chain and to what extent RFID can be used as a solution in order for VGLS to offer their customers better logistics services.

1.4 How to achieve the purpose

- Identify problems.
- Analyze problems.
- Provide potential solutions.
- Effects of the solutions.

1.5 Delimitation

- The report contains no calculations.
- Proposed solutions haven’t been tested in real life.
- Underlying technology of RFID is considered reliable.
- Only focus on rail transportation.
1.6 Company Description:

1.6.1 Volvo Group Trucks Operations, Logistics Services

Volvo Group Trucks Operations, Logistics Services (VGLS) is part of the Volvo Group and provides the Volvo Group with logistics solutions. VGLS provides specially developed services through the entire supply chain for the global automotive industry. The goal is to improve their customers’ business through efficient and sustainable logistics solutions, and in this way reduce costs, disruption and impact on the environment.

VGLS has 5000 employees on more than 60 locations world-wide. The company is divided into three main areas: Inbound, Outbound and Emballage, covering all the logistics skills needed. Their job is to design, handle and optimize the supply chain for all Volvo Group brands and for selected customers within the automotive industry. The scope for VGLS includes making sure that material is transported to the production facilities, that packaging is available, that vehicles are distributed to the dealers, and that management of material, warehouses and distribution ensures the availability of parts everywhere in the world.

1.6.2 Green Cargo

Green Cargo (GC) is national and international logistics company engaged in providing logistics solutions to meet their customers’ needs. GC is the main transportation service provider for VGLS as they provide VGLS with rail transportation services between the studied factories.

1.6.3 VCBC

Volvo Cars Body Components (VCBC) operates in Olofström, they are the main manufacturer of body parts for VCC. At VCBC the majority of the body panels and sheet metal parts that are visible on a Volvo car are stamped. VCBC doesn’t only manufacture plates to Volvo cars, VCBC also supply VTU with stamped plates for the manufacturing of cabs.

1.6.4 VTU

Volvo Trucks Umeå (VTU) operates in Umeå and manufactures cabs to Volvo Trucks. The body parts sent from VCBC to VTU is later used for the manufacturing of the cabs.
1.6.5  VTT
Volvo Trucks Tuve (VTT) is Volvo’s assembly plant in Tuve, close to Gothenburg. This is the factory which builds complete trucks as the cabs arriving from VTU are assembled with the body of the truck.

1.6.6  TÅ
Shunting yard close to VTT where arrived cabs by train are loaded on trucks to be transported to VTT.

1.6.7  UmeAssistance
UmeAssistance provides transport services between the VTU factory and shunting yard close to the factory. UmeAssistance takes care of the loading, transporting and unloading of the cabs.

1.6.8  Frakttjänst i Umeå AB
Frakttjänst i Umeå AB (Frakttjänst) provides transport services between the shunting yard and the VTU factory. Goods arriving at VTU from VCBC at the shunting yard are sent by trucks to the actual factory.
2 METHOD

This chapter describes and motivates the methods used to accomplish the purpose of this thesis. A description of practical uses of diverse methodologies such as data collection, process mapping, interviews and observations will be provided. A discussion of validity and reliability of this thesis with reference to interpretation of composed data and sources of errors are also exposed in this chapter. Finally a graphic paragraph is included to illustrate the structure of the sequence of work in this thesis.

2.1 Qualitative study

Researchers use qualitative or quantitative research methods, the aim of the investigation, what is being investigated and what is to be discovered are some of the questions determining the method used (Holme & Solvang, 1997). Merriam (1994) maintains that the design of the method used depends on the difference between an experimental or none-experimental method.

The problem’s association with entirety is tried to be clarified in a qualitative method and therefore a large amount of information is obtained from a small number of survey units. The collection of information is carried out under unstructured forms, such as interviews without prepared questions and answers, in order to get an “I-You” relationship between the researcher and the research objects (Holme & Solvang, 1997). A qualitative study is flexible in nature and since there are none strict guidelines and standards for qualitative research and contributes to the fact that each researcher approaches the analytical process in a different manner (Dale & Volpe, 2008).

The thesis is based on a none-experimental research. Due to lack of time and other resources the improvement suggestions were never tested in real life, and therefore this thesis can be considered none-experimental and more of a an exploratory study. An exploratory study needs an intensive approach which provides a greater opportunity to obtain relevant data. An intensive approach is also more exposed to unforeseen response (Jacobsen, 2002). Since the thesis is exploratory, a qualitative method is used and that’s the reason why a case study has been performed as they are most often associated with exploratory purposes. The approach of using a case study can be effective and leading for explanatory purposes as case studies have the property and ability to answer questions like “how” and “why” (Yin, 1994).
2.2 Case study

A case study examines a current phenomenon in its real context, when the border between the phenomenon and context are unclear (Ying, 2003). Theory and measurement is unclear in many cases trying to be explored and investigated through a case study. Case studies are particularly advantageous when trying to describe a process or the effects of an event that affects many different actors because it allows for a detailed description of a phenomenon and thus a deeper understanding. A case study focuses on the process rather than outcome, to discover rather than prove, and on the context rather than specific variables (Merriam, 1994).

As the supply chain process between the three locations is unclear and poorly documented, i.e. limited theory and measurement, it justified the use of a case study. In order to reach the goal of the thesis and approach the purpose in a strategic and sound way, the supply chain activities are to be identified. To acquire a deeper understanding of “how” and “why” the transportation flow works in reality was the primary goal of the case study.

The opportunity was given to visit VCBC, VTU and TÅ to investigate the transportation flow and transportation process in its real-life context. The case study was conducted through interviews and observations to get a further insight of the process. The collected data from the case study would later create the foundation of the empirical study.

2.3 Data collection

Gathering data can be categorized into two different approaches, primary and secondary data. Primary data is specifically collected by the author by eye witnessing the data. Secondary data are books, scientific articles, white papers and web search, i.e., existing and available data prior to this thesis with different objectives (Patel & Davidson, 2003).

To ensure the best possible way of executing the thesis, both primary and secondary data have been used. The primary data collected through interviews and observations created the empirical study of the thesis and determined the focus while the collection of secondary data through scientific articles and books created the theoretical framework of the thesis. Patel and Davidson (2003) point out the importance of not just including data which certify the researchers own views of the topic of investigation, nevertheless data which supports opposite views are important to investigate. With this in mind it’s important to collect data from multiple sources and put in relationship. This can ease the process of denying and/or
confirming the different data collected in the meantime. Secondary data is often more easy to get hands on and is cheaper compared to the primary data. A problem often encountered by secondary data is the amount of data being collected. This can make the process more difficult as the data should be sorted and provide the most relevant information possible (Wiedersheim-Paul & Eriksson, 1997).

It’s reasonable to start by collecting and studying secondary data, as it’s both easier and cheaper to find and use this type of data (Wiedersheim-Paul & Eriksson, 1997). Initially secondary data was collected through websites, scientific articles and books. The secondary data would give the authors an understanding of the scope in general and understand the most basic things the thesis will focus on. Since things have been poorly documented in the area of investigation the thesis quickly turned to collecting primary data. The secondary data enables and facilitates further investigation by directing the authors towards the sources of primary data. Most of the primary data collected was conducted through interviews and observations at the visited locations. The authors have met and talked with various stakeholders across the Volvo Group but also with stakeholders outside the Volvo Group such as GC and TRV and VCBC. The primary data was intended to provide information about RFID, the supply chain with regard to the transportation flow and also give an insight of the earlier performed pilot project.

The step following the collection of primary data was a mixture of both secondary and primary data. The secondary data provided the necessary tools in order to carry out the analysis by motivating and justifying the changes recommended by the authors.

2.4 Process mapping

A useful tool to get an overview of processes is process mapping. Mapping of processes can also contribute with a thorough picture of the more detailed activities within the processes. According to Krajewski and Ritzman (2004), processes might be the least understood and managed aspect of a business. Understanding and managing the business in detail and solve problems on a more detailed level compared to “quick-fix solutions” contribute with long term success. These “quick-fix solutions” never seem to live up to the expectations that in a prepare stage often are high (Loinder, 1996).

The three different questions to be answered in this thesis, mentioned by the end of the background, motivated the authors to take use of process mapping through flowcharts and
other type of illustrations. The flow charts and illustrations will both deal with the physical transportation process but also the information flow connected to the transportation flow. The various flowcharts and illustrations will be presented in different chapters, especially in the empirical and analysis sections.

Illustrations and flowcharts were of great help when the analysis of the empirical data was made. Different types of illustrations have been used and the authors haven’t followed a specific model since the characters of the different flows have varied too much, since both the physical transportation and information flow have been analyzed. Both needed different sort of attention and therefore the authors have chosen to present the flows in different ways. The sources used to create the process mappings’ were the interviews and observations conducted with the different actors.

That aim with the presentation of flowcharts has been to facilitate the reading and get a better understanding of the supply chain. Since the study contains a lot of theoretical information, mainly from the empirical and analysis chapter, the authors believe that illustrations in form of flowcharts will facilitate the reading and thereby create a better understanding of the thesis.

2.5 Interviews

In qualitative research, interviews are usually the primary method of data acquisition and perceptual information is the most needed (Dale & Volpe, 2008). Creswell (1994) states that a major advantage by collecting data at the individual level through interviews is the ability to offer and capture a person’s perspective of an event or experience.

In a qualitative study the primarily goal of an interview is to get a certain type of information. The researcher wants to find out what someone else knows, imagines and demands. The most universal way to determine what type of interview to use is to take make a decision regarding the structure demanded. An interview may have a very rigid structure, while the other hand, can be more open and conversation-like (Merriam, 1994).

In structured interviews the questions are determined and sequence arranged. This form of interview can be useful when each respondent possesses different type of information. Unstructured interviews are useful when the researcher doesn’t know enough about the phenomenon to ask relevant questions. The unstructured interview is often used together with participant observations in the early stage of a case study (Merriam, 1994).
Before interviews a questionnaire was made of the areas that were interesting and information was wanted. The questionnaires were both structured and unstructured in the sense that there were both open and closed questions.

At the first interview sessions, more of open-ended questions were provided to the respondents to get the chance to have follow-up questions and discussions. The unstructured interviews were useful as there were lack of knowledge about the transportation flow from the beginning. The early interviews also created the conditions for the next interview so it became more focused questions to achieve the purpose of the thesis. The later interviews became more structured in relation to the earlier ones as the questions were arranged in sequence and in different categories. This led to fact that a specific type of information could more easily be provided to the researchers by the each respondent. The interview questions can be found in appendix 1.

2.6 Observations

Yin (1994) argues that a visit to the case study site creates the opportunity for direct observations. There are two types of observations, open and hidden observations. An open observation means that participants are aware of and has accepted the observers. A hidden observation is the opposite, where participants aren’t aware of the observation to be made, and no contact is being made while observations are taking place (Holme & Solvang, 1997). By seeing, hearing and asking, the researcher can get an idea of how the business is structured. Observations can lead the researcher to get a network of actions and reactions from those involved. The technique is based on the researcher to spend some time with that group being studied. This method is most advantageous to use for the study of small groups and thus general conclusions cannot be drawn either (Holme & Solvang, 1997).

The framework and basis of this thesis are based on the field studies conducted at the different factories. Through various observations and interviews, data has been generated to provide a basis for the thesis. With the help of observations, the thesis can provide a more accurate picture and understanding of the actual situation of how the transportation flow really looks like in its real-life context.

The observations were conducted at VTU, VCBC and TÅ were the authors mostly made open observations as the stakeholders already knew the purpose of the visit. The observations were
hidden in some sense as well since all employees at each sight of observation didn’t know the purpose of the observation.

At VCBC observations were made both at the southern and northern factory. On the south factory observations were made on the different freight objects being used to transport the material. At VTU observations were made on the total factory plant where the cabs are built. Observations were also made on the unloading process of articles arriving from VCBC. Observations at VTU also included the loading of cabs and how the cabs were loaded into wagons for later transport to VTT. VTT was never visited since the train stops at a place called TÅ, where the cabs are unloaded and later sent by trucks the last bit to VTT. At TÅ observations were made on how the unloading of cabs look like before being sent by truck to VTT, for further assemble. The observations performed were a great addition to the interviews conducted as much of the information received through the interviews could be ensured.

2.7 Validity and reliability

This chapter discusses the methodological problems that may exist within the limits of this thesis. Measurement errors of various kinds arise from different surveys, which can lead to a result that gives a false representation of reality; these can be divided into validity and reliability (Wiedersheim-Paul & Eriksson, 1997).

2.7.1 Validity

The question about to what degree your results agree with the reality is the internal validity. The external validity signifies to what extension the results from a certain investigation are applicable in other situations than the investigated one (Merriam, 1994).

Qualitative researchers have argued that the term validity is not applicable to qualitative research, but at the same time, they have realized the need for some kind of qualifying check or measure for their research. For example, Creswell and Miller (2000) suggest that the validity is affected by the researcher’s perception of validity in the study and the choice of paradigm assumption. As a result, many researchers have developed their own concepts of validity and have often generated or adopted what they consider to be more appropriate terms, such as, quality, rigor and trustworthiness.
2.7.2 Reliability

Kirk and Miller (1986) recognize three types of reliability that can be denoted in a quantitative research:

“(1) the degree to which a measurement, given repeatedly, remains the same (2) the stability of a measurement over time; and (3) the similarity of measurements within a given time period”.

To be more specific with the term of reliability in qualitative research, Lincoln and Guba (1985) use “dependability”, in qualitative research which closely corresponds to the notion of “reliability” in quantitative research.

2.7.3 Validity and reliability in this thesis

It’s important that the thesis is trustworthy as it aims to provide a good basis for future research in the studied area. Unless the thesis can provide the right information in the current situation it will create gaps and inaccuracies in subsequent works that are based on this thesis. Better reliability has tried to be achieved through the different methods used to gather data. The methods have complemented each other in the sense that different types of data from various methods have been compiled and thus created coherence.

Interviews are a risky method to gather data as the persons concerned can choose what type of information they want to give up. To achieve greater reliability the authors could’ve sent out the interview questions to the respondents before the interviews took place. The authors chose not to do this as the authors felt that this approach would give the respondents’ time to formulate answers that sound good, rather than answers that reflects their true perception. Since the interview questions weren’t sent in advance, the authors experienced the interviewees as honest and open. Both authors were present at all interviews and recorded the interviews except one interview, which the authors only took note on. The recording of the interviews gave the authors the possibility and advantage to make a more accurate interpretation of the collected data as the interviews could be replayed many times which facilitated the analyzing process.

In order for the study to provide more validity and relevant information it was necessary for the interviewees to be best able to answer the questions. The authors started early to contact people within VGLS to get further information about the stakeholders who were most suitable to answer the authors’ questions. When designing the questions the authors have been careful
to ensure that the questions would be relevant to the purpose of the thesis and not be perceived as directing. The supervisor at VGLS helped the authors at certain times to increase the impact of the questions and thus pose questions that were more directed towards the goal and purpose of the thesis. If the authors didn’t feel satisfied with the questions provided the authors tried to ask counter questions, supplementary questions or even rephrase the question.

By visiting the case study sites the validity and reliability of the work increased, through interviews and observations. The different data collected could much more easily be put in real-life context when the opportunity was given to visit the factories. The data provided through interviews could be confirmed or ruled out as observations took place at the different factories which later made it easier for the authors to present an actual description of the transportation flow.

The thesis has been sent to the concerned stakeholders before publication to confirm or deny certain type of information. This action has led to the fact that the information provided in this thesis is more accurate but also more consistent.
3 THEORY

This chapter is the theoretical ground for the rest of the thesis. Supply Chain Management (SCM) and related elements will be presented. A more detailed description of RFID will be provided and also give a brief insight of TRV’s initiative of becoming RFID infrastructure provider in a near future. This chapter will later provide the authors with the needed foundation to connect theory with the findings from the empirical analysis.

3.1 Supply chain management

The supply chain consists of all actors involved in producing a customer’s product. The goal with supply chain management (SCM) is to maximize the supply chain value. Through the implementation of SCM a higher customer satisfaction can be reached, but also lower product costs (Chopra & Meindl, 2010). SCM helps to effectively manage the relationships and the network between companies within the supply chain (Harrison & van Hoek, 2011).

The definition of supply chain according to Harrison and van Hoek (2011):

“A supply chain is a group of partners who collectively convert a basic commodity (upstream into a finished product (downstream) that is valued by end-customers, and who manage returns at each stage”

SCM consists of planning and controlling all processes in a supply chain, from the production of raw material to the state where the end-customer purchases the product or service, until it recycles it. The planning includes making a forecast of how much material that needs to be purchased in order to produce and sell the products that are demanded each day, week, month or year. Controlling refers sticking to the plan even if problems occur. The main goal is to coordinate control and planning of every single process in order to meet the needs from the end-customer (Harrison & van Hoek, 2011).

Definitions of supply chain management:

“The systemic, strategic co-ordination of the traditional business functions and the tactics across these business functions within a particular company and across businesses within the supply chain, for the purposes of improving the long-term performance of the individual companies and the supply chain as a whole.” (Mentzer et al., 2001)
“Planning and controlling all of the business processes, from end-customer to raw material suppliers, which link together partners in a supply chain in order to serve the needs of the end-customer.” (Harrison & van Hoek, 2011)

The concept of SCM is about an integrated business planning and has during the past years developed strongly due to new information technology. According to Shapiro (2007) integrated business planning is intended for three different areas. These three areas are functional integration between different departments within a company, the integration between departments that are geographically dispersed and integration between hierarchical levels of planning as strategic, tactical and operational planning. SCM is one of the basic theories that other theories have developed around and therefore SCM can be regarded as a cornerstone to the general production planning.

The objective of SCM is to meet a given demand and at the same time minimize the total cost, meaning that all costs affecting decisions should be considered. As a given demand generates given revenue it’s important to maximize the margin through cost reductions (Shapiro, 2007). An important tradeoff of costs that must be kept in mind in order to achieve good profitability is the tradeoff between delivery performance, manufacturing cost and capital cost (Olhager, 2000). The reason for this is that improving one area often leads to a deterioration of one or both of the other areas. This statement is true as long as it isn’t about an efficiency of one area (Oskarsson et al., 2006).

### 3.2 Supply chain integration

Supply chain integration focuses on the two flows that occur in a supply chain, the flow of material and the flow of information between the partners in the supply chain. These two flows or integrations can also be mentioned as information integration and logistics integration. In other words, the logistics integration is the material flow, and the information integration is the flow of information between the partners in the supply chain. When working with integration of supply chains it’s important to include both flows and not only focus on the material flow. Companies with high level of supply chain integration often have better communication related to logistics and the supply chain organizational boundaries between suppliers and customers are often faded. With a great supply chain integration the supply chain can reach an improved overall efficiency (Prajogo & Olhager, 2012).
The integration of supply chain processes can create an ability to reduce cost and improve the level of customer service. In order to reach an integrated supply chain network it requires an infrastructure that enhance effective information flows and rationalized logistics. Robust and long-lasting collaborations with partners in the supply chain are necessary in order to reach the wanted infrastructure. The networks that will be most effective are those that manage to get the right mix of information requirements, material logistics and collaboration that provides advantages for most of the supply chain partners (Power, 2005).

In order to be a successful manufacturer in today’s business climate it’s necessary to have the internal processes integrated with the external suppliers, and even customers to reach a successful supply chain (Frohlich & Westbrook, 2001). Supply chains that use supply chain integration can achieve an improved ability to react fast to problems or changes in the chain (Fisher, 1997). There is a broad consensus among researchers today about the importance of integrating suppliers, manufacturers and customers in the supply chain (Clinton & Closs, 1997; Eloranta & Hameri, 1991). To achieve this integration Frohlich and Westbrook (2001) mentions two different approaches, first approach being the integration of forward-looking business activities, in other words logistics integration. The second approach is to address the technological and informational flow back through the chain, referring to information integration.

3.3 Information sharing and information integration

In the supply chain it’s not just important to get the material flowing and synchronized, it’s also important that the supply chain responds to some type of trigger. The trigger in the supply chain can be seen as the end-customer, since it’s the end-customer’s demand that the supply chain has to respond to. In order to create improved customer value the information regarding end-customer demand should be shared and create a demand chain. In order to capture the advantages that information sharing conveys it’s important with information technology that enables the sharing of information and demand at a high accuracy. With this integration better accurate information about business processes, markets and end-customer can be shared (Harrison & van Hoek, 2011).

Applying information integration across the supply chain creates the best scenario for meeting the demand from end-customers with a great dependability and inventory at minimum. This is important since a focal firm or a main firm needs to involve the other actors in the supply chain in order to be world class (Harrison & van Hoek, 2011).
The demand for the product in question needs to be shared across the supply chain instantly, instead of being interpreted at different stages in order for the supply chain to meet the end-customer needs with high accuracy. The material is moved from one process to another process in the supply chain and it is the information that binds together the supply chain, since it is the information that creates the knowledge of what to do (Harrison & van Hoek, 2011).

The integration of information is important but it is the quality of the information shared that is most important. The quantity and the frequency which the information is shared with are also important. An example could be a company sharing information at high quantity and frequency but still for no use as the quality of the information is poor (Prajogo & Olhager, 2012).

To be able to get the advantages that are expected when doing an information technology investment it is needed that all actors have the willingness to share the information that are important for the other actors. This includes sharing material and product orders and also strategic supply chain information (Fawcett et al, 2007).

The meaning of sharing strategic supply chain information is to enhance strategic decision making for the supply chain partners. When actors share information regarding point of sales history or real time inventory position suppliers get advantages since they can better plan their production. This type of information sharing enables suppliers to reduce inventory cost and improve service levels, leading to lower product cost with higher accuracy for the receiving company. Maintaining this type information sharing requires intense and frequent communication between actors in the supply chain (Prajogo & Olhager, 2012). According to Prajogo and Olhager (2012) studies have shown advantages for the logistics in form of agility, flexibility and a reduction of the bullwhip effect when sharing information across the supply chain.

To reach success in SCM great information sharing is important since all actors in the supply chain need information frequently and with great quality in order to handle organizational business activities and be competitive on the market. To take control and handle the business activities within a supply chain firms has to adopt connectivity to share and access information within the supply chain. This connectivity can be mentioned as a firm’s degree of information integration (Wong et al. 2005).
The connectivity at a firm or the firms’ level of information integration indicates the organizations capability to generate and share information that supports the supply chain activities. Information integration can be defined as the infrastructure of information sharing at a firm to enhance information sharing and coordinate the information sharing across different business functions and firms within the supply chain (Wong et al. 2005).

The meaning of information integration is to share information through IT-systems across the supply chain both within and outside organizational boundaries. Sharing of information will help the coordination between actors in the supply chain. When a supply chain has achieved information integration and have an information sharing infrastructure within the supply chain, the actors within the supply chain will have timely, accurate and standardized data exchanges. There are two types of information integration, intra-organizational and inter-organizational. Intra-organizational is about the linkages for a company’s IT applications to support cross-functional processes, while inter-organizational information integration considers the exchange of information between cross-organizational business activities. The meaning is to share information to the supply chain partners that needs the information to facilitate their decision making and market actions (Wong et al. 2005).

Information that is valuable for other actors in the supply chain network should be shared and the enabler is IT-systems. The main purpose of information sharing is that all actors in the supply chain should have real-time sharing and processing of the information needed for decision making. With help of information sharing companies can lower their cost through reduction in inventories and storage, but better meet the end-customer needs as well (Prajogo & Olhager, 2012).

### 3.4 Logistics Integration

As competition on the markets increase companies need to focus on improving their internal operations and integration of the supply chain with all actors involved. The impact for a company that involves suppliers can be better quality, delivery, flexibility and lower costs (Prajogo & Olhager, 2012).

The main goal for a supply chain is to get material flowing in an efficient way from the source to the end-customer. In order for this to work and don’t cause build-ups it’s important that the supply chain is well synchronized. The supply chain should work without interruptions and
the material should be delivered in time, in the right sequence and to the location where they are needed.

It’s often difficult for partners in a supply chain to see the whole view of the supply chain and it can cause ineffective responses to end-customers demand and build-ups of inventory. In order for a supply chain to function as effective as possible it’s important to have a holistic view and awareness that boundaries between organizations often create interruption or barriers in the supply chain flow (Harrison & van Hoek, 2011).

Logistics integration will contribute to well-coordinated flows of material from the suppliers within the supply chain and facilitate the production process (Frohlich & Westbrook, 2001). Flows that are well-coordinated will create a more overlapping connection between companies and suppliers and enhance the erasing of activity boundaries between the partners (Stock et al., 1998). The main purpose of logistic integration is to enhance the actors in a supply chain network to act as one unit, instead of acting as single blocks and this can lead to improved performance across the supply chain. The logistics integration can create a supply chain that works as one single company, although it’s not, and by this reach the benefits of quality, dependability, planning and control and lower costs. Well-functioned logistics integration can also gain many operational benefits within the supply chain, including reductions of costs, lead time and risks, but also creating a better opportunity for an improved customer service and customer satisfaction (Prajogo & Olhager, 2012).

3.5 RFID

The ability to effectively manage material flows along a supply chain is often a problematical process due to the many interfaces between activities, both within and between different companies (Pålsson, 2009). Bowersox and Closs (1996) strengthens this claim as they believe that managing material flows along a supply chain is a complex matter involving a great number of interfaces both between activities and between actors. Loss of control on the items, delays, and a host of other problems are imminent at these interfaces. Pålsson (2009) supports this argument as he points out how items are disordered with other items, duplication of effort in the form of registration of the items in both unloading and delivery.

Different companies use most often different types of IT-systems which lead to companies often have limited insight into the other systems. Many times there are unforeseen events
affecting material flow, leading the unforeseen events to not be addressed in an optimal way as the IT-systems differ between the companies in question.

Neighboring activities that are synchronized through a co-ordination leads to the integration of material flows. The integration can result in that the interfaces are bridged and a better supply chain is adopted (Pålsson, 2009). In literature, a large number of definitions can be found on supply chain integration and they usually include common themes and elements such as co-operation, co-ordination, interaction and collaboration (Pålsson, 2009). Gajda and Koliba (2007), for example, believe co-operation contains the lowest level of integration including shared information and mutual support. They believe that coordinated organizations are more integrated as these organizations comprise common tasks and compatible goals.

One way to achieve greater coordination and improve the control of material flows is to label the devices that are controlled, such as an item itself, transportation package, load carrier, pallet etc. with a unique label. This means that the information system knows exactly which item, transportation package, load carrier or pallet is in question when the device registers (Pålsson, 2009).

To collect data and use the information on where each individual item or load carriers are at various times is made possible by identifying technologies that can deal with unique marking. The main value of using traceability data from unique identities is their potential to enable integration of material flows and contribute to logistical improvements.

One of these identification technologies is Radio Frequency Identification (RFID). Pålsson (2009) describes RFID as a technology that enables wireless identification on many unique identities simultaneously. Reading of the identities takes place by means of radio waves which enables the identities recorded not needing to be in line of sight.

An RFID system will typically compromise of an RFID tag, RFID reader and an enterprise system, illustrated in figure 3-1.
RFID works in such way that a so-called tag with an embedded micro-chip and antenna is put on the object to be identified. The size of the tag varies depending on what is to be identified, at times sufficiently small to be integrated into a label. There are mainly two different types of tags, active and passive.

### 3.5.1 Tags

The passive tags receive their energy by a reader which sends out a radio wave. The energy the tag receives is enough to activate the micro-chip so the memory circuit inside the micro-chip can communicate its identity to the RFID reader.

The active tags have an internal battery built into the micro-chip, which means that the RFID reader doesn’t need to generate any energy to the tag for its activation.

There are also semi-passive tags which mean that the battery in the micro-chip generates the memory circuit, but the communication between the reader and the tag itself is generated by the RFID reader.

Active tags are often larger and more expensive than passive tags. The use of a battery on the active tag places a limit on the life of it while the passive tags have an unlimited life and are often lighter and cheaper. The disadvantages of the passive tags are limited data storage capability, shorter read range and they require a higher-power reader. The performance of the passive tags might also decrease in electromagnetically noisy environments.

### 3.5.2 Micro-chips

The mentioned micro-chips that are installed in each of the tags have different type of structure, read-write, read-only or write once read many (WORM).
Read-write chips make it possible to add information to the tag or write over existing information when the tag is within the range of an RFID reader. Read-write tags usually have a serial number that can't be written over. Additional blocks of data can be used to store additional information about the items the tag is attached to.

Read-only chips have information stored on them during the manufacturing process which makes the information already implemented unchangeable.

WORM tags can have a serial number written to them once, and that information cannot be overwritten later.

3.5.3 RFID reader

The reading of a tag is performed by an RFID reader. The RFID reader is a data capture device that communicates by sending out radio waves to the tag that in turn responds with its identity and the data stored. As mentioned earlier with read-write chips, you can add information to the tag or write over existing information when the tag is within range of an RFID reader. After reading, the RFID reader is connected together with an enterprise system for reporting what was on the tag, while new instructions can be made. The RFID reader consists of an ordinary PC with associated screen-reader software and an antenna.

3.5.4 Enterprise system

An equally important part of an RFID solution is the enterprise systems, many times only referred as IT-system, which can receive, process and forward on information provided from the tags and the RFID readers. Enterprise systems help different type of businesses to support their business processes by integrating and coordinating them, reporting, information flows, and data analytics. It is therefore important that the actors in the value chain with various enterprise systems build in interfaces and features to fit their available information and synchronize with other actors.

3.6 Trafikverket and RFID

Trafikverket (TRV) has signed a call-off agreement with three suppliers for 630 RFID reading stations; these reading stations will during the next five years be installed next to the railway around Sweden. TRV has already installed some RFID reading stations in pilot projects but these will now be replaced with new RFID readers so that all readers are of the same type. On April 13, 2012, the installation of the first two RFID readers was made and the idea is to
proceed with further installations of two new RFID readers during week 17, 2012. After the installation of the first RFID readers TRV will evaluate the readers for a couple of weeks and once this evaluation is made another 30 RFID readers will be installed before the mid-2012th. In total there will be approximately 150-180 RFID readers installed during 2012.

The expansion of RFID readers will start in the area of Gothenburg along the western mainline (västra stambanan), west coastline (västkustbanan) and also close to Olofström. Subsequent installations will be done from Gothenburg to Mälardalen and Norrland, during the second half of 2012 some installations will be made on the northern mainline (norra stambanan). The idea is that the first RFID readers will be installed where TRV today has detector-locations. Detector-locations are places where TRV can do readings regarding problems with wagons that are passing by. The detectors are spread all over Sweden and there are about 160 detectors. The position of the detectors and thereby the position of the first RFID readers is shown in appendix 2.

When all the detector-locations have RFID readers installed, the next step for TRV is to install RFID readers at ports, terminals and shunting yards. TRV will also install RFID readers in consultation with transport buyers and railway companies.

By the end of 2013 the plan is that approximately 300 installations of RFID readers will be made. After 2013 an additional 300 RFID readers will be installed if there is a need and if TRV has the resources needed. The goal is to create a network of RFID readers throughout the country in order to offer the best possible service.

TRV has in addition to the RFID readers developed an IT-system that manages the receipt and distribution of RFID-messages to internal and external systems and customer. In VGLS’s case when Green Cargo (GC) is the transportation service provider, GC has to grant Volvo the approval to take advantage of the information. The reason for this because GC owns the wagons that the RFID readers will receive information from.

TRV will bear the cost when it comes to purchase of readers, installation and the maintenance of the IT-system, basically the whole infrastructure behind the concept. TRV will not strive towards earning money on this solution, but rather to finance their investments by charging an amount of money per dispatch.

To allow communication or data to be transmitted between the RFID reader and RFID tag an air interface is required, the air interface that will be used by TRV is ISO 18000-6 type C /
UHF Gen 2 Class 1. TRV decided to run with this air interface after a pre-study where two different air interfaces were tested. The pre-study showed that ISO 18000-6 type C / UHF Gen 2 Class 1 worked better, had more suppliers, more of a mature technology and supported standards.

In order for the RFID tags to be useful they must contain some type of information and follow a standard, TRV has chosen to follow GS1 EPC standard for tag information. The tag will contain a company prefix, which is linked to Transportstyrelsens vehicle register, and also a 12 digit vehicle number. There will be two tags on each wagon and the tags will be left mounted on each side of the wagon on a height of 0.5-1.1 meter, see figure 3-2 for an illustration of the tags placement.

![Image](image-url)

*Figure 3-2 Placement of tags*

In order for the system of RFID readers and RFID tags to be of any value it requires that information is exchanged at each reading of a tag. TRV has chosen to follow the GS1 EPCIS standard for information exchange. EPCIS is constructed of four components and these components can be seen in figure 3-3.
Figure 3-3 GS1 EPCIS standard

“What” stands for the physical vehicle and includes the EPC vehicle number or wagon number. “When” stands for the time when the reading was done and includes date and time for the reading. “Where” symbolize where the reading was done and includes information of the specific RFID reader collecting the data. “Why” handles the activity, in this case implying which direction the wagon is travelling.

TRV has already performed a pilot test with passive RFID tags with Volvo and the pilot test indicated that the RFID readings are working and that the technology is reliable. To strengthen the argument that the technology works it can be mentioned that TRV has three additional pilot implementations with Green Cargo, SJ and Tågfrakt that have been running smoothly. In the implementation with SJ, readings have occurred at speeds up to 200km/h.

TRV will through the implementation of RFID achieve a number of advantages and they also see that transportation buyers as VGLS will benefit from an RFID implementation. Benefits that transportation buyers can achieve according to TRV are the ability to track wagons and cargo, effective planning in loading and unloading, improved reporting about delivery time and the possibility to get the right train composition.

The goal for TRV is to by year 2014 be able to offer RFID-services that are fully developed, but already in 2012 they will be offering limited services.
4 EMPIRICAL STUDY

This chapter contains data from the case study, performed at VTU, TÅ and VCBC. The different sections within this chapter describe the physical transportation flow and also the information flow between the actors.

4.1 Holistic view of the transportation flow

The examined transport route is the rail transportation between Volvo Cars Body Components (VCBC) Olofström, Volvo Trucks Umeå (VTU) and Volvo Trucks Tuve (VTT). VCBC sends body components to VTU by rail and the components are handled and processed to become body parts for different cabs for Volvo trucks. Finished cabs are later transported by rail to VTT but before the cabs reach VTT the cabs are unloaded at TÅ. From TÅ the cabs are later sent by trucks to VTT. Between these locations there are a few other small actors involved in the transportation flow, the transport process is illustrated in figure 4-1.

![Transportation flow diagram]

Figure 4-1 Transportation flow

4.2 Volvo Cars Body Components

Volvo Cars Body Components (VCBC) operates in Olofström; they are the main manufacturer of body parts for Volvo cars. At VCBC the majority of the body panels and sheet metal parts that are visible on a Volvo car are stamped. VCBC doesn’t only manufacture body components to Volvo cars; VCBC also supplies VTU with body components for the manufacturing of cabs.

VCBC has a southern and northern plant, the production is similar between these plants, they have a few different machine types and some few processes that don’t exist at both plants. The majority of the body components manufactured for VTU is produced in the southern
plant and it’s also from this plant where the initial transportation by rail to VTU departures from.

VGLS as the logistics service provider has previously used swap bodies and not end-loaded containers since VTU doesn’t have the necessary equipment to unload end-loaded containers. During the time of the study the transportation from VCBC to VTU has been transported by trucks, as the swap bodies previously used were in too bad condition.

The stamped body components from VCBC are loaded onto racks before transportation. Racks can best be understood as an undercarriage where articles are transported in to avoid damages, the racks also facilitates the identification of articles since it’s usually only on type of article in each rack. The racks containing body components are loaded into swap bodies (container soon) and subsequently the swap bodies are loaded on railway wagons. Each wagon is between 15 and 16 meters long and carries two swap bodies. Normally two wagons are sent per day from VCBC to VTU, four times a week. The cycle time for the flow VCBC-VTU is between 5-6 days and it takes approximately 2-3 days for the transportation to reach VTU.

The flow between VCBC and VTU is purely a wagon load system which means that orders are made every day for the specific volume that needs to be sent. The reason for the use of a wagon load transportation solution instead of a block train solution is due to low transportation volume, not justifying a block train solution. To get a better understanding of the difference between a wagon load solution and block train solution a comparison can be made between a bus and a taxi. With bus you need to find a bus stop and follow the timetable that the bus company has established. With a taxi you can be more flexible and take the taxi from your door, but it costs more than the bus and this is how a block train works. Wagon load systems most often takes longer time, but the customer only pays for the exact volume being sent. In a wagon load the wagons will stop at different locations and be switched to another train, taking some extra time and is therefore more time consuming than a block train.

4.2.1 Synchronization

On each rack a consignment note is attached, called an Odette flag. The Odette flag contains information about the item number, recipient, supplier, amount of articles, weight, etc. The Odette flag also indicates the date when the racks have been loaded, since the Odette flag is printed the day it is created. When VCBC loads the swap bodies with racks, a five digit
number found on the swap bodies is recorded. The Odette flag number is synchronized with the swap body number meaning it’s now synchronization between the swap body, racks and articles.

When the swap bodies have been loaded onto the wagon a forklift drives alongside the train set and writes down the wagon’s 14 digit number. This semi-manual process creates the synchronization of swap bodies and wagons, making it now possible for VCBC to know which articles are loaded onto the wagons. An illustration of the loading of racks into swap bodies and the loading of swap bodies onto wagons can be seen in figure 4-2.

![Illustration of loading racks into swap bodies and swap bodies onto wagons](image)

*Figure 4-2 Synchronization rack, container and wagon*

### 4.2.2 Information sharing

VGLS makes a transport order for delivery between VCBC and VTU, on behalf of VTU. VGLS makes a booking towards a transportation service provider such as GC and the booking is communicated solely between VGLS and GC in this case. Date and time for departure of the shipment is determined earlier between VGLS and GC as it already exist a forecast of the quantity of articles being transported between the factories. The forecast is based on VTU’s demand for body components. The predetermined schedule enables VCBC to know in advance when the train departs and when it’s time for loading.

Just before the train departures, VCBC sends an electronic message called AVI EXP, a type of delivery notice to VTU. What isn’t available in the system is the synchronization between the articles and swap bodies, making VTU unaware of the content in each swap body. If that specific information would be of interest for VTU they have to contact VCBC manually. When the train departures from VCBC their responsibility ends and is considered sold to VTU. The interface occurring at this stage is economically called for Free Carrier, meaning
that VTU is now responsible and pays for the transportation. To summarize, VTU uses VGLS as their logistics solution provider and VGLS in turn contracts GC to perform the actual transportation between the factories. Figure 4-4 illustrates the ordering and payment process between the actors.

Figure 4-3 Transportation ordering- and payment process

4.3 Volvo Trucks Umeå

4.3.1 Arriving
The train arrives at the shunting yard in Umeå, about 5 kilometers from the VTU factory, see figure 4-3. When the train arrives at the shunting yard the swap bodies are unloaded from the wagons and loaded onto trucks that transport the swap bodies the last distance to the VTU factory. The company in charge of the unloading and transportation of swap bodies from the shunting yard to VTU is Frakttjänst. The swap bodies are transported to the goods reception (GR) at the VTU factory.
The reception of goods is done through the scanning of a single Odette flag in a swap body, resulting in that all content in the swap body becomes receipted automatically. When the goods have been receipted through the scanning, new Odette flags are printed for each rack in the swap bodies. The new Odette flags are attached to the racks and compared with the existing flags to confirm that the receipted goods are in compliance with what’s been ordered. The personnel at GR compares the new Kolli ID with the existing Kolli ID and in this way makes sure that receipted goods are in compliance with what’s been ordered. The new Odette flag provides additional information regarding internal storage.

When the swap bodies have been unloaded they are being loaded again with empty racks that will be sent back to VCBC. The racks stay for about two days at the VTU factory before they are being returned to VCBC. In average, half of the swap bodies are being filled with empty racks while the other half is empty on the way back to VCBC.

### 4.3.2 Departing

Once the production of the cabs are finished it’s time for the cabs to be transported to VTT. The cabs from the VTU factory must be sent to the shunting yard and this process is outsourced to a company named UmeAssistance. They handle loading, transporting and unloading of the cabs between the factory and the shunting yard.
Before UmeAssistance transports the cabs from the VTU factory to the shunting yard VTU performs an inspection of the cabs that will be transported. VTU personnel uses a scanner that reads the identification number of the cabs before UmeAssistance can begin the transportation, to ensure that UmeAssistance transports the right cabs.

When the cabs arrive by trucks to the shunting yard it’s time for the cabs to be loaded on the MP-wagons. The cabs are sent on a transportation undercarriage, a base for the cabs, preventing them to get damaged during the transportation and to ease the handling of the cabs.

The cabs are to be loaded by UmeAssistance in a specific sequence order containing 12 cabs which is communicated and issued earlier by VTU. Once the cabs are delivered at the shunting yard UmeAssistance makes sure that the cabs are loaded into wagons. UmeAssistance determines in what wagon the different sequence of cabs should be loaded into. When the loading is done UmeAssistance synchronizes each wagon with its containing cabs and sends the information back to VTU.

The initial communication is done via paper documents received by UmeAssistance from VTU, containing information about the sequence order. When the loading is completed UmeAssistance fills in the blanks on the paper documents, making sure that VTU knows which wagon number that is attached to each sequence of cabs. An illustration of the process can be seen in figure 4-5.

Figure 4-5 Material- and information flow, VTU-VTT
Approximately 7 multipurpose (MP) wagons with cabs depart every day, with 12 cabs in each wagon, between VTU and VTT. Green Cargo owns the wagons and the transportation time is approximately 1 day since it’s a block train.

Once the train departure, VTT receives information about the shipment from VTU through Electronic Data Interchange. VTT may also get a cab delivery note, meaning that VTT gets an advice the day before the shipment arrives, including information about the content of the shipment. VTU also sends a shipping label to GC. VTU pays for the transportation of the cabs since it’s delivered at place (DAP) which means that VTU is responsible for the transportation all the way to VTT. VTU uses VGLS which accounts for the transportation which means that VGLS bills VTU and VGLS later gets billed by GC, the actual transportation service provider.

4.4 Volvo Trucks Tuve / TÅ

The cabs coming from VTU arrives at TÅ, before being sent to VTT. TÅ makes sure that VTT receives the cabs in the right sequence order by making sure that the content of the MP-wagons are correct. The cabs are later loaded on trailers which will be taking the cabs from TÅ to VTT factory. The transportation undercarriages accompany the cabs to VTT in order for minimizing the risk of damage during the transportation by truck. Once the cabs are delivered at VTT the transportation undercarriage are sent back to TÅ and loaded onto the MP wagons to be sent back to VTU. VTU is responsible for the transportation between TÅ and VTT and provides them with a predetermined schedule for the transportation. No contact occurs between TÅ and VTT; instead VTU has contact with VTT.

The production is volume-based, so the numbers of trucks that are built at VTT, the same amount of cabs are built at VTU. Information about the exact number of cabs received at TÅ is sent by VTU. VTU sends a weekly forecast, including how many cabs there are to be sent to TÅ, but this information is adjusted up and down depending on how the production at VTT progresses. Information about delayed trains is received by TÅ as soon as the transport service provider is aware of the delay, in other words, GC.
5 ANALYSIS

In this chapter the empirical data will be analyzed. Identified problems in the transportation flow will be explained and solutions will be provided to each one of these. The later part of this chapter provides a bigger form of solution that treats all the identified problems into a single solution.

5.1 General analysis

Careful reviews of the collected data through interviews, discussions and observations have led the authors to an understanding of where there are efficiency opportunities in the transportation process. The physical transport process proved to be better than expected, no problems have brought the authors’ interest and considered worthy of further investigation. The area that has captured the author’s attention and where emphasis will be put is the flow of information during the transport flow, which hasn’t functioned optimally and has a potential for improvement. The positive potential derived from the information flow deserved more attention versus the physical transportation flow, as more problems have been identified in the information flow. The effects of each positive improvement change in the information flow will be more important rather than a change in a well-functioning material flow. A more efficient flow of information can provide benefits such as lower cost through reduction in inventories and storage but also provide better conditions to meet the end-customer needs (Prajogo & Olhager, 2012).

Further analysis shows that the ongoing administration is the manual labor which is the most time consuming and has the most potential for improvement. The analysis shows that there are processes in the supply chain that could be automated or eliminated in order to achieve a more efficient information flow. There are also processes that should be added in the information flow in order for the information to reach all actors in the supply chain. If the actors don’t receive the necessary information available and don’t get a holistic view, it can create inefficient responses to end-customer demand (Harrison & van Hoek, 2011). Quality, delivery and flexibility are other factors that can be improved through better information sharing (Prajogo & Olhager, 2012). Parts of the efficiency measures proposed later don’t have a direct impact on the daily transportation flow but is more of a preventive measure in order to react quickly when problems arise.
5.2 Problem identification

The empirical study found four different types of problems to be analyzed. The problems will individually be examined by explaining the problem, provide a solution and explain the effects and impact of each solution.

5.2.1 Problem 1: UmeAssistance

UmeAssistance is the company that operates the service to load and transport the cabs between the VTU factory and the shunting yard, where the cabs are later sent by train to VTT. UmeAssistance receives 6-7 paper documents every day regarding the loading of cabs into the MP wagons. The information is sent from VTU to UmeAssistance as VTU plans the delivery of cabs down to VTT. Every paper document contains information of what cabs that should be loaded together in each wagon and in what sequence they should be loaded. Each paper document contains information on 12 cabs, which are in sequence. The wagons that the cabs are being loaded on are decided by UmeAssistance. When the loading of the cabs are finished, UmeAssistance writes down the wagon number related to each sequence, meaning that each paper documents with 12 cabs gets a wagon number attached to it. The paper documents are later sent back to VTU from UmeAssistance. VTU types down the wagon numbers of each sequence in their system. The status is now: wagon delivered and a transport notification is printed out. The personnel at VTU later creates a bill containing wagon number, cabin number, bill number, weight, waybill number and date, to be mailed to GC, Hallsberg. VTT receives an EDI notification showing that the cabs that have been called-off are on their way.

5.2.1.1 Solution

What appears to happen here is that information doesn’t flow in an optimal way between the actors and therefore extra work arises. A solution is that more responsibility is placed on UmeAssistance. UmeAssistance should in the first place via computers in the trucks have access to VTU’s IT-systems, where information regarding the sequence order of cabs is available. If UmeAssistance have access to that information they could rather easy be loading the cabs in the right sequence. By having access to VTU’s IT-system UmeAssistance could also type in the wagon numbers related to each sequence of cabs. This eliminates the step where paper documents are being sent between VTU and UmeAssistance, and UmeAssistance doesn’t need to manually type in the wagon numbers on the paper documents and send them back to VTU, see figure 5-1 for illustration of the solution.
Figure 5-1 Shared IT-system between VTU and UmeAssistance

5.2.1.2 Effects

The changes might seem to put extra burden on UmeAssistance but they won’t be seriously affected considering that the personnel at UmeAssistance already have to write down and forward information regarding the wagon numbers. This will lead to time savings for VTU and the elimination of a work process, many times considered to be a kind of duplication. The change in work will also create a decrease in the handling and use of paper documents. Since this process will be handled by UmeAssistance, it will create a greater integration between these two actors in the supply chain and the boundaries between the companies will blur, and a better collaboration and information sharing will be created (Prajogo & Olhager, 2012).

5.2.2 Problem 2: GR at VTU

When goods arrive to VTU from VCBC, they are received at the goods reception (GR). The personnel working with the unloading of goods at GR doesn’t receive any information regarding delays from VTU; the personnel at GR are instead contacted by Frakttjänst, the company taking care of the transportation of goods from the shunting yard to VTU. As GR receives the information about delays from Frakttjänst and not from other business areas within VTU, GR doesn’t receive the information about delays in advance. GR has to wait until Frakttjänst contacts them, sometimes making it difficult for GR and it would facilitate GR’s workload if the delays could be informed in advance.
5.2.2.1 Solution

A simple solution to this problem would be that the personnel at VTU or VGLS receiving the information regarding delays from GC would forward the information to GR. In figure 5-2 an illustration of how it works today and how the solution should work can be seen.

Figure 5-2 Information forwarding to GR

5.2.2.2 Effects

GR doesn’t need to contact or be contacted by Frakttjänst regarding delays, instead they will receive the information simultaneously with the others at VTU and VGLS. This creates better conditions for GR to plan their work as they are more updated around the current situation.

5.2.3 Problem 3: Information on the consignment

When VTU requests information about a specific article’s location during the transportation flow from VCBC manual work is required to acquire the information. VTU must navigate their way to the article by contacting VCBC and GC through e-mail or phone. VTU must first contact VCBC to receive information about what wagon the specific article is loaded on. Then, VTU has to contact GC to obtain information about the wagon, i.e., its location. This work is time-consuming and it may in some situations be very important to get this information quickly as important decisions must be made rather hasty. In figure 5-3 an illustration of the contact between VTU, GC and VCBC is showed. Today VTU doesn’t receive any information from GC regarding the position of a wagon during the transport; this may not be a problem but rather an opportunity for improvement. The problem that arises is that is takes time to find the location of an article, time that many time is costly. Locating a type of article may be needed if it’s a short supply being transported, or that the delay is so large that the whole consignment must be re-planned. When a larger delay occurs it may be
important that a specific swap body is handled first, and being transported from the place where the train has been delayed.

Figure 5-3 The process of finding a specific article during transportation

What troubles the authors is that VTU most often isn’t interested in this type of information regarding the synchronization if it isn’t a bigger problem or whether it’s a short supply. If VTU would receive all the different information from VCBC regarding the synchronization it would be too much information to handle considering how the sharing of information works today, which is mainly by e-mail or paper documents that are faxed. Therefore, this problem becomes more difficult to attack since VTU only demands this type of information at certain times which aren’t too often, but still very important to receive once VTU demands it.

5.2.3.1 Solution

This calls for better information sharing as VCBC from the very beginning has the information regarding the synchronization of article - swap bodies - wagon. At this point it’s difficult to come up with a straightforward solution but in the next chapter an IT-system will be presented that will treat the different problems into one single solution.

5.2.3.2 Effects

Positive effects can be reached through better routines or changes in the information sharing. Time savings will be apparent for VTU, both for the time it takes to contact VCBC and GC, but also time savings for making decisions as information will be received quicker. Other positive effects can be better track of articles, better conditions to protect VTU from production stoppages, better circumstances for critical decision making situations due to a shortage of a certain type of article.
5.2.4 Problem 4: Information about deviations

Information about deviations and other type of information concerning the transportation flow are today available, mainly being provided through e-mails, most of them being sent from GC. The e-mails being sent regarding the deviations are many times of no interest for Volvo personnel since the deviation in question many times don’t call for any changes. This process is time consuming as the various stakeholders at Volvo Group receive many e-mails every day and they have to read them to determine if the e-mails are relevant or not. Occasionally e-mails about major deviations are sent from GC on Saturdays when nobody is present at work at the different Volvo factories. This automatically becomes a problem as the personnel most often don’t read their e-mails during weekends and assume that the transport will arrive on the agreed time. Other similar problems that arise are that e-mails are sent late in the evening, leading for the information about the deviation not coming through. It can clearly be read how this can create major problems since the personnel at Volvo may experience the fact that they won’t receive any delivery after the weekend. There’s an agreement with GC that GC should contact Volvo when larger deviations appears, more than 8 hours. This agreement isn’t always applied and followed and is therefore a cause to the problem. The conclusion is that the information about deviations isn’t shared among the actors in an optimal and efficient way. Not being able to receive information about deviations can cause major consequences for VTU especially, but also for VTT.

5.2.4.1 Solution

To make the process of information sharing concerning deviations more efficient there must be better and clearer procedures of how e-mails should be sent between GC and the Volvo factories. What needs to be emphasized and done is to make sure that right personnel receives the information about deviations, and at the same time make sure that the information is relevant. The biggest problem is that the processes when major deviations occur don’t work as they should. Since it’s very important for VTU to receive this type of information the routines should be overlooked again. It must become clear for all actors what the guidelines are so they are followed.

This deviation procedure might be facilitated and give more of a specific and continuous information via the use of RFID. When the implementation of RFID is made different reading of deviations will be available during the transport. This gives VTU and GC bigger opportunities to receive more accurate information and in a continuous way follow up the
shipment. In order to enable this type of information it’s necessary to have a good contact with TRV as they are the service and infrastructure providers of RFID. It’s important to communicate the various type of information needed from Volvo’s point of view. Volvo should establish a good relationship with TRV from the very beginning and make clear for TRV to follow certain standards with respect to the information being exchanged.

5.2.4.2 Effects

With better routines of how deviations are handled VTU will be sure that the shipment has arrived at the correct time if they haven’t heard anything else. VTU will now know if a train won’t be coming the next day and is thus able to start planning on how to get the articles to VTU. It’s important to get the articles to the factory within the required time and therefore the communication efforts must be more efficient. The solution will provide VTU with faster response to deviations in delivery and at the same time give VTU better control of how the transportation progress. VTU gets better conditions for ongoing planning but also re-planning, since they now know more precisely when the articles will be delivered.

5.3 Total solution

After identifying problems and presenting possible solutions for each individual problem, thoughts have gone towards a single solution model that addresses all the problems. The idea has been obtained after studying the problems individually, only to see that the common denominator for most of the problems is the lack of sharing of information between the actors. The authors believe that a joint solution that addresses all the problems will become a more effective solution with greater potential. The information needed for someone can almost always be found with an actor in the value chain, but the information most often stays with that actor until a problem arises. The authors’ solution will have more of a preventive purpose so problems can quickly be detected and solved. In order for the solution to work, its necessary that the information between the actors are shared and everyone who is positively affected of the shared information should in an easy and convenient way access the information. Prajogo and Olhager (2012) state that information of value for other actors within the supply chain should be shared in order to reach benefits. The information that hasn’t been available previously for VTT, VTU and VCBC is the positioning of wagons on the move. This information will soon be available when TRV implements RFID readers throughout the Swedish rails.
With this in mind the authors suggests a solution in form of a system with information that all the different actors can access and take part of. In order to gain the advantages that is possible through information sharing its important with information technology that enables sharing at a great accuracy (Harrison & van Hoek, 2011).

5.3.1 Purpose of the Total solution

The solution that will be presented is an illustration of the information and different functions that must be accessible, in order to solve the identified problems. The solution will be presented through a theoretical description of what an IT-system should contain in this case. The authors have put emphasis on this since the most important factor for a successful information sharing is the quality on the information being shared (Prajogo & Olhager, 2012).

The purpose of the Total solution is to serve as a guideline for further studies in this area but at the same time contribute with new alternatives of how different problems can be solved. This will be done through an IT-system that provides large amount of data in a systematic way and is accessible to all actors within the supply chain. The solution has been chosen to be known as a Total solution which means that all actors should be entitled to the same type of information which will facilitate the communication efforts. The idea is that a simpler system will be implemented which will create a uniform and shared flow of information throughout the supply chain. The new system will help the supply chain to become more of an integrated chain where the boundaries between the actors and create a single unit. Stock et al. (1998) argues that when supply chains acts as one single unit it can reach improved performance across the supply chain.

The transportation flow which this thesis focus on has a number of different actors involved, creating an information flow that is difficult to control and not accessible to all. The system currently used for inbound transport at VGLS is named Atlas, but the problem is that rail transports isn’t integrated into Atlas and is something that is currently being developed. Before Atlas gets fully developed the authors believe it’s important to highlight and present the different information types and functions a system should contain, in order to “solve” as many of the encountered problems.

The solution in form of a new IT-system is supposed to be a complement to Atlas, a parallel system, until the solution is integrated into Atlas itself. The Total solution doesn’t necessarily have to be integrated into Atlas; it can just work as a guideline of the different functions Atlas
should contain once the information flow of rail transportation is developed in Atlas. The actors should use a shared IT-system where information is inserted in order to quick and smoothly share the information between the actors. The actors that should have access to the system are VGLS, VCBC, VTU, TÂ and VTT. The information which is necessary for GC, coming from the other actors, should still be forwarded but what’s more important is that the information coming from GC to the actors is fully integrated into the system. The information from TRV through RFID should also be integrated into the system so all information regarding the transportation flow is compiled, see figure 5-4 for an illustration.

![Diagram of information sharing and a shared IT-system](image)

**Figure 5-4 Illustration of information sharing and a shared IT-system**

### 5.3.2 Detailed description of the Total solution

The system will present all the different transportation flows in Sweden where various Volvo companies operates. The transportation flow that is of interest can provide further information regarding that specific flow. It should be possible to connect e-mail and telephone to the system in order to receive updates on the flow. Previous to this it was mentioned that much of the information that is being sent today or even not being sent is unnecessary, but this system will only provide the most necessary information. The personnel in question who use the system has the option to choose different functions and set personal parameters for what type of information they want to receive on their phone or e-mail. The parameters enable functions such as receiving emergency messages regarding the shipment, for example, if there is a delay.
or if the articles which were ordered aren’t included in the delivery. The system should also be linked to inventory so it can be seen if a container contains a scarce commodity.

The system must contain all information necessary regarding the transportation flow that is currently available from the different actors. This thesis will however only present and refer to the information needed in order to solve the problems previously encountered. It’s important to have an effective search function where wagon ID, container ID, package ID or item number can be searched.

What’s not really associated with the system is the function of who is going to have access to the information. The authors believe that once a working system is running where sharing of information is possible, then anyone working within the previously mentioned companies should have access to it.

The system must be user-friendly since the personnel at the different organizations have various computer skills. This also assumes that the presentation of the transportation flows and the different applications connected to them are presented in a clear manner. It’s very important to make the system user-friendly since the grade of how easily the information is accessible affects the user to share and utilize the information or not (Byström & Järvelin, 1995).

The system will make it possible for information to be divided more quickly between the actors. It will go even faster when the RFID implementation is in place as the information from the RFID readers will go straight into the system and no manual work is needed, such as typing in data into the IT-system. The proposed system with RFID functions can be seen in figure 5-5. According to Bensoussan et al. (2005) the complexity of sharing information can contribute to delays in the sharing of information. This solution removes some of the involvement of people in a system and therefore the sharing of information becomes less complex and hence the delays in the information sharing procedure disappear.
The authors have now presented “how” and “what” a system should contain to meet the challenges that’s been identified. In the next section, various sub-categories will be presented that should be present in the IT-system.

To create an IT-system that solves the identified problems, there are certain functions and applications that a system should meet, below follows the categories that should be included in the system:

- Delays/Deviations.
- Personal Messages between the stakeholders.
- Special events.
- Previous events.
- Forecast.
- Wagon information.
- Container information.
- Article information.
- Scarce commodity information.
- Location/positioning
- Invoice
- Notification messages
- Search function for article, container, and wagon.

These subcategories are intended to cover the questions that sometimes occur between the actors. For example, let’s say that you click on a transportation flow that you are interested of and want further information about. Once you clicked on that flow these subcategories will be present and you will be able to see what wagons are on the move, where they are, what the wagons contain. All this information does facilitate a lot of the workload for the interested.
This solution makes it possible to make quicker decisions as information is received much quicker. A supply chain that is well integrated and share information at a great frequency and with high accuracy increases the possibilities for planning (Prajogo & Olhager, 2012; Stock et al, 1998) and through that the possibility to take actions. In cases where there’s a scarce commodity that is delayed it might be very important to take a quick decision of how to get that article to the factory in the fastest possible way.

For the system to be as effective as possible and in order to be able to obtain greater precision of where the wagons, articles and containers are located it’s important to utilize TRV’s RFID readers once they are implemented. TRV’s readers will tell what zone the train is in. The zone refers to the area between two reading stations, meaning that the more reading stations installed and available, the better accuracy will be obtained. The use of RFID readings also enables to get continuous information about the flow of the transport since the different readers inform the time the train passes them. In order for information to be obtained about any delays the train’s actual passing time should be compared to the time that the train should have passed the station.

Since the RFID tags don’t include information regarding the content of the wagons but only the wagons’ identification number, the IT-system must contain the information about which containers are loaded on what wagon and which articles are contained in the container etc. This shouldn’t be any problem since the different actors in the transportation flow possess all the required information that should be included into the system. Once the RFID tag has been identified and scanned via a RFID reader information such as “when” and “where” should be integrated into the IT-system and be synchronized with the already existing information that Volvo possesses in their system (articles, container, wagon etc.).

5.3.3 Solving problems through Total solution

Below are the earlier four identified problems and how these problems can be solved by means of the Total solution.

5.3.3.1 Problem 1

The solution that was presented earlier to this problem is based on the concept of information sharing through IT-systems. The system used should either be part of the Total solution or be linked to it. This allows all actors within the supply chain to have the information about what cabs that have been loaded onto what wagons, and in what sequence the cabs have been
loaded. Further information can also be obtained about the time of departure, updates using RFID to get information about the location of the train and a deeper understanding of the time aspect in form of delays etc. This improvement will not only make UmeAssistance and VTU’s work more efficient but also improve the working conditions for the staff at TÅ and VTT working with the reception of goods since all the information will be available for them as well in the Total solution. Better information about delays and other form of deviations through RFID will enable TÅ and VTT to plan their respective work better.

5.3.3.2 Problem 2

A system providing the actors with information about delays and deviations make GR and VTU to receive information about major delays earlier, without any involvement of Frakttjänst. This would facilitate the planning of unloading the goods for GR as there will now be more certainty and accuracy of the shipment’s arrival. Although if there are minor delays, GR will still know if the goods are for example 30 minutes late. Previously, GR hasn’t received information about delays and deviations from other functions within VTU, but from the external company Frakttjänst. With the Total solution GR now can access information about delays whenever they need and different form of documents and contact via e-mail and telephone can be eliminated. It also gets easier for GR to see if there is shortage of articles and in what container they are loaded in, making the job easier for GR as they now can manage that specific container first and get it unloaded first.

Whenever there are major delays it’s of great benefit if GR receives information at an early stage about the delay because there may be a need of rescheduling the workload. A reason may be if a transport is delayed there might come two transports at the same time and this will force GR to cope with a heavier workload.

When the RFID implementation is in place and being used, then successive updates will be received about the wagons’ location during the transportation flow. This information will then immediately be received by all actors, GR included.

5.3.3.3 Problem 3

Through the Total solution the manual search of articles during the transport would be eliminated since everyone who has access to the system can see the content of the container, an illustration of the new process for finding articles can be seen in figure 5-6. The searching
The process of finding articles has previously included phone calls back and forth between VTU, VCBC, and GC. VTU calls VCBC to know on what wagon the specific articles are and later VTU calls GC to find out the location of the wagon. All this work will be eliminated with the Total solution since VTU can now automatically through the IT-system find out where their articles are located. Better information about the location of the wagons and articles facilitates the work of the personnel handling the material administration at VTU since they can now plan better. If there’s a short supply being transported and VTU needs information about it in order to make a decision it can now be made faster since the information is accessible and no time will be spent on finding the information, before taking a decision, for example, changing the transportation method. This is in line with previous research; Fisher (1997) argues that through an integrated information chain, a better response capacity can be created within the supply chain.

![Diagram](image)

**Figure 5-6 The new process for finding a specific article during transportation**

Figure 5-6 shows how the information from TRV and VCBC are embedded into the system and the personnel at VTU no longer need to contact the different stakeholders by phone. In extreme scenarios or when the exact position of a wagon wants to be found VTU may still have to contact GC to receive the information. This is depending on the level of RFID implementation.

### 5.3.3.4 Problem 4

What’s already been mentioned in problem 4 applies in this solution. Shared information between the actors allows the actors involved to directly receive information about the delays through the IT-system. Through already set parameters it should be possible to determine whether an emergency message will be forwarded to phone or e-mail. The system should also offer the ability to set the different time intervals, referring to delays, when the emergency message should be sent. Someone might care if the transport is 30 minutes late and wants a notification and someone else maybe only needs notification when the transport is 4 h late etc.
This makes the different actors not needing to contact each other as the system will take care of the information sharing. The system will create a greater reliability than what’s available today and the information will be shared more quickly as different data, in this case delays, will be inserted to the IT-system at the smallest indication. This enables VTU and VGLS to act and make quicker decisions when delays appear. This will create a security for the different actors since the necessary information about the transportation flow will be available at all times.

The future development of the Total solution will be with the help of RFID and its future implementation. Details of the movement of the transport will be available since more reading stations will be available and also create a better understanding of the time issues. Before the implementation is completely finished, the e-mails regarding the deviations being sent by GC can be integrated into the system. These measures will show a drop in the number of e-mails being sent from GC to the other actors and the personnel’s own set parameters in the system determines what type of information that is displayed for them.

An example of a solution could be that someone would like to have information on deviations if it’s greater than 4 hours. The personnel in question specify which flow is of interest and a set a parameter that an emergency message should be sent to its phone or e-mail when there are deviations greater than 4 hours. If a wagon hasn’t been read by an RFID station within 4 hours from the time it should have been read (passed RFID reader) a message is sent, informing about the delay. By the use of the IT-system, delays won’t only be the information provided but there’s also the possibility to check in the system where the last reading took place and thus get information of where the wagon is located.
6 DISCUSSION

This chapter concludes the findings of the thesis and provides multiple discussions on the covered areas of the thesis. The purpose of the chapter is to justify and motivate the various approaches used for each area of investigation. Information on interesting areas not covered prior to this chapter will be discussed as well.

6.1 Conclusion

At the start of the thesis the authors thought that RFID would have a greater impact on the efficiency of the supply chain activities treated. What emerged during the analysis of the empirical data was that the main problem in the supply chain was the sharing of information and that RFID in some cases could be used to improve this process. The reason to the development in this direction was that the authors where not looking for specific problems that could be solved through RFID, but was rather looking for the areas with the larges efficiency possibilities in the supply chain activities examined. RFID solutions are sought to be applied to areas where it would make most effect and contribute to the overall efficiency of the supply chain. The conclusion is that information sharing among the actors in the supply chain has to increase and be more effective, which the Total solution can contribute with.

6.2 RFID’s potential

The use of RFID for tracking the shipments in an already well-functioning information exchange between the actors will only lead for the actors to receive faster and more frequent information. RFID thus creates the conditions to receive information faster, enables quicker decision making and plan better. The authors can’t through this study make a conclusion that the use of RFID will lead to cost savings. Further research is therefore necessary on RFID and if the information via RFID, leading to quicker decision making and better planning opportunities will lead to cost saving for Volvo.

The benefits encountered by the use of TRV’s RFID solution will be faster and more frequent information regarding deviations between the actors. Volvo won’t have to rely on GC to provide information about deviations. This entitles the different functions within the Volvo Group to make quicker and earlier decisions of how to handle deviations. This also applies to decisions of a transport with a short supply since it’s now possible to faster track the article, and based on the information given make a decision if the short supply should continue its
transport with train or not. What’s important to remember is that an implementation of RFID on the transportation flows subject to TRV’s solution will not lead for the transport times to be shortened, i.e., not affecting the tied capital. The only thing that TRV’s RFID solution will contribute with is to provide Volvo with a structured way of sharing information regarding the transportation itself. In some cases, the information could lead to a more daring decision making by reducing the safety stock since there’s a bigger aware of the shipment. The reduction of the safety stocks wouldn’t be possible to any great extent since the safety stocks already are low and the majority of the safety stocks are the things being transported.

In the specific flow the authors have investigated, it has been found out that RFID at lower levels isn’t of any great advantage. This is mainly because of the size of the flow, being quite small, especially the flow between VCBC to VTU. This will most likely contribute to the fact that the cost of an RFID implementation will exceed the savings that can be made. The manual work currently being made for the synchronization works generally well and doesn’t take long time. The manual work for the synchronization takes a little bit more time in the flow between VCBC-VTU, but since the volumes that are being transported are rather small it automatically leads the savings to become quite small in the end. Between VTU and VTT the synchronization is done in between MP-wagons and cabs, where 12 cabs are loaded into an MP-wagon. The process of loading the cabs works smoothly and the authors don’t really see any opportunity for savings here either.

The authors believe in order to achieve greater impact when implementing RFID at lower levels, further research must be made inside the manufacturing process, seeing if there’s an opportunity of starting the RFID tagging prior to the actual transport. This could lead for an entire process to become automated and this may lead to bigger savings.

6.3 Introductory discussion

The thesis was originally meant to focus on a specific problem area within the physical transportation flow, but the authors quickly determined to focus on the information flow in the supply chain. The authors believed there were more improvements to be done compared to the physical transportation flow.

What appeared to the authors was the fact that there must be a careful documentation of the process, prior to identifying problems occurring in the supply chain. In order to still maintain focus on the initial purpose where problems in the supply chain were to be identified the
authors chose a mix. The mix would include identification and the creation of a document illustrating the actual transportation flow but also inform and highlight the problems that arise in the process.

What the authors also have done is to propose various solution efforts in order to solve the identified problems. The identified problems weren’t dealt with on a deeper level, mainly due to prior delimitations. Solving the problems on a deeper level might have created other conditions, such as a presentation in monetary terms and also included time aspects, i.e. how much money and how much time could be saved. Great emphasis has instead been on pointing out the improvements made for each area, such as better opportunities for planning. The authors consider the thesis to contribute with good knowledge of the changes that should be done and the related effects on the supply chain.

The reason for this approach is due to the authors’ view of a long-term investment from Volvo’s perspective. The area covered in this thesis is something that Volvo Group aims to work with for many years to come and develop, until it reaches its full potential. In order to develop and optimize the area it’s important to work with the right conditions and tools. The authors had this in mind as they chose to attack the problem from a different angle than previously thought. If the right conditions aren’t available from the beginning it makes the development process more difficult and the problems get harder to identify and solve. What this thesis has managed to create is a documentation of the transportation flow through process mapping and other theory, creating better conditions for further research and development in the studied area. A number of problems in the supply chain have been identified and analyzed which also have created a good foundation for later research. The authors’ intention is that their work will be used in future development and research where specific problems can be addressed and solved right away on a deeper level, without being forced to map the processes first, which is time consuming.

6.4 Method discussion

The quality of the methods used to accomplish this thesis has been well adapted to the task performed. A qualitative study in form of a case study has been applied as the thesis has studied and investigated a phenomenon in its real life context, where a non-general conclusion can be drawn. Previous research in form of theoretical background within the field has been very difficult to obtain since a case study many times study a particular situation and not a general situation. The area examined including RFID is a relatively new area, both for Volvo
Group and also RFID’s function in the railway transportation system. Interviews and observations have been made since the authors believe that it is the only practical approach to obtain information that reflects reality, considering no previous documentation. It was important for the authors to get an idea of how the transportation works in real life and not only have an image of how it should work.

Patel and Davidson (2003) emphasize how important it is to include data that not only ensures and motivates the authors’ own thoughts but also provide data that supports the opposite. Since the area is relatively unexplored with lack of previous theory and research it has led to the fact that the authors’ own opinions, thoughts and suggestions have been a major part along the thesis, based on the information received from the empirical study. It has been difficult to find information that denies or shows the opposite of our ideas and conclusions but since this is a case study that examines a specific situation and not a general one, there is not much data available. Since the thesis has investigated a certain specific area within the supply chain through a case study, the data collected from the various interviews and observations haven’t been put in relation to existing theory. The theoretical section has been applied in the analysis in order to motivate and further explain the effects of each problem and solution.

By interviewing a number of stakeholders an accurate picture was obtained, that’s mainly because of the possibility to set the various interviews in comparison to each other. In order to confirm or deny the collected data from the various interviews there have been observations made in order to compare the answers from the interviews with the observations by the authors. Secondary data have been applied in such way where it tries to explain the area of RFID and SCM in general, but have later focused and been tied to the core of the thesis as the secondary data has many times proven the effects of better information sharing.

The primary data was ensured once by some of the stakeholders as they got to read some sections of the thesis and provide the authors with feedback. More time would have surely resulted in more interviews and observations to receive a deeper understanding of the problems, but also given the authors more time to spend on the actual solution to each problem. Since the authors chose to study several problems on a superficial level and not in-depth the time frame was sufficient. If research is being made on a specific problem the authors find that more time should be devoted to that specific problem. The identification process itself to encounter the problem should occur at an early stage of the work.
The number of problems encountered was larger than expected which gave the opportunity to focus on a single problem or treat them all on a superficial level, the authors chose the latter alternative. This thesis has therefore been formed in such way that it could facilitate further research as this thesis provides theoretical knowledge about the area in form of process mapping, problems that can be further analyzed but also potential solutions to each of the problems that can be further worked on. The thesis can be used as a template for further research, providing the researcher with theoretical background about the transportation flow, allowing a quicker process of attacking the problem, and thus saving time.

6.5 Problem focus

The analysis of the empirical data and observations made by the authors has raised many interesting thoughts around the studied area. The expectations from the authors’ perspective were that the major problems to be identified would be encountered in the physical transportation flow, not in the information flow. After initial interviews and observations, the authors got the impression that sharing of information didn’t get the chance and opportunity to be shared in a smooth way, both for the receiver and the transmitter. It was also noticed that the available information among the various actors weren’t of interest to everyone which led the actor who was interested in another actor’s information to locate and retrieve the information on their own. The majority of those interviewed have been satisfied with the physical transportation flow and the reason why the authors didn’t choose to look into the physical transportation flow was because the numbers of problems identified were few compared to the existing problems in the information flow. The authors also concluded that the effects of the improvements made in the physical transportation flow wouldn’t do as much impact compared to effects the improvements in the information flow would contribute with.

Another reason that motivated the authors’ decision was the sequence of how a problem is best solved. If the physical transportation flow would be improved at first without considering the information flow it wouldn’t make much of an impact since there would still be gaps in how information is shared between the actors. The authors believe by reversing the sequence where an improvement in the information flow is first applied can automatically create a better physical transportation flow, as the actors now have the necessary information needed to manage the transportation flow more efficiently.
It’s therefore very important to get a well-functioning transportation flow with a good quality of information sharing. Previous theory indicates that it is the information that creates cohesion and connects the various processes within a supply chain into a working flow.

6.6 Analysis discussion

The analysis indicates that a more efficient information sharing and use of RFID can affect the information flow and the transportation flow towards a more efficient direction. The various solutions to each problem and the Total solution have only been developed by the authors themselves on the basis of the collected empirical data. The authors haven’t discussed or investigated deeply if the solutions are applicable in a real-life context. The Total solution is presented and developed as a framework of the utilities that should be included in a future IT-system or Atlas in order to solve the identified problems. The identified problems have been of highest priority since they need to be solved while the solutions related to each problem have been more of a suggestion of how the problems can be solved in a smooth manner.

The reason why monetary terms haven’t been used to further describe the effects of the proposed solutions is due to the reason that the efficiencies proposed has been more of a prevention to avoid arising problems. It’s difficult to put a specific value of knowing for example where the articles are located during the transport since it doesn’t have a value as long as the traffic moves like it should. When deviations arise in the transportation flow, the information regarding the positioning of an article appears to be very important since certain decisions can be made faster.

The proposed improvements developed by the authors and the impact they make on the information sharing have been consistent with previous research in the area of SCM. The authors have identified effects such as faster response, better planning opportunities and therefore also the opportunity of potential cost savings. The thesis has also shown the importance of more automated information sharing in order for the information to reach out quicker. Throughout the work it has been seen that delays and deviations trying to be handled through different procedures has led to problems within the supply chain. Therefore it’s important to get a solution where the processes are being followed and a solution that is less dependent on a person to follow a certain routine.
What’s important to mention is that the identified problems in this transportation flow may also exist in flows between other Volvo factories. A solution in the direction of the one presented in this thesis can thus improve information sharing between actors in other flows. The solutions might have a greater impact for VGLS and other actors of the ones just seen in this thesis. Since this is a qualitative study it’s difficult to apply any general conclusions but the authors mean that it may be interesting to look upon other flows in order to see if there’s any resemblance.

One problem regarding the Total solution might be that certain type of information may be sensitive to share to other actors in the supply chain. The authors consider this to be a minor issue since the primarily sharing of information will be between Volvo Group companies and therefore the information being shared has a smaller risk of harming any of the actors. The other problem is that the information being obtained from GC and TRV is already available, but is provided through other communication methods today, e.g., e-mail. The biggest change is the development of an IT-system in order to facilitate the sharing of information, not to create sharing of information that is sensitive to share. This is important to point out as information between the actors stop at some point because of the poor ability to share and receive information, and is only sent and received when problems arise, i.e., the sharing of information doesn’t flow naturally and is rather forced to work when problems arise.

6.7 Selection of theory

“What”, “when”, “where” and “why” are the questions the technique behind RFID tries to explain and that’s the reason why the authors chose to direct the theory towards SCM, in particular information sharing. RFID is made to collect data and if this data isn’t shared in an optimal way between the actors and being reached it’s of no use. As mentioned earlier the authors found that the information sharing didn’t work in an optimal manner and it was therefore important to develop a framework for the improvements that need to be done. The authors believe that the theory section that has been taken into account is of great importance for the work in general as it many times justifies and motivates the different effects of better information sharing.

6.8 Other actors

The authors have been in contact with TRV and GC in order to seek their views and attitudes towards RFID. What came out was in particular that TRV is investing heavily on the use of
RFID in order to make it more efficient for them but also to provide better service concerning
the rail transportation for transportation service providers. During a discussion with TRV they
pointed out the importance of being involved at an early stage of the RFID project as it creates
a bigger opportunity for the involved actor to make decisions about the coming development
and create various demands. An example could be for the involved actor to choose the
functions and applications included in the system but also the location of the RFID-readers.
This allows the authors to believe that it is very important for VGLS to actively collaborate
with TRV.

The information received from GC and their attitude towards RFID is positive, it can be said
that the ball so far is on TRV’s court and they have to act first by implementing the system,
before GC can take the next action. GC is positive concerning the tagging of their wagons in
order to utilize the RFID system and this makes it beneficial for Volvo once RFID will be
applied on wagon level and reading of the wagon will occur.

The authors find it very encouraging that both the major actors that Volvo is dependent on are
positive towards RFID and the benefits that follow with it. This allows the actors together to
reach their goal in a smooth way, without any obstacles regarding their attitude.

The theory section includes information about TRV’s initiative regarding RFID but isn’t
analyzed, since the problems identified weren’t directly related to the data collected from
TRV. The authors chose to include TRV’s initiative and thoughts regarding RFID since
Volvo is interested in the ongoing process and wants information of how the process is
proceeding. Sections about TRV have been mentioned in this section as it will play a big role
for the future implementation to come. TRV is the main actor in the RFID chain as they are
the provider of the technique and infrastructure related to it. Information concerning them
directly affects Volvo’s future initiative and that motivates the reason for having the section
of RFID and TRV.

6.9 Identified efficiency areas not included in the analysis

The authors have encountered a few problems which aren’t highlighted in the thesis. The
reason why the problems didn’t get addressed in the thesis was because a solution to each of
the non-mentioned problems and efficiency areas was too difficult to enforce, didn’t have a
potential in the transportation flow studied or didn’t have a connection with the information
flow and RFID.
6.9.1 Wagonload system VCBC - VTU

One of the non-addressed problems is the wagonload system between VCBC and VTU. As the transportation flow is rather small compared to other flows it’s not economically feasible to use a block-train. The problem with the wagonload system is that is sometimes takes two days and sometimes three days to transport the articles. This makes VTU to not be very sure of how long the shipment takes; to be on the safe side VTU must have a safety margin on three days. The safety margin on three days makes VTU to sometimes tie up capital unnecessarily. Further efforts should be made according to the authors in order to get a better precision concerning the wagon load system. One of the reasons this problem wasn’t analyzed and emphasized was because RFID wouldn’t be able to provide any type of solution to the problem.

6.9.2 Transportation of empty racks

The transportation of articles between the locations usually goes with fully loaded containers but on that way back the containers aren’t fully utilized. On the way back the containers aren’t fully loaded since the racks aren’t loaded with any articles and thus need less space. This allows the containers to carry other types of goods on the way back since there is space available. In the flow between VTU and TÅ a solution has been looked at where discussions have been made regarding transportation of cars from TÅ back to VTU. This allows the cost of the total transportation to decrease since other actors take use of the transportation. What’s not to forget is that it will be more time consuming since the train might have to stop at different locations along the way and the loading will take longer time as there are cars involved and not only empty racks. This solution might be applicable in the flow between VTU and TÅ since the production level isn’t on maximum capacity. The authors believe it can be interesting to make further studies in this area where collaborations between different companies can be made to share the same transport and thus reduce their costs. Earlier attempts have been made by Volvo in order to utilize the empty wagons. The attempts haven’t reached their expected potential since it hasn’t been cost efficient, but also because VGLS has stopped their outbound collaboration with VCC. Another reason is that the wagons used in the flows aren’t optimal for carrying other type of material and goods since in comparison to a regular truck.
6.9.3 RFID tags on container and article level

Since the thesis has focused on the use of RFID, different thoughts related to the use of RFID technology have been looked at along the way. The proposed solutions haven’t currently been suitable and discussed for implementation. One proposal of a solution was that VCBC, VTU and TÅ would all install an RFID-reader near the tracks where the train departures from, in VTU’s case that would be at the shunting yard. The idea was that the technology would synchronize container with wagon so it wouldn’t be done manually. Further examination in form of interviews and observations later showed that there weren’t any actual problems concerning the manual registration, but rather a problem in the information flow to spread the information about the synchronization. The reason why the authors started to investigate the solution where Volvo’s own RFID-readers would be implemented and make reading to synchronize container and wagon was because they thought the human error would be much greater than it really was. The transportation flow between the locations is quite small and therefore wouldn’t an implementation of the RFID-readers pose a significant time saving and according to the authors probably cost more than it would give.

Looking at problem 1 alone when the loading of cabs are done at the shunting yard in Umeå by UmeAssistance there could have been other solutions to that problem. UmeAssistance could have integrated computers in the fork lifts they use to load the cabs into the wagons. With the computers inside the fork lifts UmeAssistance could synchronize the wagons with the containing sequence of cabs. Later it was found out by the authors that the process of synchronizing wagons with the loaded cabs wasn’t too time-consuming and therefore once again it would cost more than it would give. The solution provided in the analysis section would have a greater impact contra the solution with the computers inside the forklifts.

In order for a system with RFID-readers and tags to be beneficial on a container level, there must be deficiencies in the solution used today. The authors couldn’t identify and trace any deficiencies in this flow regarding the manual synchronization.

Another idea the authors looked into was the tagging of single articles which would eliminate much of the manual work spent on the synchronization between article-rack and rack-container. In this area there are big opportunities for an RFID implementation to be successful and provide significant benefits. The authors chose not to focus on this issue since the thesis wanted to focus on the transportation of articles and secondly, a solution as the one mentioned above would need to look more into the internal processes and activities at each factory. In
order to start up an RFID implementation it might be wise to start on the upper level (wagon) and slowly work downwards to a detailed level (articles). There is a big difference between the upper level of tagging and the bottom level of tagging. An example in the flow between VCBC-VTU is that there are two wagons sent each time by rail. The system, including RFID technology must cope to identify 2 wagons at first. Once this is done it’s time to go down to container level which means the identification of 4 containers, 2 on each wagon. Next level is rack level where it can be around 30-40 racks and last level is article level where it can be around 300 articles being sent and has to be tagged. It can here be seen that the number escalates for every level that needs to be tagged, from wagon to article level. It’s therefore very important to have a fully working system on a wagon level before developing the system for lower levels, such as container, racks and articles. If problems occur regarding the identification of wagons, the levels below it will encounter problems as well.

The authors suggest that the next step in the process should be to look into solutions where RFID can be utilized on the synchronization of container and article level. Once the synchronization on a container and article level is applied it’s also important to look into the manufacturing process, since RFID can be applied in that stage as well. By applying RFID throughout the whole supply chain and not only the transportation flow it enables the fact to make both the manufacturing process and loading of articles more efficient. In order to utilize RFID in the best possible way it should be used on article level as it is important from an economic perspective to look at as many efficiency areas as possible since there are many tags to be installed.
REFERENCES


**Personal sources**

*Bertil Axbom* – VGLS

*Erik Påhlsson* - TÅ

*Ewa Nordström* - VGLS

*Fredik Engblom* – VGLS

*Lennart Andersson* – TRV

*Malin Mattson* - VTU

*Martin Wettemark* - VGLS

*Peter Samuelsson* – VGLS
APPENDIX 1 INTERVIEW QUESTIONS

Trafikverket

- How are the plans going regarding the implementation of RFID?
- How many RFID-readers will TRV install?
- Will there multiple RFID-readers installed on one route?
- Where will the RFID-readers be located?
- What type of data will the readers provide?
- Will the provided data from the readers later be sent to the transportation service provider?
- Will TRV provide an IT-system that handles the data and translates it to information?
- Will you share the information that your customers demand?

Olofström

RFID:

- In what areas can more profit be created through RFID?
- Which manual labor has the greatest potential of becoming automated?

Container/traceability:

- Are the containers traceable? If no, would traceability facilitate the transportation flow?
- Does it occur that a container that was supposed to be sent or received haven’t been sent or received?
- How is wagon-container-rack associated with each other?
- Does it occur that a container “disappears”?

Racks:

- What type of information does the Odette flag attached to the racks provide?
- Do the body components or cabs connect with the belonging rack in any sense? If yes, how is this done?
- If traceability would be possible for the racks, would the number of racks decrease?
Transportation flow:

- If a transport is delayed to VTU, how will VTU be affected?
- Are there times when VTU must wait for the transport to arrive?
- How often are the transports from/to VCBC handled by trucks? What’s the main reason for this?
- How many wagons and trains are being sent to VTU every day?
- Number of MP-wagons? What flows and purposes are MP-wagons used for? Are you overall satisfied with the MP-wagons?
- Cycle time for the different routes?
- Deviation situation?
- Safety stock?
- How many trains and wagons departure to VTT from VTU every day?
- The undercarriages/racks, are they being sent back every day as well? Do they get sent back on the same train and wagons?
- Are the MP-wagons being used in another transportation flow or is it a closed flow?

Loading/Receiving:

- How does the reception of goods look like at VTU? How is the goods handled once received at VTU?
- How large stocks of body components does VTU have?
- Does it occur that the containers don’t contain what they are supposed to? If yes, what’s the reason?
- How does the goods reception at VTU control the arrived cargo?
- Which manual labor is most time-consuming in relation to the consignment of goods and where most problems occur?
- How does the consignment of empty racks between VTU and VCBC look like?
- Are the swap bodies sent back to VCBC?
- How does the process of loading the cabs into MP-wagons look like?
- If problems occur in the loading of cabs, what are they and why do they occur?
- Number of MP-wagons per dispatch?
- Number of cabs in each MP-wagon?
- Where does the goods reception take place when the body components arrive at VTU?
• How does the goods reception make sure that everything is sent from VCBC and nothing is missing?

Information sharing:

• When and how provides/receives VTU information about the dispatch from/to VCBC?
• How does the information sharing look like today between VTU and VCBC?
• Is the information sharing similar between VTU and VTT?
• Order entry, rolling basis or planned?
• Prior notice to VTU? How is it done and what does it include?
• Prior notice to VTT?
• When empty racks are sent back from VTU, does VCBC receive any type of message about the racks being sent back?
• How does your relationship with GC work?
• What kind of complaints do VCBC receive from VTU?

Others:

• How does the relation between VTU, VCBC, VTT, TÅ, VGLS, GC and TRV work?
• How does the payment process look like between the different actors in the supply chain?

Umeå

RFID:

• Any plans of changing the Odette flag for RFID?
• In what areas can greater profit be made through RFID?
• Which manual labor has the greatest potential of becoming automated?
• When will full implementation of RFID be in place between VCBC and VTU?
• Number of RFID-readers and where will they be located?
• What results and improvements are you expecting with respect to the coming implementation of RFID?
• Do you believe TRV wants to read containers as well and not only wagons?
Container/traceability:

- Are the containers traceable? If no, would traceability facilitate the transportation flow?
- Does it occur that a container that was supposed to be sent or received haven’t been sent or received?
- How is wagon-container-rack associated with each other?
- Does it occur that a container “disappears”?

Racks:

- What type of information does the Odette flag attached to the racks provide?
- Do the body components or cabs connect with the belonging rack in any sense? If yes, how is this done?
- Are the racks used for specific articles and are the racks always fully loaded?
- If it’s possible to trace containers and decrease their cycle time (number of containers used), would it be possible to decrease the number of racks used as well?
- If traceability would be possible for the racks, would the number of racks decrease?

Flow VCBC-VTU:

- If a deliver is delayed to VTU, how is VTU affected by that? Are there times when VTU are waiting for the delivery without the knowledge of it being late?
- Are there any locations where the wagons or containers are reloaded in some way?
- How often are goods transported by trucks? What’s the reason?
- Are the containers in the flow between VCBC and VTU used for another flow?
- Number of containers in the flow? Cycle time for a container?
- How many wagons and trains depart every day between the locations?

Transportation flow:

- If a transport is delayed to VTU, how will VTU be affected?
- Are there times when VTU must wait for the transport to arrive (delays/deviations)?
- Is there any location between VCBC and VTU during the actual transport by train where wagons and containers have to be unloaded/loaded again?
• How often are the transports from/to VCBC handled by trucks? What’s the main reason for this?
• How many wagons and trains are being sent to VTU every day?
• Number of MP-wagons? What flows and purposes are MP-wagons used for? Are you overall satisfied with the MP-wagons?
• Cycle time for the different routes?
• Deviation situation?
• Safety stock?
• How many trains and wagons departure to VTT from VTU every day?
• The undercarriages/racks, are they being sent back every day as well? Do they get sent back on the same train and wagons?
• Are the MP-wagons being used in another transportation flow or is it a closed flow?

Loading/Receving

• How does the reception of goods look like at VTU? How is the goods handled once received at VTU?
• How large stocks of body components does VTU have?
• Does it occur that the containers don’t contain what they are supposed to? If yes, what’s the reason?
• How does the goods reception at VTU control the arrived cargo?
• Which manual labor is most time-consuming in relation to the consignment of goods and where most problems occur?
• Number of racks in each container? How does it work?
• Number of containers for each consignment?
• How is the synchronization done between the containers and the racks that go with them?
• When does the VCBC report VTU about the consignment and what type of information is received by VTU?

Information sharing:

• When and how provides/receives VTU information about the dispatch from/to VCBC?
• How does the information sharing look like today between VTU and VCBC?
• Order entry, rolling basis or planned?
• Prior notice to VTU? How is it done and what does it include?
• Does VTU receive information regarding the content of each wagon and container?
• When empty racks are sent back from VTU, does VCBC receive any type of message about the racks being sent back?

Others:

• How does the relation between VTU, VCBC, VTT, TÅ, VGLS, GC and TRV work?
• What’s the relationship between the synchronization and identification of article, rack, container, wagon and train?
• Cost of a container and the maintenance?
• Cost for a wagon?
• How does the payment look like between the actors, who pay who?
APPENDIX 2 TRAFIKVERKETS DETECTOR-LOCATIONS